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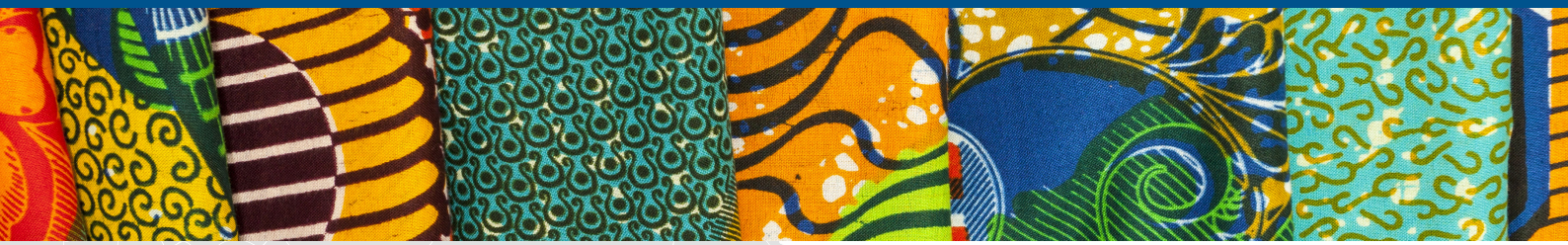

PROMOTING COTTON BY-PRODUCTS

In Eastern and Southern Africa

Synthesis Report on Cotton By-Product in Eastern and Southern Africa

July 2019

Project: 1617K - Funded by the United Nations Development Account - 2016-2019

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Geneva, July 2019

Acknowledgements

UNCTAD commissioned this study as part of United Development Account Project 1617K "Improving the value added of cotton products in Eastern and Southern Africa (ESA)". The synthesis report will inform the indicators on financial viability of investing in some cotton by-products identified in each participating country. Furthermore, the report will share lessons gained during the implementation of the project in the participating countries. The synthesis report has been written by Mr. Stephen Kabwe who is a Senior Research Associate of the Indaba Agricultural Policy Research Institute of Zambia. The report was developed based on the four cases studies of investment profiles for cotton by-products from Uganda, Zambia and Zimbabwe:

- Nalumu, Rebecca (2019b). Investing in Uganda's Cotton By-Products: From Cotton Growing to Value Added Absorbent Cotton Wool. UNCTAD Report for UIA. Geneva. Switzerland
- Nalumu, Rebecca (2019b). Investing in Uganda's Cotton By-Products: Biomass briquettes and Pellets Production from Cotton Stalks and Other Biomass Sources. UNCTAD Report for Uganda Investment Authority (UIA). Geneva. Switzerland
- Hamusimbi, Coillard (2019). Zambian Cotton and Cotton By-Products: Cotton Stalks and Other Biomass Processing into Pellets and Briquettes Investment Profile. UNCTAD Report for Zambia Development Agency (ZDA). Geneva. Switzerland
- Hove, Chikukwa Agnes (2019). Value Addition of Cotton By-Products in Zimbabwe: Biomass Pellets and Briquettes Processing from Cotton Stalks Investment Profile. UNCTAD Report for ZIA. Geneva. Switzerland

The Author is also grateful to cotton value chain stakeholders from participating countries who provided lessons on the project activities and also on their respective cotton sector's performance. Furthermore, the author acknowledges the immense feedback provided by participants at the regional Cotton by-product Workshop in South Africa. The study was supervised by Mr. Kris Terauds, Economic Affairs Officer, Commodities Branch, UNCTAD, under the general supervision of Ms. Yanchun Zhang, Chief, UNCTAD Commodities Branch.

While due care was taken in compiling this report any errors and omissions remain the author's responsibility. This report has not been edited.

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Note

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Executive Summary

The importance of the cotton sector in Eastern and Southern African countries like Uganda, Zambia and Zimbabwe cannot be overemphasized. The sector is the source of income for many smallholder farmers who grow the crop, therefore has the potential to fight poverty and income inequality among rural populations, women and youth. Furthermore, the entire cotton value chain is a source of revenue for the economies of the three countries. In all the countries, lint - the primary product - has faced stiff competition from synthetic fibres, and this has undermined the profitability and performance of the cotton value chains.

Several studies have revealed that there are many opportunities to systematically develop the cotton by-product value chains in the three project countries. For example: population growth steadily increases demand for necessities like edible oil, fuel and absorbent cotton products; widespread dependence on charcoal represents an opportunity for cleaner, more efficient biomass fuels; and a vibrant livestock sector demands seed meal for feed. Furthermore, governments prioritize cotton as a key crop for textile industry development, job creation and economic development. However, the cotton value chain has not realized its full potential. Therefore, further investment and policy support is needed to tackle the various challenges that may hinder the development of the by-product value chains.

In the context of UNCTAD's technical assistance project, "Promoting cotton by-products in Eastern and Southern Africa", this report evaluates the investment potential of some key cotton by-products prioritized by the project countries Uganda, Zambia and Zimbabwe. The evaluation shows that the four proposed investment projects – including biomass briquettes in all three countries and absorbent cotton wool in Uganda – are profitable ventures, with positive net present values (NPVs).

However, the success and sustainability of the proposed cotton by-products projects requires that cotton by-products are not treated in isolation from the rest of the chain. This is because of the shared reliance of cotton-related industries on a common source of raw material. Therefore, improving production and productivity of seed cotton should be a priority in the participating countries. This can be achieved through training of farmers in good agricultural practices. Furthermore, governments should be encouraged to increase spending on public goods, such as infrastructure and research. This may help the sectors to cope with various risks associated with climate change, such as drought, floods and pest infestation. As demonstrated, cotton is a strategic crop in all the three countries, so governments must be encouraged to ensure an enabling environment for private sector investment. The creation of industrial parks, such as those in Uganda and Zambia, should also be encouraged and supported.

List of Acronyms

CIRCOT.....Central Institute for Research on Cotton Technology
CDO.....Cotton Development Organization
COMESA.....Common Market for Eastern and Southern Africa
ECA.....Economic Commission of Africa
ESA.....Eastern and Southern Africa
GDP.....Gross Domestic Product
GoU.....Government of Uganda
GoZ.....Government of Zimbabwe
GRZ.....Government of the Republic of Zambia
IRR.....Internal Rate of Return
LCMS.....Living Conditions and Monitoring Survey
MAAIF.....Ministry of Agriculture, Animal Industry and Fisheries
MEMD.....Ministry of Energy and Mineral Development
MoA.....Ministry of Agriculture
MoE.....Ministry of Energy
MT.....Metric Tonnes
NAP.....National Agricultural Policy
NDA.....National Drug Authority
NIP.....National Investment Plan
NPV.....Net Present Value
NTEs.....Non-Traditional Exports
SATU.....Serere Albar Type of Uganda
SMEs.....Small and Medium Scales
SNDP.....Seventh National Development Plan
SSA.....Sub-Saharan Africa
TPD.....Tonnes Per Day
UGX.....Uganda Shillings
UIA.....Uganda Investment Authority
UNCTAD.....United Nation on Conference and Trade Development
ZDA.....Zambia Development Agency
ZIA.....Zimbabwe Investment Authority
ZIMRA.....Zimbabwe Revenue Authority

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1. Introduction

1.1 Background

Cotton remains an important crop in Africa, especially for producing countries such as Uganda, Zambia and Zimbabwe. Cotton production is undertaken by more than two million rural households in Sub-Saharan Africa (SSA) and between 500,000 and 750,000 households in Uganda, Zambia and Zimbabwe, for whom it is a primary source of income (GoZ 2014, GRZ, 2017). Its production is more widespread with the involvement of a large number of subsistence farmers. The heavy involvement of smallholder farmers means that the effect on rural poverty is greater and felt more widely (Buka 2016, Lugojja 2017, Kabwe 2018, and Tschirley 2009). Furthermore, the sector generates export revenues for governments, as well as employment and incomes for families, particularly in rural areas of Eastern and Southern Africa. For example, in Zambia, the cotton value chain up to ginning level employs over 1,000 permanent and approximately 10,000 seasonal workers. The cotton sector also generates over US$ 60 million in lint exports and accounts for 16 per cent of Zambia's annual non-traditional exports (NTEs), valued at US$ 203.1 million in 2017. In 2016 cotton contributed about 0.3 per cent to Zambia's gross domestic product (GDP). At its peak, cotton contributed up to 1.45 per cent to national GDP in 2012 (Kabwe 2018, Hamusimbi 2019). While in Zimbabwe the cotton value chain employees over 6,800 workers in the front line of the value chain and the sector has been contributing below 2 per cent to GDP of the country (GoZ, 2014, Buka, 2016). In Uganda, the cotton value chain employs a total of 2.5 million people, directly and indirectly, in the production and marketing of its primary products, such as textiles and garments, as well as its by-products, such as soap, edible oil and animal feed (Lugojja 2017). The cotton value chain contributes about US$ 31.6 million to the economy of Uganda.

Although cotton is primarily used for lint, several by-products can be derived to increase value added, to the benefit of a variety of actors, including farmers, traders and processors and governments. Cotton by-products include: edible oil from cottonseed, cake used for animal feed, soap manufacturing, and waste used for industrial applications, such as polishing cloths and wipers. In addition, particle boards, pulp, paper, corrugated boxes and fuel pellets/briquettes all can be produced from cotton stalks (See Figure 1).

1.2 Knowledge Gap

Despite the value-added potential they represent, cotton by-products are underdeveloped in Africa, including 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) and its regional partners, the United Nations Economic Commission for Africa (UNECA) and the Common Market for Eastern and Southern Africa (COMESA), designed a project to address some of these challenges, in particular to fill the data and policy gaps that restrained the development of cotton by-products industries in the region and implemented in Uganda, the United Republic of Tanzania, Zambia and Zimbabwe.

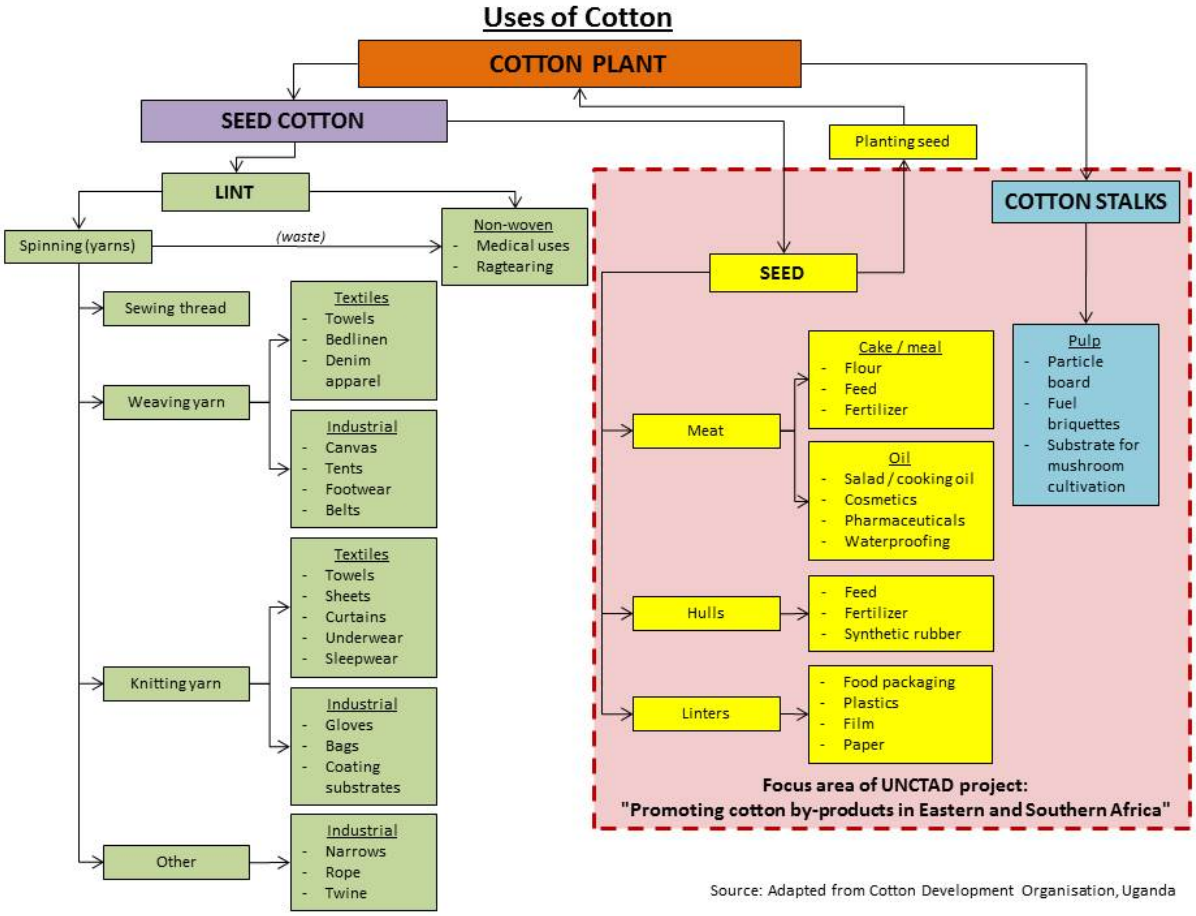
1.3 Objectives and Scope of the Study

The study aims to increase the value added to cotton by-products. Specifically, the report aims at synthesizing the investment profiles on briquetting/pelleting and absorbent/surgical cotton wool developed in order to attract investments in these cotton by-products in Uganda, Zambia and Zimbabwe.

In the context of project activities, the United Republic of Tanzania did not produce investment profiles, therefore the report does not include any information about the technologies that were identified there.

The remainder of the paper is organized as follows: Section 2 discusses the approach and methodology of data capturing and in Section 3, performance of the cotton sectors of Uganda, Zambia and Zimbabwe are presented. Section 4 synthesizes the investments profiles of the technologies identified and the rationale for their selection in each participating country. Section 5 presents the key lessons learnt, testimonials from stakeholders that went to India for a study tour, and some aspects of South-South cooperation in the participating countries. Section 6 discusses the conclusions and recommendations.

Figure 1: Cotton By-Product Value Chain Diagram



Source: Adapted from the Cotton Development Organization, Uganda

2. Approach and Methodology

The approach and methodology were based on the desk review of different project documents and specifically the investment profile reports drafted in each of the participating countries (Uganda, Zambia and Zimbabwe). Other sources of information were the stakeholders' interviews with the participants of the Indian study visit and other cotton stakeholders in participating countries respectively. Table 1 summarises the activities that were done in the process of capturing the data used in the report:

Table 1: Schedule of Data Collection Activities

Activities	Date
Review of materials and write-up (e.g. investment profiles)	18 February – 15 March, 2019
Develop interview guides for the focal point persons and also associations/cotton boards	4-8 March, 2019
Interview focal point persons, and personnel from association and cotton boards from participating countries	24 – 29 March, 2019

3. Performance of the Cotton Sectors in Participating Countries

Cotton is an important cash grown in Uganda, Zambia and Zimbabwe. However, the performance of the cotton sectors of these countries have fluctuated over the years due to various factors ranging from weather conditions, price expectations and the cost of farm inputs provided (Hamusimbi 2019, Hove 2019, Shinyekwa 2018). Nevertheless, cotton remains the major smallholder cash crop and is key to socio-economic growth for these countries. Currently, cotton is grown mainly for lint in all the three countries, but there is potential for the development of the cotton by-products. Subsections below summarize the current cotton production, processing and marketing dynamics. Furthermore, the section summarizes key challenges and opportunities experienced along the cotton value chains in the respective countries.

3.1 Cotton Production

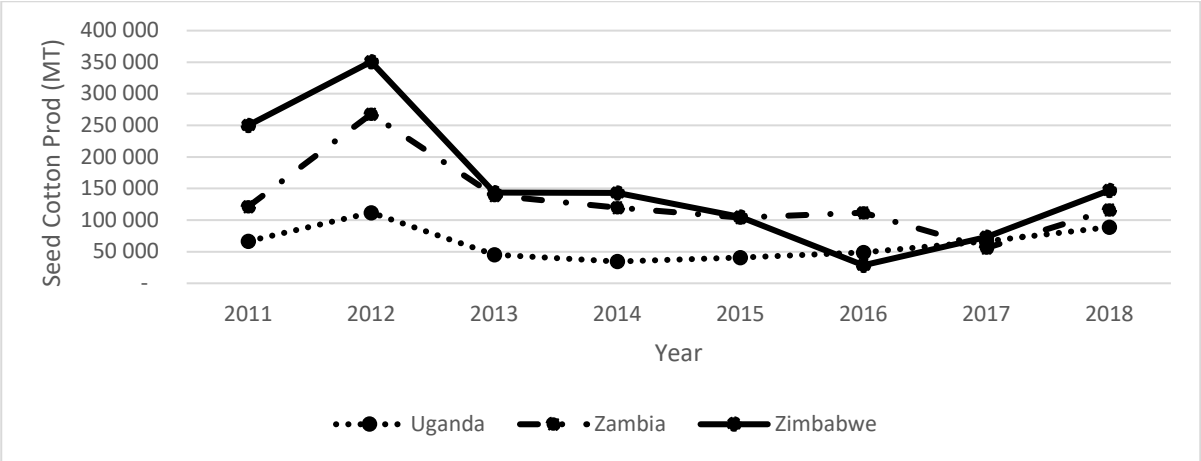
Seed cotton production is key in the cotton by-product value chain developments. Seed cotton production varies from year to year in Uganda. For instance, from 2008 to 2009, total area under cultivation reduced from 101,215 ha to 68,000 ha, before increasing to 80,000 hectares (ha) in 2010 (MAAIF, 2010). The area has since increased to 109,312 ha by 2017 according to preliminary estimates by the Cotton Development Organisation (CDO). Since 2012 to 2019 agricultural season, seed cotton production ranges from 111,900 metric tonnes (MT) to 34,500 MT, with an average of 65,600 MT (see Figure 2). This shows that production has been fluctuating and it is also important to note that cotton production has not reached its historic peak of the late 1960s. In fact, production is still far below the estimated potential of 440,500 MT of seed cotton, based on assumption of full employment and achieving the yield potential of seed varieties (MAAIF, 2010).

While in Zambia, area under seed cotton has vacillated from as low as 113,000 ha in 2017 to as high as 298,000 ha in 2012. The average area during this period (2011 – 2018) was around 154,800 ha (MoA 2018). The performance in terms of yield has also been below the potential of all the cotton seed varieties grown in Zambia. During the eight-year period, seed cotton production ranged from as high as 267,000 MT in 2012 and as low as 55,000 MT recorded in 2017 (Figure 2). The average yield of seed cotton between 2011 and 2018, ranged from 490 kg/ha in 2017 to as high as 970 kg/ha in 2011 with a national average of 850 kg/ha (Kabwe 2018).

Zimbabwe's cotton production reached a record high of 350,000 MT of seed cotton, or 140,000 MT of cotton lint, in 2012, as shown in Figure 2, then dropped to its recent low of 29,000 MT in 2016. However, seed cotton production is since on an upward trend. Average seed cotton yields have declined from a high of 1,098 kg/ha in 2004, to a low of 519 kg/ha in 2016. Yields recovered to 600 kg/ha in 2017 (Hove 2019, AMA, 2017).

All three countries record the highest seed cotton production in 2012 because of a relatively high price offered to the farmers in 2011 season. However, Figure 2 shows a downward trend in seed cotton production even though the rate of decrease was higher in Zimbabwe than the other two countries (2013-2016). Since 2014, 2017 and 2018 there has been a positive growth in seed cotton production in Uganda, Zambia and Zimbabwe. The positive growth in seed cotton production seen in the later years is attributed to relatively higher nominal price paid for seed cotton to farmers and deliberate government initiatives to increase productivity through supply of pesticides, herbicides, fertilizers, and seed to farmers, especially in Uganda and Zimbabwe (UIA 2019, Hove 2019).

Figure 2: Seed Cotton Production in MT (2011 – 2018)



Source: Hamusimbi, 2019, Hove, 2019 and UIA, 2019

3.2 Value Addition

Lint and cottonseed oil/cake are the main products from seed cotton in the three project countries. At average ginning outturn rates, seed cotton is separated into approximately 40-42 per cent lint and 55 per cent cottonseed, with the balance as waste.

Established value chains exist for both lint and cottonseed. Lint is the primary product of cotton and is transformed by the textile industry into yarn, textiles, garments and apparel, as well as into absorbent cotton wool. Among the three countries, only Uganda and Zimbabwe have some form of value addition into yarn and garments/apparels, which has resulted in the consumption of 5 per cent or less of the lint produced. Zambia's once-thriving textiles and clothing industry has collapsed, opening up the country to imports, including of second-hand clothes. Enhanced and thriving textile and clothing industry is needed to help these countries industrialize and lengthen their cotton value chain. This may help catalyse cottage handloom businesses, especially in rural areas, and help create wealth for cotton, textile and apparel value chain players.

Meanwhile, cottonseed is a by-product that can be processed into four products, namely: edible oil, cottonseed cake, cotton husks, and soap. There are millers adding value to the cottonseed oil/cake and this value chain is developed in all the three countries.

Stalks are a cotton by-product with newly identified commercial potential. The cotton stalks are currently unutilised in all the three countries, as farmers destroy them, either by burning them in the field or as wood fuel, to comply with pest management regulations (Hamusimbi 2019, Hove 2019, UIA 2019). Cotton by-products can have a significant impact on the economic benefits of cotton as a crop enterprise. One of these creative ideas is the production of biomass briquettes and pellets from cotton stalks. Briquettes can be used in industrial boilers and pellets in household stoves or restaurant cookers.

3.3 Industry Challenges

Key challenges that may affected the development of the cotton by-product were identified in all the three countries and these are:

a) Low production and productivity of seed cotton has been singled out as the main threat to the development of cotton by-products (Hamusimbi 2019, Hove, 2019, Shinyekwa et al., 2018). For example, yields have remained low ranging from 220-850 kg/ha, against the yield potential of 2,000 kg/ha and 1,500 kg/ha for seed varieties in circulation in Zambia and Zimbabwe respectively (Hamusimbi 2019, Hove 2019, Shinyekwa et al., 2018). Several factors contributing to low yield and production of seed cotton include:

(i) Climate change, which has resulted in irregular rainfall patterns;

(ii) Low seed cotton prices and reduced profit margins, motivating farmers to plant more profitable crops such as soybeans, maize, tobacco and rice; and

(iii) Reduced pre-financing due to increasing input loan default rates, in particular in Zambia and Zimbabwe.

b) Imports of cheap refined or semi refined cooking oil in the countries affecting the demand of locally produced cooking oil, including cottonseed oil, undermining the growth of the edible oil industry;

c) Lack of appropriate and inexpensive technology to develop cotton by-products on commercial basis such as particle boards, briquettes/pellets. Furthermore, the continued reliance on foreign technology for processing cotton by-products may affect the steady and sustained development local industries;

d) Inadequate financial platforms that can provide affordable finance may dissuade small and medium scale entrepreneurs from investing in cotton by-product industries;

e) A lack of appropriate skills among players along the cotton value chain; and

f) Inadequate infrastructure development, such as properly maintained feeder roads, which increases transaction costs for rural farmers.

3.4 Sector Opportunities

There are a number of unexploited investment opportunities in productivity enhancements and improved value-added by-products in all the three countries.

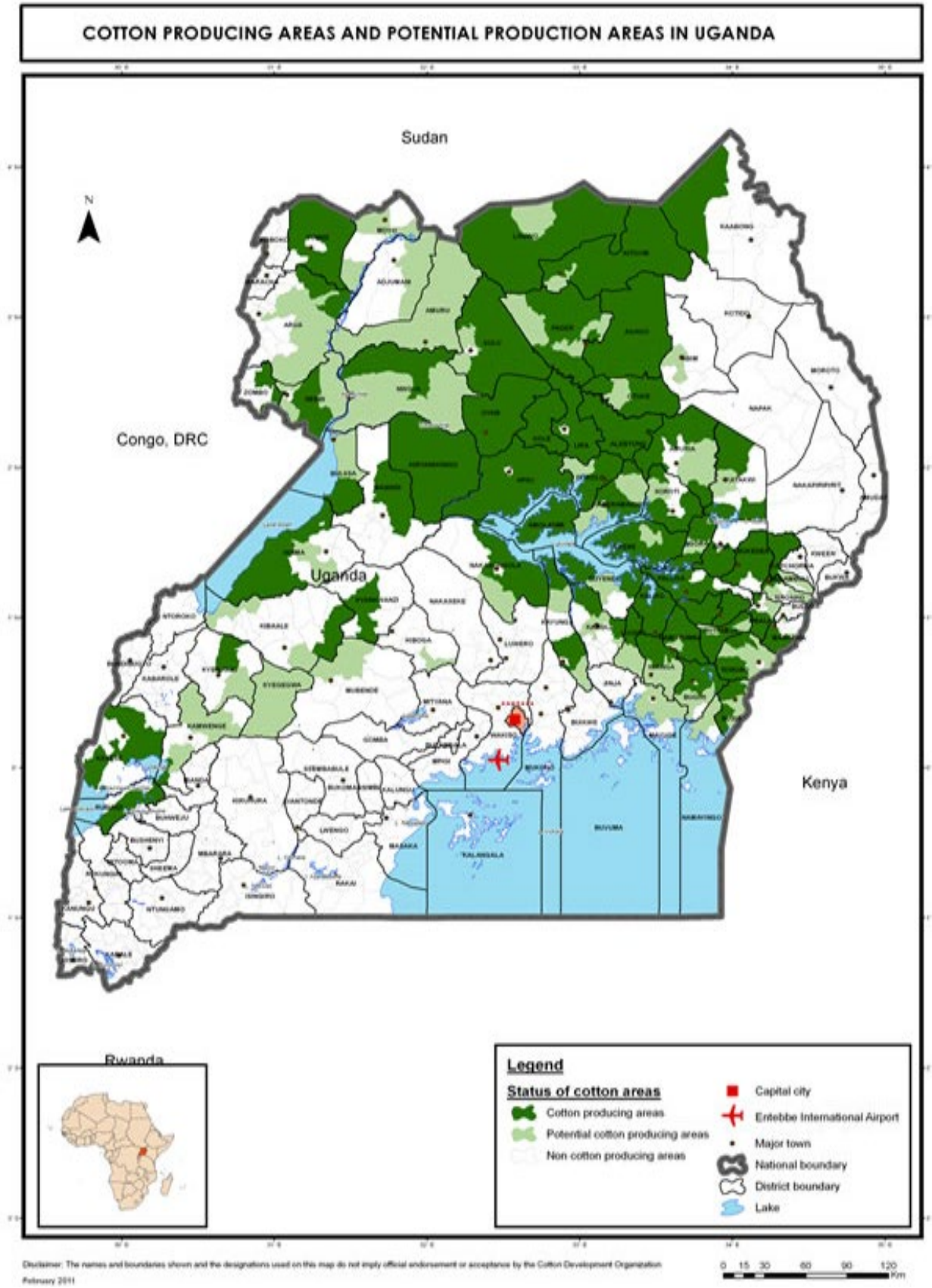
Generally, there is a good climatic condition for cotton production. Furthermore, the soil conditions are suitable for cotton production as highlighted in figure 3 below where vast soils are suitable for cotton production. In Uganda cotton is grown across approximately two-thirds of Uganda's land area *(Lugojja, 2017).* The main growing areas include Eastern, Northern, Lower West Nile and South Western regions in the Kasese area. In Zambia, the main cotton growing include Central, Eastern, Southern and Muchinga Provinces. While in Zimbabwe, cotton is grown in four region that are hot and receive rainfall of between 400 millimetres (mm) and 600 mm per annum, namely: Midlands covering areas in Gokwe South and Gokwe North; the northern part of the country, in parts of the Mashonaland Central province; Manicaland and Masvingo provinces, in the south-eastern part of the country and Binga in the Zambezi Valley of the Matabeleland North province (Hove 2019).

Secondly, cotton is considered as a priority crop for industrial development for the textile value chain and cotton by-products in all the policy documents of Uganda, Zambia and Zimbabwe respectively. Therefore, incentives are put in place to attract potential investors in the textile and cotton by-product value chains (UIA 2019, Hamusimbi, 2019, Hove 2019).

Availability of raw material is key for the development of the cotton by-product value chains. Cottonseed, a by-product of seed cotton, is available. Furthermore, cotton stalks, which by law was supposed to be burnt to prevent spread of diseases in all the three countries, can easily be made available for production of cotton by-products such as particle boards, briquettes or pellets. Other agro-residues are available from soybeans, maize, wheat, and sugarcane bagasse, can supplement cotton stalks as raw material in the production of briquettes and pellets. Banana leaves are also available in Uganda. Raw waste cotton lint is also available for processing into absorbent cotton wool. Uganda has a dedicated Serere Albar Type Uganda (SATU) variety which is short course fibre and suitable for production of absorbent cotton wool.

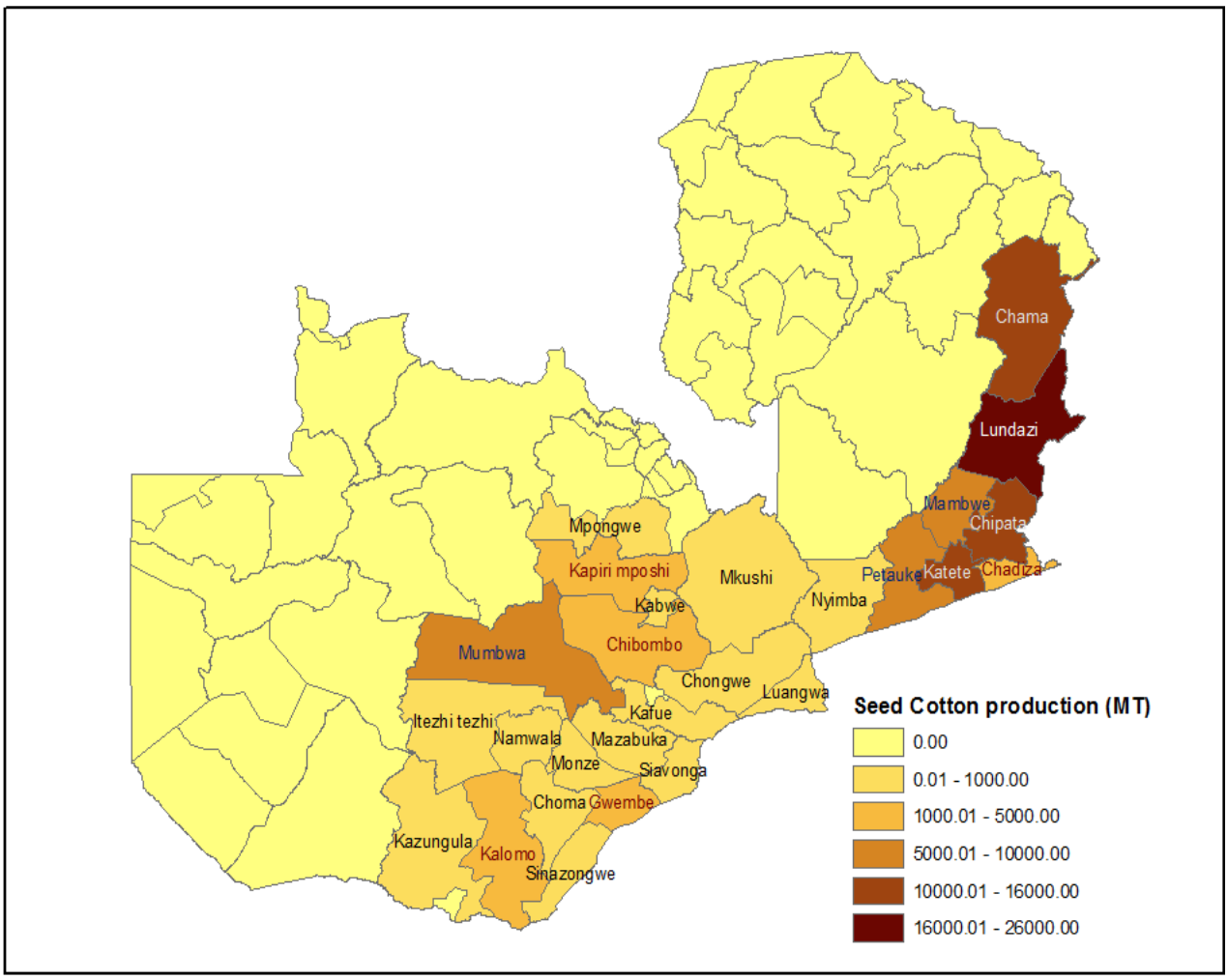
Figure 3: Cotton Growing Areas for Uganda, Zambia and Zimbabwe

Cotton Growing Areas in Uganda



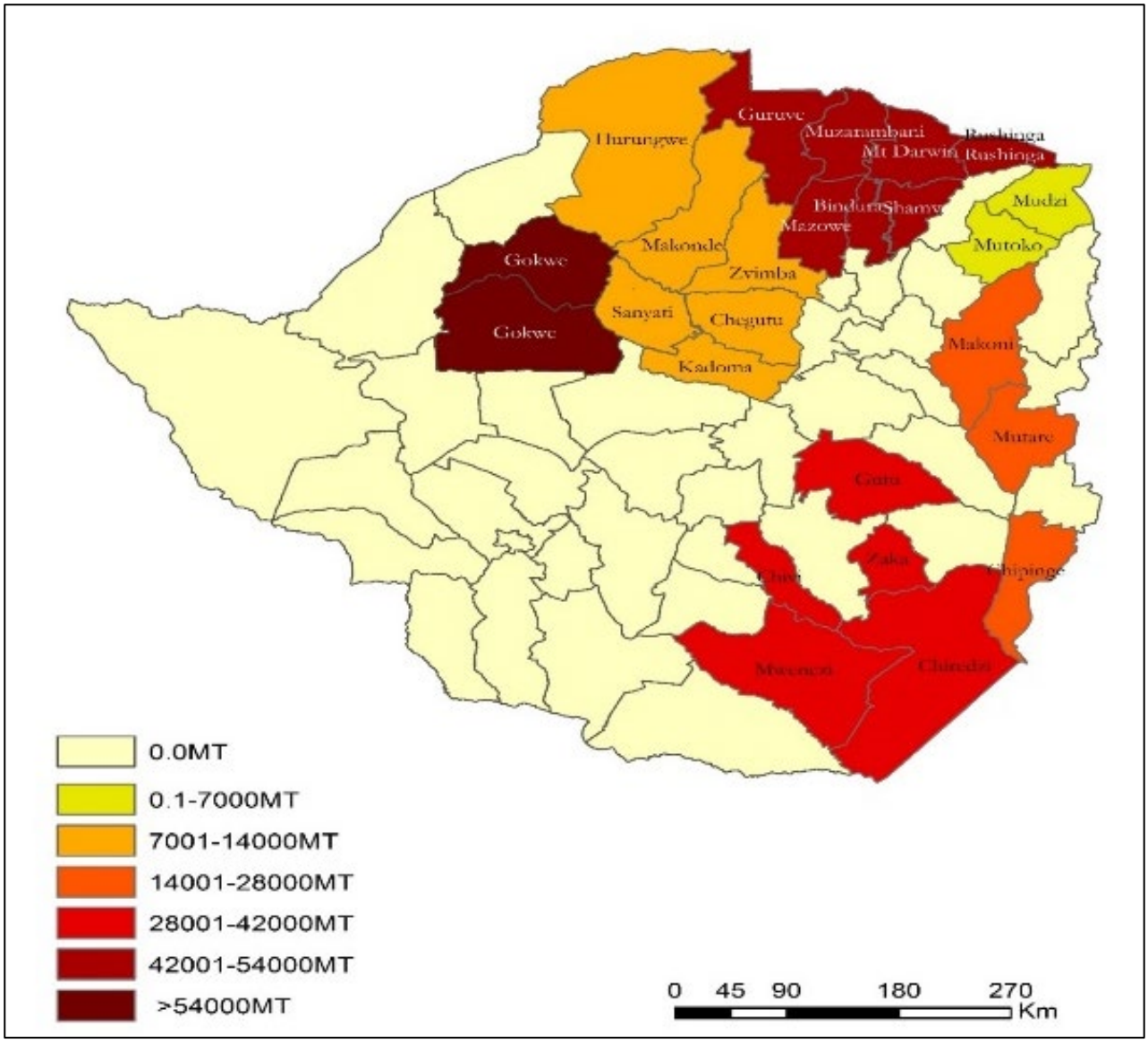
Source: http://www.cdouga.org/production/production-trends-earnings/

Cotton Growing Areas in Zambia



Sources: IAPRI 2015; Hove 2019; Kabwe *et al.*, 2018.

Cotton Growing Areas in Zimbabwe



Sources: IAPRI 2015; Hove 2019; Kabwe *et al.*, 2018.

Source: IAPRI 2015

4. Cotton By-Products Investment Profiles by Country

4.1 Proposed Cotton By-Product Investments

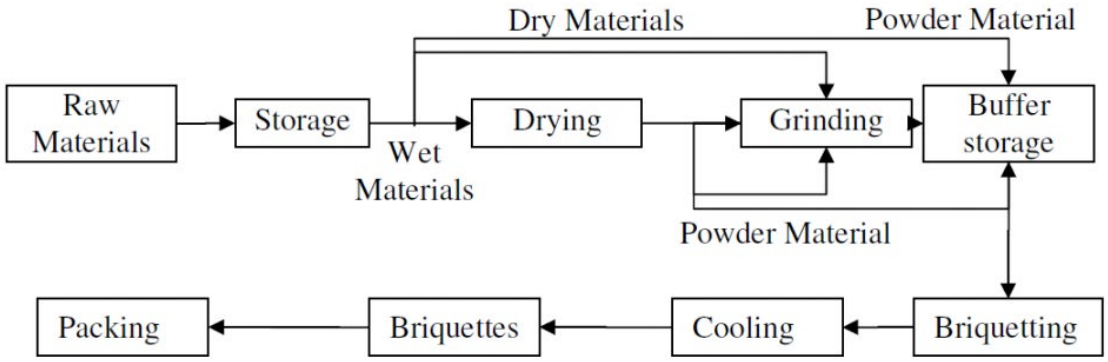
This section highlights the proposed cotton by-products investments that were identified in the UNCTAD cotton by-product project participating countries. These include the pellets/briquetting technologies and the absorbent cotton investment. These investments are described briefly below.

4.1.1 Pelleting and Briquetting Technologies

Densification and carbonization technology processes will be used in transforming cotton stalks and other agricultural residues into bioenergy pellets and briquettes. The former technology process will involve chipping of cotton stalks and other residues to less than 15 mm loose biomass; compaction under pressure of chipped and loose cotton stalks and other agro-forestry residues to reduce its volume; and naturally agglomerating the compressed stalks/residues into briquettes, depending on market preference. While the latter, will involve having cotton stalks and other agricultural residues be burnt in the kiln to create carbonisers, which are crushed and bound with a binder, and then compressed with a machine to form briquettes/pellets. These processes are summarized in Figure 4 below.

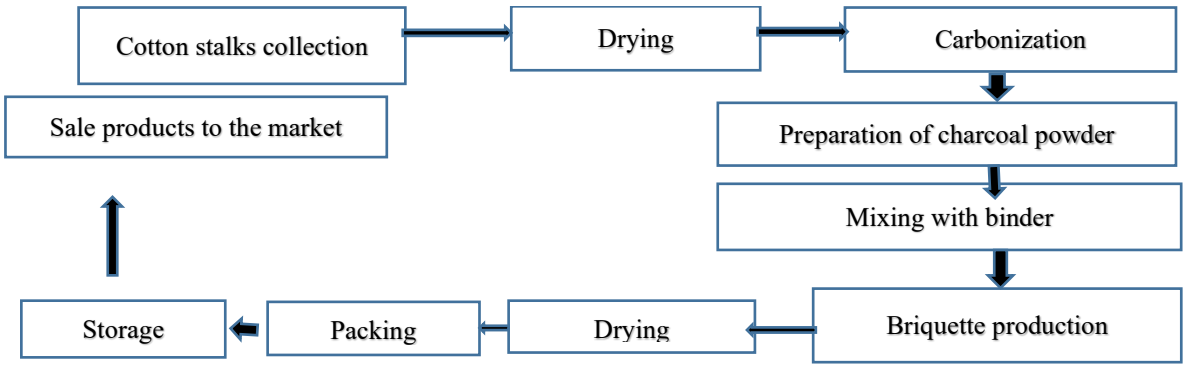
Figure 4: Briquetting Process Flowchart

Non-carbonized Process



Source: Hamusimbi 2019

Carbonized Process



Source: UIA 2019

Figure 5 shows the final products of the briquetting and pelleting process.

Figure 5: Images of Briquettes and Pellets

Non-carbonized Briquettes **Non-carbonized Pellets** **Carbonized Briquettes**

Source: Hove 2019 and UIA 2019

A number of biomass pelleting, and briquetting plants have been established and being promoted in African countries such as Ethiopia, Kenya, Malawi, Uganda, Sudan and Zimbabwe (Bhattacharya 2018). Some of these plants use cotton stalks and other agro-forestry waste as a feedstock for processing biomass into alternative clean and cheaper cooking and heating fuel pellets and briquettes.

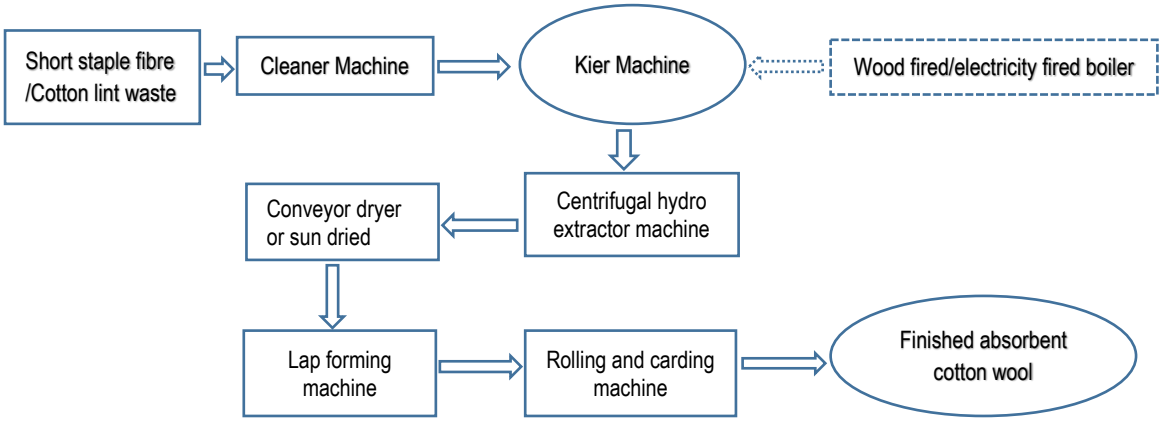
4.1.2 Absorbent Cotton Wool Technology

On the other hand, the demand for absorbent cotton in Uganda, Zambia and Zimbabwe is on the rise driven by growing population, resulting in increasing investments in hospitals, clinics and health services. For example, imports of absorbent cotton wool in Uganda grew by 50 per cent, from 177,537 kg in 2016 to 266,753 kg in 2017. Absorbent cotton wool is mostly manufactured for medical purposes, but can also be processed further into other consumer products, which are also marketable. These consumer products include sanitary pads, baby diapers, cotton sliver, cotton dental rolls, boric cotton rolls, cigarette filters, cotton gauze, cotton balls, cotton ear buds, and facial pads. In response, there has been some form of investment in production of absorbent cotton wool in Uganda, Zambia and Zimbabwe.

Producing absorbent cotton wool starts with pressing raw cotton or gin waste in a vertical opener machine and fed into a porcupine cleaner or horizontal cleaner machine to remove foreign substances such as husks, leaves and seeds. The loosened cotton is then placed into a pressure kier boiler where chemicals such as caustic soda and other detergents are mixed with water and steam and boiled for about six hours. The process is carried out to eliminate natural waxes and oils, and to soften and disband the remaining foreign impurities. The treated cotton lint is conveyed to washing tanks to clean it completely. The stage is intended to remove brownish colour resulting from chemical treatment of the raw cotton. Bleaching agents, such as hydrogen peroxide are added to the cotton, making it whiter and hydrophilic. Then the bleached cotton is washed all over again to remove any remaining chemicals. After washing, the cotton is neutralized using regulated amounts of diluted hydrochloric acid or sulphuric acid to reduce excess alkali properties. The cotton is transferred into a centrifugal hydro-extractor machine to remove excess water. Thereafter, cotton is conveyed to a wet or humid cotton opening machine to separate the fibre.

The cotton goes through a continuous drying process using the conveyor dryer machine. In most cases, absorbent cotton manufacturers sun dry their cotton wool to save on power costs.

Figure 6: Absorbent Cotton Wool Production Flow Chart



Source: UIA 2019

The dried cotton is transferred to a blow room where it is opened and set into laps using a lap former. The laps are fed into a carding machine in which cotton is warped around rollers in thin layers. Cotton is compacted and rolled using a roller machine into suitable roll size together with packaging paper. Using a weighing scale, the rolls are weighed and cut with a cutter machine into the required weight and size, before being labelled, packed in polythene sheets and heat sealed. Figure 6 above shows the process of making the absorbent cotton wool, while Figure 7 below shows the some of the end products.

Figure 7: Images of Absorbent Cotton Wool

Source: https://www.google.com/

The transformative biomass fuel of briquettes/pellets and the absorbent cotton wool business opportunities remain under-exploited in Uganda, Zambia and Zimbabwe due to, among other reasons, limited information on the techno-economic viability, as well as on product development and promotion.

The investment profiles prepared for the UNCTAD project propose investments in small to medium sized pelleting plants (up to 6 tonne per day (TPD) capacity) and a briquetting plant (up to 8 TPD capacity) for the case of Zambia and Zimbabwe and a 1,500 MT briquette plant for the case of Uganda, depending on the desired end products, i.e. pellets for modern energy-saving cooking stoves or briquettes for industrial cookers and boilers in all the three countries. Furthermore, the profile proposes investment projects in absorbent cotton wool plants with production capacity ranging from 260 MT per annum for Uganda.

4.1.3 Investment Rationale

The supply of modern and eco-friendly energy sources has not kept up with growing demand for cooking and heating fuels in Uganda, Zambia and Zimbabwe. For example, in Zambia the majority of households consume fuelwood and demand continues to grow (*Tembo, Mulenga, & Sitko, 2015*). In Uganda 18 per cent of the households depend on charcoal for cooking while another 78 per cent depend on firewood, totalling 96 per cent (GoU 2016). In Zimbabwe, the consumption of charcoal and firewood has also increased as well because firstly the majority of households are not connected to the electricity grid and

depend on charcoal and firewood. Secondly, the smallholder farmers that took over commercial farms after the land reforms, use firewood in the tobacco curing process because the majority cannot afford to buy coal for curing (Hove 2019). Demand growth has outpaced the supply of legal, commercial fuelwood. Coupled with the insufficient supply of substitute cooking fuels, this has contributed to acute supply shortage and price increases for cooking fuel (Hamusimbi 2019). Increasing fuelwood use by majority households from the three countries is fast becoming unsustainable and risks depleting forest cover, intensifying climate change effects, raising cooking fuel prices beyond reach, and triggering a surge in morbidity and deaths related to household air pollution. It is against this background that countries like Uganda, Zambia and Zimbabwe are working to reduce the consumption of fuelwood and conserve forest cover. For example, Zambia plans to reduce the share of fuelwood to less than 40 per cent by 2030 as part of its planned universal access to modern and clean energy, especially cooking fuels (Hamusimbi 2019). Meanwhile, Uganda also plans to restore the forest cover from the current less than 10 per cent to 1990 levels of 24 per cent of the land area which will translate to 2.5 million ha of land restored to forest (GoU 2016).

Proposed investments in cotton stalks and other biomass processing into solid bioenergy for cooking and heating in all the three countries (Uganda, Zambia and Zimbabwe) and also in absorbent cotton wool technologies in Uganda fit perfectly well with each individual country's current development priorities seeking to promote value addition of agricultural products (GRZ 2013, UIA, 2019, Shinyekwa et al., 2018, GoZ 2014); jobs and wealth creation especially among youths and women in rural areas; contribute towards countries ongoing efforts of achieving universal access to modern cooking fuels and also access to quality health products; and its goal to achieve a productive and well conserved natural resource for sustainable development. The proposed investment in processing cotton stalks and other agro-forestry waste into pellets and briquettes is meant to sustainably provide affordable, cleaner and eco-friendly cooking and heating fuel options for urban and peri-urban households and SMEs, replacing firewood and charcoal. While the proposed investment in absorbent cotton wool technologies in Uganda is meant to increase the industrial use of cotton lint waste and also short cotton fibre and enhance its marketability.

The main agricultural and cotton producing areas in each participating countries have been earmarked for the proposed investments in biomass pellet and briquette and absorbent cotton wool plants. For example, in Zambia, Central, Southern and Eastern provinces have been earmarked for establishing the pellet/briquettes plants. These provinces account for 91 per cent of Zambia's total seed cotton production, 53 per cent total maize and 68 per cent of total soybeans output. In addition, Southern Province accounts for over 90 per cent of sugar cane output, while Central Province accounts for over 40 per cent of national wheat output. The same applies in Zimbabwe, where the proposed briquetting and pelleting plant will be situated in Gokwe, which accounts for about 45 per cent of Zimbabwe's total seed cotton production. Along from an abundant availability of raw materials, these productive agricultural areas are also faced with widespread deforestation because of high fuelwood demand as a result of tobacco production, continuing opening up of new farming lands, and increasing illegal charcoal trade and exports. Meanwhile, the proposed location for a briquette plant in Mukono district in Uganda gives it proximity to the Uganda Industrial and Business Park and also to Kampala and the surrounding districts of Wakiso and Jinja. Considering that the plant will be using carbonized char, mobile carbonisers will be placed in major cotton growing areas which then will be transported to briquette and pellet production plant in Mukono district. On the other hand, the proposed location for the absorbent cotton wool plant in Uganda is Mbale District, on the eastern side of Uganda. It is 225 km from Kampala and about 58 km from Kenya/Uganda border. The main reason for choosing Mbale is because it is near the short staple cotton production areas.

Proposed investments in biomass pelleting and briquetting, absorbent cotton wool is suited to small and medium enterprises (SMEs) looking to enter the markets for affordable, cleaner and eco-friendly cooking and heating fuels and medical supplies. Cotton stalks and other agricultural crop residues, waste cotton

lint/short staple cotton fibre represent an opportunity to transform the cooking and heating fuel segments and development of healthy absorbent cotton wool. This investment opportunity will also assist small-scale farmers earn additional income as suppliers of agricultural residues to these plants and cotton waste.

Increasing adoption of energy-saving cooking stoves by low-income urban and rural households is another key fundamental supporting biomass pellets and briquettes businesses. Urban households solely depending on charcoal for cooking and heating will be the prime market target for cotton stalks pellets. This category is searching for cheaper and better cooking fuels alternatives. Secondary target markets for pellets will be restaurants and the urban households currently using a mix of charcoal and electricity for cooking. Schools, health institutions and industrial plants will be the primary target market for the cotton stalks briquettes as a cheaper, healthier and, more eco-friendly cooking and heating fuel substitute to the coal, furnace oil and charcoal they currently use in their boilers.

The target market for the absorbent cotton wool in Uganda, will be the local market from which the demand has been increasing for the products. For example, demand for absorbent cotton wool in Uganda has grown dramatically, increasing by 50 per cent from 177,537 kg in 2017 to 266,753 kg in 2018. Most of the cotton wool produced locally is sold to National Medical Stores (NMS), Joint Medical Stores (JMS), private pharmacies, supermarkets, hospitals, clinics, and drug shops around the country. NMS and JMS combined, import over 124 MT of absorbent cotton per annum.

With these factors, it is important to attract investors who can invest in pellets/briquettes and absorbent cotton wool technologies in Uganda, Zambia and Zimbabwe for the benefit of value chain actors, farmers included.

4.2 Project Activities by Country

4.2.1 Absorbent Cotton Wool Plant in Uganda

4.2.1.1 Introduction

The project seeks to manufacture absorbent cotton wool, using short-staple cotton, gin and spinning waste as raw materials. The demand for absorbent cotton in Uganda is on the rise driven by, the growing population, increasing number of private hospitals, health centres, pharmacies, and drug shops among others. The current demand outstrips local production. In 2018, the import demand for absorbent cotton wool grew by 50 per cent to 267 MT in 2018 from 178 MT in 2017.

Absorbent cotton wool in Uganda is mostly manufactured for medical purposes, but can also be processed further into other value-added products which are also marketable. The products include sanitary pads, baby diapers, cotton sliver, cotton dental rolls, boric cotton rolls, cigarette filters, cotton gauze, cotton balls, cotton ear buds, and facial pads.

The proposed investment project has a production capacity of 260 MT per annum of absorbent cotton wool. Production is estimated to start at 55 per cent capacity in the second year of operation but is expected to rise to 60 per cent in year 3 and grow to 75 per cent and 90 per cent respectively in Year 4 and 5 with increased seed multiplication and growing of short staple cotton in Uganda. Export is projected to commence in year 4 of implementation.

The raw cotton will be processed through a sequence of stages to make it hydrophilic and free from external impurities for use in medical dressings and personal hygiene. A 260 MT facility with a capacity to consume 1,728 -2880 bales of lint per annum, with a single shift per day, is proposed. The machinery and equipment can be purchased from India or China. The suppliers for various plant and machinery can be accessed via online marketplaces. Alternative sources also exist in China, America and other

European countries. Majority of the existing absorbent cotton wool plants and machines in Uganda were imported from India. Some plants, machines and spare parts were also imported from China.

4.2.1.2 Estimated Total Investment Costs (US$)

The estimated capital investment of the proposed project is around US$ 390,200, as shown in table 2 below. The financing of this investment is by equity and long loan debt. Equity contribution will account for 75% while the long loan debit will account for 25%. The machinery/equipment cost is exclusive of tax and transit cost. This accounts for 44% of the total investment costs.

Table 2: Estimated Total Investment of the Absorbent Cotton Wool Project in Uganda

S/N	Description	Quantity	Unit Cost, US$	Total, US$
1	Land and site preparation (1012 sqm)	1	27,024	27,024
2	Civil works and Built up area (607 square meters)	1	72,840	72,840
3	Machinery and Equipment		173,225	173,225
4	Office Furniture and Equipment	1	9,433	9,433
6	Pre-operating Expenses	1	4,700	4,700
7	Electricity installation	1	45,000	45,000
8	Heavy duty truck (7000 tonnes)	1	42,857	42,857
9	Water system installation	1	15,135	15,135
	Total			**390,214**

Source: Nalumu 2019a

4.2.1.3 Proposed Location and Transportation Logistics

The proposed location for the factory is Mbale district. The district is situated in Eastern Uganda and is about 225 km from Kampala Capital City and 58 km from the Kenya/Uganda border. The district is 119 km from Serere district, which is the target area for piloting short staple cotton growing. Mbale district was selected due to its proximity to the raw material source.

The existing road transport and utility infrastructure facilities such as power, water and ICT in the district favour manufacturing activities in the area. The district is home to Uganda's Mbale Industrial and Business Park with an estimated area of 250 ha. The ginneries within the locality will also ease transportation of the short staple cotton lint and gin waste to the factory. The district has tarmac roads which will favour transportation of the raw material and finished goods to various markets.

The ginners or their agents will transport the cotton lint from the ginneries to the factory. Cost of transport will depend on the distance between the ginnery and the factory plant. The cost for transporting unginned cotton to a ginnery ranges between 30-50 Uganda shillings (UGX) per kg i.e. (US$ 0.008–0.014 / kg).

Similarly, the lint per kilogram supplied by ginners to factories usually includes cost of transport and is calculated based on distance to the factory.

4.2.1.4 Status and Proposed Infrastructure and Indicative Utility Costs

Underlying assumptions are:

- A borehole will also be sunk on-site from which water shall be pumped using and Electric Pump to supply the factory.
- Rainwater will also be collected on site and stored in underground tanks for additional use by the plant.

i. The plant will have its own waste disposal facility that will include a septic tank and soak pit which shall be constructed in the first year of the project.
ii. Electricity tariffs will be lowered after the installation of Karuma Hydro-Power Plant in 2020.

Table 3: Selected Indicative Utility & Transit Costs in Uganda

Category	Description	Unit Cost, US$
Electricity	Medium industry consumers Low voltage 415 volts with maximum demand of 500 kV	0.166
	Large industry consumers High voltage 11,000V or 33,000v with maximum demand exceeding 500kVA but up to 1500kVA	0.10
	Extra Large industry consumers High voltage 11,000V or 33,000v with maximum demand exceeding 1500kVA and dealing in manufacturing	0.085
Internet	Broadband Installation	2,000
	Broadband dedicated internet 3Mbps per month	800
Telephone	Fixed Line, per second on average	0.0011
Road	20ft & 40ft Container from Mombasa to Mbale, including clearing fees, charges and insurance.	3,300
	20ft & 40 ft Container from Mbale to Mombasa, including clearing fees, charges and insurance	2,200

Source: Nalumu 2019a
Note: The proposed plant falls under Medium Industry Category

4.2.1.5 Proposed Labour Costs

Underlying assumptions are:

- Proposed rates include health benefits, taxes and social security contributions; and
- All administrative and production management personnel are readily available.

Table 4: Estimated Personnel Costs for the 1st Year of Production of Absorbent Cotton Wool in Uganda

S/N	Type	Unit Cost, US$	Qty	Annual Salary, US$	NSSF Contrib, US$	Total ,US$
1.	Managerial & Administrative	500	3	18,000	1,800	19,800
2.	Skilled	195	5	11,700	1,170	12,870
3.	Semi-skilled	110	20	26,400	2,640	29,040
4.	Unskilled	50	30	18,000	1,800	19,800
	Other costs					
5	Staff Uniforms and Protection Clothing	58	41	2,351		2,351
6	meals for staff	58	1	18,096		18,096
Total salaries and other staff costs				**94,547**	**7,410**	**101,957**

Source: National Social Security Fund (NSSF).

The estimated total number of staff is 58. Three fall within the managerial category, five are skilled, 20 are semi-skilled and 30 are casual labourers. The estimated monthly salary per manager is US$ 500. The five skilled staff will include electricians, and mechanics among others. The estimated salary per

month is US$ 195. The semi-skilled staff include machine operators, and storekeepers, among others. The estimated monthly salary for this category is US$ 110. The casual labourers will earn US$ 50 per month. The estimated total salaries and staff costs per annum in year 1 are US$ 101,957.

4.2.1.6 Financial Viability Analysis of the Proposed Project

The following are the underlying assumptions:

1. Purchasing of lint normally takes place during October and April during the ginning season. The factory will purchase sufficient volumes of baled lint to enable production all year round.
2. Exchange rate used is US$ 1.00 = UGX 3,700.
3. The production capacity of the absorbent cotton production line is based on a single shift working 8 hours per day. There are 6 working days per week.
4. Conversion rate of lint to cotton wool of 86 per cent.
5. Investor contributes 75 per cent equity and the balance will be a US$ bank loan from a commercial bank.
6. Funds will be borrowed in US$ from a local bank at US$ interest rates not exceeding 12 per cent for a period of 5 years, including 1 Year of Grace Period.
7. Selling prices are taken as: (a) US$ 1.65 per Kilogram of cotton lint (CDO, 2019); (b) US$ 4.60 per Kilogram of absorbent cotton wool; and US$ 0.825 gin waste.
8. Cotton Development Organization (CDO) will market and popularize growing of the short staple cotton in the Zoned area.
9. Lint and gin waste will be baled and sold by the ginneries.
10. The Serere Albar Type Uganda (SATU) variety of cotton, which yields short course lint fibres, will be suitable for processing into absorbent cotton wool.
11. Intermediary agents will aggregate all the lint and gin waste from ginners and deliver it to the factories. The agents either work for the ginnery or are independent.
12. The lint will have superior fibre characteristics since it will be hand-picked by farmers.
13. The availability of a ready market for the short staple cotton will ensure that farmers obtain competitive prices and this will attract farmers to grow the variety.
14. Production will commence in January of the 2nd year of implementation at 60 per cent capacity utilization. Sales will also commence in the 2nd year of implementation. 90 per cent production capacity will be attained in the 5th year of implementation and total sales are expected to reach US$ 1,076,400.
15. Funds will be mobilized in the 1st year of project implementation.
16. Working Capital for the first three (3) months will be available before production commences.
17. All staff required will be trained and recruited by the end of the 1st year of implementation.

4.2.1.7 Total Investment for an absorbent cotton wool plant

The total investment of an absorbent cotton wool plant is comprised of total fixed capital and total recurrent costs. Table 5 below shows the costings for fixed capital of the absorbent cotton wool plant

which is at US$ 282,522. The major costs will be the cost of construction of the plant and will constitute about 26 per cent of the total fixed capital, followed by electric installation and connections.

Table 5: Land, Building, Machinery and Equipment for the Absorbent Cotton Wool Investment in Uganda

S/N	Description	Units	Unit Cost, US$	Amount, US$
1	Land and site preparation (1012 sqm)	1	27,024	27,024
2	Civil works and total built up area (607 sqm)	1	72,840	72,840
3	Wood fired steam boiler 50kgs/hour	1	10,000	10,000
4	Round Automatic Plucker	1	5,000	5,000
5	Vertical Opener 200kgs/hour	1	6,000	6,000
6	Porcupine/Step Cleaner	1	7,000	7,000
7	Pressure Kier	1	4,000	4,000
8	Overhead Crane	1	5,000	5,000
9	Air compressor	1	2,500	2,500
10	Centrifugal Hydro extractor	1	2,000	2,000
11	Wet/Humid Cotton opener	1	3,000	3,000
12	Conveyor Dryer & HAG System	2	15,000	30,000
13	Hopper Feeder	1	725	725
14	Lap Former/Blow room line	1	12,000	12,000
15	Carding machinery with a conveyor	3	9,000	27,000
16	Rolling machines	2	2,100	4,200
17	Rolls Cutting machine	1	250	250
18	Water overhead tank of 10,000 litres capacity and tube well fitted with accessories	2	600	1,200
19	Water infrastructure (borehole drilling, rainwater harvesting system, pipe connections with water			7,000
20	Weighing scale	1	350	350
21	Testing machine for PH meter, soxhlet-extractor, chemical balance, crucibles, furnace, oven etc		1,000	1,000
22	Electricity connection and installation charges		45,000	45,000
23	Office furniture, equipment, computers and accessories			9,433
	Total fixed capital cost			**282,522**

Source: Nalumu 2019a

Table 6 shows the estimated working capital requirements for a period of five years. The capital includes salaries of staff, administrative costs and the cost of raw materials and utilities. The cost of raw materials is the largest cost, representing 80 per cent of the total working capital.

Table 6: Working Capital (Recurrent Expenses) of Absorbent Cotton Wool Investment in Uganda (US$)

S/N	Description	Year 1	Year 2	Year 3	Year 4	Year 5
1	Selling, general and administrative costs	169,203	183,715	192,906	201,068	210,242
2	Total cost of raw materials	-	336,062	415,392	442,675	496,073
	Total	**169,203**	**519,777**	**608,298**	**643,743**	**706,315**

Source: Nalumu 2019a

4.2.1.8 Profit and Loss Analysis of the Absorbent Cotton Wool Project

The projection of the profit and loss values show that in year 1, the plant would make a loss of (US$ 207,194). After year 1, the plant is expected to be making a profit as shown in table 7. The profit at the end of year 2 is US$ 165,297, while in year 3 profit is expected to be US$ 261,046. Profits up to year 6 will be progressive and in year 7 onwards, profits are expected to be increasing but at a diminishing returns.

Table 7: Profit and Loss Statement for the Absorbent Cotton Wool Project

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Total Fixed Costs (US$)	165,712	165,884	166,922	168,736	171,260	174,439
Total Variable Costs (US$)	41,482	386,418	469,032	498,286	554,367	610,553
Revenue from the Sale of Cotton Wool (US$)	-	717,600	897,000	956,800	1,076,400	1,196,000
Profit	**-207,194**	**165,297**	**261,046**	**289,778**	**350,773**	**411,009**

Source: Nalumu 2019a

4.2.1.9 Investment Viability Assessment

In analysing the investment viability of the absorbent cotton wool, a period of 11 years is considered and is shown in Appendix 1. The Net Present Value (NPV) was used to assess the added value to be generated by the proposed absorbent cotton wool plant. The NPV calculation assumed of a required return of 8 per cent (bank interest rate in most of the banks in Uganda). Cash inflows are poised to decrease during the second year of operation, before increasing from year 3 onwards. In year 7, net inflows are expected to be positive.

Based on these calculations, the absorbent cotton wool plant has an NPV of US$ 3,141,504 after repaying capital investment, operating costs and debt in the eleventh year of the plant. Therefore, the proposed plant is viable as of its 10th year.

Table 8: Rate of Return on Total Capital Investment for an Absorbent Cotton Wool Investment in Uganda

Profitability Analysis Item	Year 1	Year 2	Year 3	Year 4	Year 5
1. Profit Ratio on Sales (%)	-	23.03	29.10	30.29	32.59
2. Rate of Return on total capital investment	-49.54	39.53	62.42	69.29	83.88

Source: Nalumu 2019a

The absorbent cotton wool project will earn profits starting in year 2. The year-by-year percentage of profit ratio on sales from year 2 to 5 onward show that the project would convert 23 per cent, 29 per cent, 30 per cent and 33 per cent of its sales into profits respectively. The proposed absorbent cotton wool project has an Internal Rate of Return (IRR) of over 39 percent starting year 2. These values are higher than the 8 per cent cost of capital if one borrowed capital from the bank. Therefore, the project is a profitable venture.

4.2.1.10 Risks and Mitigation Strategies

a) Farmers may not be willing to venture into the growing of short-staple cotton variety due to uncertainty of the market. This may affect the supply of the lint which is the proposed primary raw material for production of the absorbent cotton wool. To mitigate this, CDO should sensitize and popularizes the SATU variety among the farmers, ginners and absorbent cotton manufacturers. The Manufacturers

will then provide a sure market for the lint which in-turn provides a better price and income for the growers.

b) The volumes for SATU may not increase to the required quantities. CDO identifies expansion areas of land and zones specifically for planting of SATU variety.

c) The SATU variety may not be a suitable variety. CDO will undertake more research in other varieties to ensure that the right variety for the production of absorbent cotton is identified and multiplied.

4.2.2 Briquette and Pelleting Production from cotton stalks and other biomass in Uganda

4.2.2.1 Introduction

The plant seeks to manufacture briquettes and pellets from cotton stalks and other agricultural residues in Uganda. According to Ministry of Energy and Mineral Development (MEMD), population growth is the driver of biomass demand for most households in Uganda since the majority cannot afford modern clean forms of energy like electricity and Liquefied Petroleum Gas (LPG). Biomass energy is used across all sectors, with close to 100 per cent of rural households and 98 per cent of urban households using the biomass energy. In Uganda, some manufacturers such as breweries have adopted use of vegetal wastes such as coffee and rice husks which are more cost effective instead of furnace oil technology. Briquettes and pellets are also used by rural and urban households, hotels, restaurants, small eating places, hospitals, and educational institutions. Therefore, briquettes and pellets will be produced for the domestic market and also exported to the regional market. The plant is expected to help in conserving the forest resource, contributes to Uganda's energy security and provides employment opportunities and incomes to several people across the value chain. Investment in the project, therefore, will provide a livelihood to the local population and benefit Uganda as a whole.

The proposed investment project has a production capacity of 1,500 M.T. per annum of carbonized briquettes and pellets. Production will start at 75 per cent capacity in the second year of operation but is expected to rise to 80 per cent in year 3 and grow to 85 and 100 per cent respectively in Year 4 and 5 with increased demand of the energy fuel. Export is projected to commence when the project reaches 100 per cent production. The project will adopt both local and imported technology. Mobile carbonisers will be purchased locally while the largescale carbonizing machine, transformer, cotton crusher, automatic briquetting machine, and semi-automatic flash drier, will be imported.

4.2.2.2 Estimated Total investment costs (US$) for a briquetting plant

The estimated capital investment of the proposed briquette project is US$ 401,034 as shown in table 9 below. The cost of constructing the plant, buying of machinery/equipment, installation and connecting of electricity and buying of heavy-duty truck will account for about 89 per cent of the total investment cost. Financing of investment capital less working capital (US263,075) will be done through equity at 60 per cent and the remainder 40 per cent will be financed by loan from the bank.

Table 9: Estimated Total Investment of the Briquetting Investment Plant in Uganda

	ITEM DESCRIPTION	Nu	Unit Price	Year 1
			US$	
1	Land and site preparation (acres of land)	2	7,000	14,000
2	Civil works and built up area	1	97,140	97,140
3	Machinery and equipment	1	46,200	46,200
4	Office Furniture and equipment	1	6,148	6,148
5	Pre-operating expenses	1	2,000	2,000
6	Electricity and water installation	1	45,000	45,000
7	Heavy duty truck (7,000 tonnes)	1	42,857	42,857
8	Water system installation)	1	9,730	9,730
9	Working Capital	1	125,331	125,331
10	Repayment of loan + Interest	1	12,628	12,628
	Total Investment Capital			**401,034**

Source: Nalumu 2019b

4.2.2.3 Proposed Location and Transport logistics

The proposed location for the factory is Mukono district. The district is about 24 km east of Kampala and other surrounding urban areas. Mukono district was selected due to its proximity to the target market segments and points of sale. The location will ease transportation, sales and distribution of briquettes and pellets to various customers located in Kampala, Wakiso, Jinja and surrounding towns.

In addition to proximity of the district to the Kampala Industrial and Business Park, Namanve makes it suitable for supply of briquettes and pellets to industries. Uganda is planning an industrial park and free zone along the Eastern Route of the Standard Gauge Railway (SGR) in Mukono District (approximately 1,200 ha). The Eastern SGR Route will run from Kampala to Malaba extending its sidings to the industrial park. The park will also provide business opportunities to the factory.

The raw material will be transported by road using contracted agents. The targeted agents are those that ferry merchandise from Kampala or Mukono to cotton growing areas. The agents are assumed to be familiar with the route. The estimated cost of a 12-tonne truck per collection of raw materials will be US$ 135. Other agricultural residues such as coffee husks, maize stalks and cobs, groundnuts, banana shells will be purchased directory by the factory from the distributors with cash on delivery at the firm gate. The briquettes will be distributed through established retail outlets such as food stalls or kiosks in major trading centres. The factory will also supply the briquettes and pellets directly to institutions such as schools, hospitals, restaurants, hotels, and poultry farms.

4.2.2.4 Raw Material Availability and Indicative Utility Costs

The raw materials for briquettes/pellets are the agricultural residues. The key raw material is cotton stalks. Though, cotton stalks will first be chipped and burnt in a kiln with low oxygen to make carbonized char. It is the carbonized char that will be used to make briquettes. Cotton is grown across approximately two-thirds of Uganda's land area *(Lugojja, 2017).* The main growing areas include eastern, northern, lower west Nile and south western regions in the Kasese area. The crop is grown by smallholder farmers and purchased by ginners or their agents at farm level. Considering 2018 area and the yield rate of cotton stalks of 2 MT per hectare, the country can produce 330,000 MT every year (Shinyekwa, et.al, 2018). It is assumed that the briquette plant will purchase mobile carbonizing machines which will be taken to cotton producing areas where farmers can sell their cotton stalks. Therefore, the carbonized char from cotton stalks will be transported from the cotton production areas to Mukono briquette plant for the

production of briquettes. Considering that cotton stalks is in supply for a short period, the company will make sure it buys enough during the season, then store them throughout the remainder of the year. However, other agricultural residues such as rice husks, coffee husks, banana fibres, will be sourced and burnt to make carbonized char. With all the agricultural residues, government has estimated about 7.4 MT of agricultural residues available in Uganda (Uganda Renewable Energy Policy 2007).

Table 10 below shows the indicative utility costs available in Uganda.

Table 10: Selected Indicative Utility & Transit Costs of a Briquetting Investment in Uganda

Category	Description	Unit Cost, US$
Electricity	Medium industry consumers Low voltage 415 volts with maximum demand of 500 kV	0.166
	Large industry consumers High voltage 11,000V or 33,000v with maximum demand exceeding 500kVA but up to 1500kVA	0.10
	Extra Large industry consumers High voltage 11,000V or 33,000v with maximum demand exceeding 1500kVA and dealing in manufacturing	0.085
Internet	Broadband Installation	2,000
	Broadband dedicated internet 3Mbps per month	800
Telephone	Fixed Line, per second on average	0.0011
Road	20ft & 40ft Container from Mombasa to Mukono, including clearing fees, charges and insurance.	3,300
	20ft & 40 ft Container from Mukono to Mombasa, including clearing fees, charges and insurance	2,200

Source: Nalumu 2019b
Note: The proposed plant falls under medium industry category.

4.2.2.5 Market Analysis

The market for briquettes is categorized into four to include domestic, institutional, industrial and export market. Majority of the briquette manufacturers in Uganda supply their products to peri-urban and urban centres and few are export-oriented. Carbonized briquettes are also supplied to households and institutional consumers in rural areas while the non-carbonized briquettes are supplied to brickmaking, and cement industries as well as institutional kitchens such as restaurants, schools and hospitals (Asamoah et al., 2017). In East Africa, declining wood resources (due to over-exploitation of forest resources) coupled with rising prices of charcoal (due to a decline in wood resources) has resulted in the briquetting business gaining momentum (Ferguson 2012). For example, in 2008 the average price of a 40kg charcoal sack was US$6 and in 2009 it rose by 67 per cent. In 2017, the priced a 40kg bag to about US$16 (Ferguson, 2012). Currently, the price of a 40kg bag of charcoal costs about US$27. While the cost of a 40kg bag of briquette cost about US$10.8. Therefore, the existing price trends and increased awareness of briquettes as a cheaper source of energy coupled with the consistent heat output builds briquettes an economic case for using the energy source by domestic and institutional consumers and even the small and medium industries.

Briquettes are suitable for institutional markets because they can substitute wood without modification of the stoves. Schools, restaurants, hospitals, refugee camps, roadside food vendors, poultry farmers, army

barracks, etc are potential markets and future opportunities will arise if the government and local authorities further enforce the restriction on cutting down trees. The domestic market in Uganda notwithstanding, there is a great export market potential in the East African Community, with an estimated population of 120 million people in addition to market opportunities within the Common Market for Eastern and Southern Africa states (COMESA). Securing regional markets require consistency in the quality and supply of briquettes and well-integrated marketing techniques and distribution channels. A steady market in the region starting with Kenya, or Rwanda will require securing contracts with bulk buyers of briquettes to ensure consistent supply of the briquettes. The main buyers of carbonised briquettes in Kenya are poultry farms, restaurants, hotels and safari camps (Asamoah et al., 2017.)

4.2.2.6 Financial Viability Analysis of the Proposed Briquetting Plant

The following are the underlying assumptions in the financial viability analysis of the proposed project.

a. Purchasing of carbonized char will be carried out February-April after harvesting the cotton crop. The factory will purchase sufficient volumes to enable production all year round. In addition, other agricultural residues will be supplemented to ensure constant supply of the raw material.
b. The factory will provide crushers/chipping machines and carbonizing kilns to farmers.
c. Farmer groups will engage in chipping, collecting, and carbonizing the cotton stalks into char at a cost sharing arrangement.
d. Carbonized char will be purchased from farmers at a cost of UGX 75 (US$ 0.02) per kg. The current selling price for a kilogram of charcoal briquettes is UGX 1,000 (US$ 0.27).
e. Transport agents will pay and collect the carbonized char and transport it to the factory.
f. The production capacity of the briquette and pellet production line is based on a single shift working 8 hours per day. There are 6 working days per week.
g. Funds will be mobilized in the 1st year of project implementation.
h. Investor contributes 60 per cent equity and the balance will be a US$ bank loan from a commercial bank.
i. Funds will be borrowed in US$ from a local bank at 8 per cent interest rate.
j. Working capital for the first three (3) months will be available before production commences.
k. All staff required will be trained and recruited by the end of the 1st year of implementation.
l. The factory will stock up to 100 tonnes of briquettes at a time to cover demand during the rainy season when production drops due to slower outdoor drying. Outdoor drying will supplement the flash drier to reduce costs of production.

4.2.2.7 Financial Analysis

In analysing the investment viability of the briquette investment project, financial analysis methods were used. The financial analysis of the project is summarized

Table 11: Profit and Loss Statement (USD) for a Briquetting Investment in Uganda

	Year1	Year2	Year3	Year4	Year5	Year6	Year7	Year8	Year9
Total gross margin	-	229,723	245,038	260,353	306,297	306,297	306,297	306,297	306,297
Total Operation costs	(125,331)	(133,52)	(137,544)	(141,672)	(146,527)	(150,581)	(154,757)	(159,058)	(172,751)
PBID	**(125,331)**	**96,195**	**107,494**	**118,681**	**159,770**	**155,716**	**151,540**	**147,239**	**133,546**
Depreciation	- 17,627	-15,099	-13,012	-11,285	-9,849	-8,650	-7,646	-6,800	-4,955
Interest	-8,418	-6,735	-5,051	-3,367	-1,684	-	-	-	-
PBT	**-151,376**	**74,362**	**89,430**	**104,029**	**148,238**	**147,066**	**143,895**	**140,440**	**128,591**
Corp Tax	-45,413	22,309	26,829	31,209	44,471	44,120	43,168	42,132	38,577
Net Profit	**-105,963**	**52,053**	**62,601**	**72,820**	**103,767**	**102,946**	**100,726**	**98,308**	**90,014**

Source: Nalumu 2019b

The analysis covers 11 years. The project is profitable. Net profits were positive in the second year and reach their peak in the fifth year at US$ 103,767. The positive net profit ratio indicates that more profits will be earned from the sales revenues. The return on investment in the same year will be 65.74 per cent. With continued profitability, payback period is in 5 years of operation.

4.2.2.8 Financial Viability of the Proposed Briquette Plant

Financial viability analysis of the proposed 1,500 MT per annum briquetting plant is done using the net present value (NPV). The NPV calculation was done based of 8 per cent interest rate on loan from a commercial bank. After repaying capital investments, operating costs and debt for the proposed briquetting plant has a positive NPV of US$488,799 after 11 years. The NPV of the briquette investment plant is positive, therefore, the plant is financially viable.

4.2.2.9 Required Licences and Standards Certifications for Absorbent Cotton Wool and Briquette Plants

Business Licences

An investor in manufacturing of briquettes/pellets plant or absorbent cotton wool plant shall require the following two licences as shown in table 12 below to start a business in Uganda respectively. The absorbent cotton wool plant shall require Manufacturing and Investment licences. While the briquette plant would also requirement an investment licence as well as the trading licence. Manufacturing, Investment and Trading licences are issued by National Druq Authority (NDA), Uganda Investment Authority (UIA) and Municipal Council respectively. Though the licence is free, for a Foreign investor requires a minimum of US$ 100,000 in planned investment in order to secure an Investment license from UIA, whereas a local investor's minimum planned investment requirement is US$ 50,000.

Table 12: Licences Required for Setting an Absorbent Cotton Wool/Briquetting Plants in Uganda

S/N	Name of Licence/Permit	Cost in US$	Issuing Authority	Licence Processing Time	Proposed Project
1.	Manufacturing	208[1]	National Drug Authority (NDA)	3 months	Absorbent Cotton
2.	Investment	Free	Uganda Investment Authority	2 days	Absorbent Cotton Wool and Briquette Plant
3.	Trading licence		Municipal council	1 week	Briquette Plant

Source: Nalumu 2019b

Standards Testing and Quality Control

Quality control and standards testing for absorbent cotton wool and briquettes is carried out by UNBS. Standards testing are provided in Uganda's Standard Catalogue US 704:2014. The standard specifies requirements and methods for testing absorbent cotton wool (specifically when sterilized into surgical cotton wool) for medical use. Surgical cotton is classified as a medical device. The premise of the intended project is licensed and product registered as per section 29 of the Drug Registration regulation 2014. The Standards can be procured at the UNBS Information Resource Centre at a total cost of UGX 35,000, which is equivalent to US$ 9. While standards for briquettes can be accessed at a cost of UGX 40,000 which is equivalent to US$ 11. Standards for wood charcoal and charcoal briquettes for household. These can be accessed from the UNBS at a cost of UGX 40,000. The standards specify requirements for charcoal derived from wood, in lump or briquette form intended for household use. Standards for making briquettes and pellets for industrial use using agricultural residues such as cotton stalks are yet to be developed. Quality control and standards testing of lint used in the factory is guaranteed by Cotton Development Organization (CDO). CDO has a cotton classing laboratory and carries out inspections of ginneries for their suitability. The Organization guides farmers and ginners on seed and lint quality as well as packaging requirements. The strict quality control mechanisms ensure that the raw material for manufacturing absorbent cotton wool meets international standards.

Workforce Skills and availability of Specialized Skills

Uganda has a ready supply of skilled and semi-skilled workforce for both absorbent cotton wool and briquette and pellets manufacturing industries. The existing Absorbent cotton manufacturers and expatriates have provided practical training of the local manpower in the industry. Potential investors will therefore find it relatively easy to hire suitable trained and trainable human resource. The labour rates for unskilled and skilled labour are also competitive ranging between US$1.08 -1.35 and US$4-6 per day respectively. In addition, the technical colleges and universities provide a regular supply of trainable young workforce including chemists, mechanics, electricians, accountants, and managers, suitable for working in the factory.

4.2.2.10 Tax & Non-Tax Incentives

Taxes

An investor in briquettes and absorbent cotton wool can benefit from the following tax incentives in accordance with the Domestic Tax Laws.

[1]Uganda shillings 770,000 – Local Manufacturers Licence 420,000, and Suitability of premises licence is 350,000

a) VAT deferment on Plant and machinery where payment of VAT at importation on specified imports is postponed to a future date. The cost of the plant and machinery should be at least $22,500 and above.

b) Industrial replacement spares parts used exclusively on industrial machinery classified in Chapters 84 and 85 of the EAC Common External Tariff are exempted from all taxes under the Fifth schedule of the East African Community Customs Management Act, 2004.

c) VAT is deferrable for pre-fabricated buildings for factory use imported by registered manufacturers or other entities such as warehouse construction

d) 100 per cent deduction of scientific research expenditure - Employers who train permanent residents employed by them.

e) Depreciation allowances Initial Allowance - Capital deduction of 50 per cent of qualifying plant & machinery and 20 per cent on Industrial building placed in the radius of 50 Km outside the Capital Kampala.

f) Carry forward losses - Any investor who for any year of income, the total income is exceeded by the deductions allowed. The assessed loss is carried forward as a deduction in the following year of income.

g) Medical products - Refund of excise duty paid on goods which are converted into approved health care or medical products - Approved healthcare products to be approved by Ministry of Finance, Planning and Economic Development in consultation with Ministry of Health.

h) 10-year Income Tax Exemption in the manufacturing and exporting of consumer or capital goods for a period of 10 years from the date of issuing the certificate. At least 80 per cent of the raw materials used should have been bought in Uganda and export 80 per cent of the manufactured goods.

i) Industrial Building Sec 29 of the Income Tax Act - Taxpayers with commercial buildings that are also used as offices are given Industrial Building Depreciation allowance at a rate of 5 per cent for 25 years.

j) VAT is exempt on supplies to Free Zone and Industrial Park developers (US$ 100 million investment)

    i. Services to conduct feasibility study, design and construction

    ii. Earth moving equipment and machinery

    iii. Construction materials

k) VAT Supplies are exempt to operator within an industrial park, or single factory operator or any business outside industrial park or free zone who meets the following requirements- US$ 15 million (foreigners) or US$ 10 million (citizen);

l) VAT is also exempt to an Operator on Services to conduct a feasibility study and design, locally produced materials for construction of a factory or warehouse and locally produced raw materials and inputs or machinery and equipment. This is on condition that 70 per cent of raw materials

are sourced locally subject to availability. The company directly employs minimum 60 per cent of citizens.

m) Withholding Tax - 6 per cent withholding tax exemptions for Uganda Revenue Authority compliant taxpayers.

n) Stamp Duty - No duty payable on instruments executed by Developers and Operators of Free zones.

o) No Excise Duty on Construction materials for factory or warehouse exclusive of those on local market, locally produced raw materials and inputs to operator in Industrial Park, Free Zone, single factory or other business outside the Park or Free Zone who meets listed requirements.

However, it is advisable for an Investor to consult the URA Customs Department to be advised on applicable taxes before a consignment is brought into the country.

Non-Tax benefits

a) Bilateral Investment and Trade Agreements (BITs)

Uganda has entered into a number of BITs agreements for the promotion and protection of investment in Uganda. The BITs provide best investment practices, guarantee against expropriation, national treatment and non-discrimination, compensation for losses, repatriation of investment and returns, and dispute settlement among others, etc. BITs exist with the following countries: Denmark, Egypt, France, Germany, Italy, Netherlands, South Africa, Switzerland and the United Kingdom of Great Britain and Northern Ireland.

b) Double Taxation Agreements (DTAs)

Uganda has signed Double Taxation Agreements with the following countries: Denmark, India, Mauritius, Netherlands, Norway, South Africa and the United Kingdom.

c) National Treatment and Non-discrimination

i. Uganda does not restrict the percentage of equity that foreign nationals may hold in a locally incorporated company. In the same way, the country has no rules or regulations restricting joint-venture arrangements between locals and foreigners or prohibiting the acquisition of Ugandan firms by foreign-owned firms.

ii. Uganda imposes no limit on equity ownership. Investors are free to bring in and take out their capital. In practice, a company faces no obstacles in divesting from its assets in Uganda.

iii. Non-citizens can lease land up to 99 years.

iv. Entry/work permits are usually granted to key personnel of foreign enterprises approved to operate in Uganda. Any enterprise, local or foreign, can recruit expatriates for any category of skilled manpower where Ugandans are not available. In this case, however, the investor must prove the need for such employees.

v. Investors can invest in any part of Uganda as long as security and environmental laws are observed. Investments are not permitted in protected areas.

Security of Investment

Security of the investment in Uganda is guaranteed by the Constitution of Uganda, the Investment Code Act 2019. Furthermore, Uganda is also a signatory to major international trade and investment-related institutions including the Multi-lateral Investment Guarantee Agency, Overseas Private Investment Corporation, Convention on the recognition and enforcement of foreign arbitral award, Islamic Corporation for the Insurance of Investment and Export Credit (ICIEC), International Centre for Settlement of Investment Disputes, and the Agreement on Trade-Related Aspects of Intellectual Property Rights among others.

4.2.3 Briquettes and Pellets Investment Projects from Cotton Stalks in Zambia

4.2.3.1 Introduction

Plants to produce briquette and pellets from cotton stalks and other agricultural residues have been proposed in Zambia. The main driver for this proposal is an increase in demand for charcoal due to high levels of urbanization and population growth. It has been anticipated that consumption of charcoal by Zambian households is expected to skyrocket by 2030, in line with projected population growth (2.8 per cent annually) and rapid urbanization (4 per cent annually).[2] Therefore, production of briquettes and pellets may help ameliorate the situation of deforestation since production of briquettes/pellets use agricultural residues such as cotton stalks, soybean straw, maize stover/cobs and other location specific agro-forestry waste suitable for the purpose. The two proposed models give prospecting investors options on the end-product (pellets or briquettes) depending on market demand dynamics in their intended local areas at the time of investing.

The proposed briquette and pellet plants have production capacities of 8 Tons per Day (TPD) and 6.4 (TPD) respectively. These medium-sized briquetting and pelleting models have been chosen under this profile to help demonstrate the techno-economic viability of cotton stalks and other agro-forestry residues processing into bioenergy pellets or briquettes. The chosen pelleting project and briquetting mill models use a wide range of raw materials including cotton stalks, residues from soybean, maize, wheat and sorghum, saw dust, bagasse and other wild grasses, forest twigs and other waste.

The proposed investments are earmarked for high seed cotton producing areas especially in Chipata and Katete in Eastern Province, and Mumbwa in Central Province. Tables 13 and 14 summarize the technical specifications of a 6.4 TPD pelleting and 8 TPD briquetting plants respectively.

[2] Source: Ministry of Energy (MoE) (2008).

Table 13: Technical Specifications for a 6.4 TPD Pelleting Plant

Product and Raw Materials		Electricity/Power Requirements	
Item/Description	**Specifications**	**Item/Description**	**Specifications**
Finished product	8-10 mm diameter, 60-150 mm in length cylindrical pellets	Required power connection	59 hp/45 kW
Production capacity	700-800 kg/hour depending on raw materials	Amp. load	50-60 Amp approximate
Raw material size & moisture content	Up to 10mm size raw materials of 8-12% moisture content	Power consumption	25-30 Unit / hour

Table 14: Technical Specifications for an 8 TPD Briquetting Plant

Product and Raw Materials		Electricity/Power Requirements	
Item/Description	**Specifications**	**Item/Description**	**Specifications**
Finished product	75 mm diameter, 50-350 mm in length cylindrical briquettes	Required power connection	59hp/45 kW
Production capacity	800-1,000 kg/hour depending on raw materials	Amp. load	59-73 Amp approximate
Raw material size & moisture content	Up to 10 mm size raw materials of 8-12% moisture content	Power consumption	Unit / hour

Source: Hamusimbi 2019

Furthermore, the proposed briquetting or pelleting plants will require about 6,000 square metres of land where to build a project, product storage, office space and space for raw materials bulking and future expansion.

The plants will start with a single 8-hour shift operations for 150 days (from June/July to November/December) per year. Production is expected to increase by 16 per cent annually until it hits 300 days of production per annum. The 300 days will be achieved by both introducing double production shifts during the harvesting period, when raw materials are abundantly available, and by building raw materials storage facilities for off-season processing.

4.2.3.2 Estimated Capital Investments for Briquette Plant in Zambia

Planned capital investments will include a complete pelleting or briquetting plant mill with raw materials handling equipment, a tractor, trailer, a tractor driven raw materials chippers and a hammer mill in case of the pelleting project; and a light truck for product distribution to markets.

A 6.4 TPD pelleting mill costs around US$ 45,000 ex-factory inclusive of all materials handling equipment, while an 8 TPD briquetting project costs about US$ 40,000 ex-factory inclusive of all materials handling equipment. Most pelleting and briquetting mills are modular and their TPD capacity can easily be increased by adding on more units. Smaller mobile pelleting mills of up to 3 TPD cost around US$ 27,000

and bigger briquetting mills are also available and/or could be tailor made. India and China are the leading manufacturers and suppliers of most pelleting and briquetting technologies currently on the market. Though some countries in Europe also do manufacture such equipment.

Table 15 shows estimated total project development costs for an 8 TPD briquetting project of US$ 113,688 while 6.4 TPD pelleting project, the cost is US$ 111,050. The total amounts for both include costs for the land and building, project and equipment and assorted equipment such as tractor and trailer, light truck and a raw materials chipper. Plant development fees are assumed to be 5 per cent of all the other capital costs.

Table 15: Total Briquette and Pellet Capital Investment in Zambia (US$)

Capital expenditure	Briquetting Plant	Pelleting Plant
Land and building	17,750	10,250
Project and equipment	40,000	45,000
Hammer mill	10,000	10,000
Tractor & trailer	18,000	18,000
Light truck	15,000	15,000
Chipper	4,000	4,000
Brailing machine	4,000	4,000
Project Development Fees	4,937	4,000
Total capital investment	**113,687**	**111,050**

Source: Hamusimbi 2019

The main operational cost centres for a pelleting project or a briquetting mill will include:

- Salaries and wages for up to 6-8 labourers, 2 skilled machine operators, a supervisor and 2 drivers. Salaries and wages will account for 6 per cent of total operational costs;
- Electricity costs which at the estimated daily consumption rate of 25-30 units/hour will account for 7 per cent of total operational costs;
- Repairs and maintenance which are estimated at 10 per cent of total operational costs;
- Marketing and selling costs estimated at 20 per cent of total operational costs;
- Packaging costs estimated at 1 per cent of total operational costs;
- Raw materials costs have been estimated to account for 40 per cent of total operational costs; and
- General expenses estimated at 20 per cent of total operational costs.

The estimated operating average costs for the first 5 years is around US$ 257,750. Of this cost, the major share is that of raw materials as shown in table 16.

Table 16: Proposed Briquette and Pellet Plant Operational Cost Structure in Zambia

Description of Variable Costs items	Proportion of total (%)
Raw materials	40
Electricity	7
Wages and salaries	6
Marketing and selling costs	20
Repairs and maintenance	10
Packaging	1
General expenses	16
Profit margins	18

Source: Hamusimbi 2019

With the above operational cost structure, the proposed briquetting and pelleting models assume a conservative profit margin of 18 per cent. This profit margin means that 82 per cent of the turnover is taken up by operational costs, which give the model some flexibility in covering any unforeseen costs early in the projects.

4.2.3.3 Financial Analysis of the Briquetting and Pelleting Plants in Zambia

Table 17: Detailed Briquetting Project Revenue and Operational Costs

	Y1	Y2	Y3	Y4	Y5	Y6
Revenue (USD)						
Sales	168,000	212,419.20	268583	339,596	429,385	468,030
Total revenues	**168,000**	**212,419**	**268583**	**339,596**	**429,385**	**468,030**
Operating Costs						
Raw materials	55,104	69,673	88,095	11,388	140,838	153,514
Electricity	9,643	12,193	15,417	19,493	24,647	26,865
Wages and Salaries	8,266	10,451	13,214	16,708	21,126	23,027
Marketing & Selling costs	27,552	34,837	44,048	55,694	70,419	76,757
Repairs and Maintenance	13,776	17,418	22,024	27,847	35,210	38,378
packaging	1,378	1,742	2,202	2,785	3,521	3,838
General Expenses	22,042	27,869	35,238	44,555	56,335	61,406
Total Operating Expenses	**137,760**	**174,184**	**220,238**	**178,469**	**352,096**	**383,785**
Earnings before interest and Tax (EBIT)	30,240.00	38,235.46	48,344.91	61,127.30	77,289.36	84,245
Debt Service						
Interest	6,8434	5,979	5,019	3,953	2,770	1,457
Principal	7,862	8,727	9,687	10,753	11,935	13,248
Total Debt Service	**14,706**	**14,706**	**14,706**	**14,706**	**14,706**	**14,706**
Cash flow Available to Equity (Surplus/Deficit)	**15,534**	**23,529**	**33,639**	**46,422**	**62,584**	**69,540**

Source: Hamusimbi 2019

The proposed 8 TPD is expected to start producing briquettes at 1,200 MT and will increase at an annual rate of 16 per cent. The selling price has been set at US$ 140 per MT and is expected to increase by approximately 9 per cent due to inflation-related changes. The 1,200 MT of briquettes will therefore be worth approximately US$ 168,000. Table 17 illustrates the expected sales revenue from briquettes, with a 16 per cent annual increase in output through year 6. The table shows the positive cash flow meaning that the briquetting project can pay its debt.

On the other hand, the profiled pelleting project on the other hand is expected to produce an initial quantity of is 960 MT of pellets during its first year, during which it is expected to operate for a maximum of five months. Initial pellets production volume is expected to increase at an annual rate of 16 per cent. At US$ 140 per ton, year one pellets output will be valued at US$ 134,400. Table 18 shows detailed profit and loss analysis for the pelleting model. The cash flow is also positive for the 6 years and this means that the pelleting project can also manage to pay its debt.

Table 18: Detailed Pelleting Project Revenue and Operational Costs

	Y1	Y2	Y3	Y4	Y5	Y6
Revenue (USD)						
Sales	134,400	169,935	214,866	271,677	343,508	374,424
Total Revenues	**134,400**	**169,935**	**214,866**	**271,677**	**343,508**	**374,424**
Operating Costs						
Raw Materials	44,083	55,739	70,476	89,110	112,671	122,811
Electricity	7,715	9,754	12,333	15,594	19,717	21,492
Wages and Salaries	6,612	8,361	10,571	13,366	16,901	18,422
Marketing & Selling costs	22,042	27,869	35,238	44,555	56,335	61,406
Repairs and Maintenance	11,021	13,931	17,619	22,278	28,168	30,703
Packaging	1,102	1,393	1,762	2,228	2,817	3,070
General Expenses	17,633	22,296	28,190	35,644	45,068	49,124
Total	110,208	139,347	176,190	222,775	281,677	307,028
Earnings Before Interest and Tax (EBIT)	**24,192**	**30,588**	**38,676**	**48,902**	**61,831**	**67,396**
Debt Service:						
Interest	7,330	6,404	5,376	4,234	2,967	1,561
Principal	8,421	9,348	10,376	11,517	12,784	14,191
Total	**15,752**	**15,752**	**15,752**	**15,752**	**15,752**	**15,752**
Cash flow Available to Equity (Surplus/Deficit)	**8,440**	**14,837**	**22,924**	**33,150**	**46,080**	**51,645**

Source: Hamusimbi 2019

4.2.3.4 Investment Viability Assessment of the briquetting and pelleting projects

Financial viability analysis of the proposed 8 TPD briquetting and a 6.4 TPD pelleting plants were done using: i) net present value (NPV); ii) internal rate of return (IRR).

The Net Present Value (NPV) was used to assess the added value to be generated by the proposed cotton stalks and other biomass for a briquetting and pelleting investment projects. NPV calculation was based on assumption of 9 per cent as a required rate of return, i.e. based on Zambia's Eurobonds prevailing interest rates, which are hovering at approximately 8.5 per cent per annum. The results show that, after repaying capital investments, operating costs and debt, the proposed biomass briquetting project has an NPV of US$ 65,478 after six years. While the proposed pelleting project has an NPV of US$ 10,182 after six years of operation. The positive NPV shows that the investment projects could be positive to the investor(s).

On the other hand, internal rate of return (IRR) was another metric which was used to assess financial viability of the proposed cotton stalks and other biomass for briquetting and pelleting investment projects. As a viability metric IRR measures the annual return that the project would be generating for the project investors/owners. In other words, this is a measure of the maximum cost of the fundraising activity, in order to maintain project profitability. The proposed cotton stalks and other biomass for a briquetting and pelleting investment projects have an IRR of 24.6 per cent and 11.5 per cent, a much higher figure than

the 8.5 per cent WACC respectively. This means that the projects' returns are much higher than the cost of setting up the projects and therefore the projects could be profitable to the investor(s).

4.2.3.5 Socio and Development Impact

The proposed pelleting project and briquetting mill investment projects were also evaluated for their alignment with national development priorities, jobs creation potential, benefits to local community players, and for their ecological soundness. Results of this appraisal exercise are summarized below.

Proposed investments in cotton stalks and other biomass processing into solid bioenergy for cooking and heating fits perfectly well with Zambia's current development priorities seeking to promote value addition of most agricultural products; jobs and wealth creation especially among youths and women in rural areas; and contribute towards Zambia's ongoing efforts of achieving universal access to modern cooking fuels by 2030.

On the other hand, the proposed projects will create a number of job opportunities starting with biomass suppliers in rural areas, transporters, briquetting/pelleting project workers, wholesalers and retailers. An 8 TPD briquetting and 6 TPD pelleting mills are capable of creating the following jobs:

- Over 400 youths and women each supplying over 5 MT of cotton stalks and other agro-residues at US$ 25 per ton;
- Over 6 biomass pre-processing jobs (tractor and biomass chipping and baling operators and loaders);
- Over 10 unskilled, 2 skilled machine operators, and a supervisor in the biomass processing plant/mill;
- Over 3 drivers for value-added products distribution/transportation to markets; and
- Many more indirect jobs in wholesaling and retailing of biomass pellets and briquettes.

The pellets or briquettes is a transformative venture capable of providing farmers and entrepreneurs an additional source of income. At 2,400 MT production per year, an 8 TPD briquetting and 6.4 TPD pelleting mills are capable of contributing over US$ 60,000 income to biomass producers. Once well-established cotton stalks processing will provide cotton farmers with additional income ranging from US$ 25 – 75 per hectare. This value addition of cotton by-product will ultimately help revitalize smallholder farmers' interest in growing cotton. Cotton stalks and other biomass value addition investments will also contribute up to US$ 36,000 income to biomass pre-processors (chipping and transporter/distributors) to the processing mill. This will bring the potential income from biomass supplying and pre-processing close over US$ 100,000 for an 8 TPD cotton stalks briquetting and pelleting projects.

Cotton stalks processing will be done and during after cotton harvesting when most labour from rural youths and women is idle. This is meant to make maximum use of cotton stalks and other agro-residues which currently are mostly destroyed.

Pellets and briquettes from cotton stalks and other agro-residues can also be produced and sold at up to US$ 20 per MT lower than charcoal, assuming a cost-effective supply of raw materials. Based on an average calorific value of 4,100 kcal/kg, 2,400 MT of cotton-based pellets would result in a savings of US$ 48,000, relative to charcoal, making them a cheaper, cleaner more efficient substitute for firewood and charcoal.

4.2.3.6 Legal and Policy Environment

Zambia has a range of supportive national policies and an adequate legal corpus for the planned investments in biomass processing into modern cooking and heating fuels. Key among the development policies is Zambia's Seventh National Development Plan (SNDP 2017-21). The SNDP sets out Zambia's

envisioned development agenda anchored on creating a diversified and resilient Zambian economy for sustained growth and socio-economic transformation driven, among others, by agriculture, tourism, manufacturing and mining. The SNDP plans attaining these goals through value addition and industrialization of agriculture and tourism, amongst other sectors with high growth, poverty reduction and job creation potential. Therefore, the development of the cotton by-products responds well to the key goal of the plan.

The 2nd National Agriculture Policy (NAP) is another key national development policy which seeks to develop "an efficient, competitive and sustainable agricultural sector, which assures food and nutrition security, increased employment opportunities and incomes". Improved cotton stalks processing is also in line with the NAP prime objective increased employment opportunities and incomes. Cotton is one of the eight manufacturing subsectors prioritized under the National Industrial Policy 2018.

The proposed cotton stalks processing investment projects also fits well with the National Industrial Policy 2018 (NIP), which seeks to transform Zambia "*from a producer and exporter of primary products into a net exporter of value-added goods utilizing local primary resources with increased citizens' participation*". Specifically, the NIP aims at increasing growth of the manufacturing sector from an average of 5 per cent to 20 per cent and its contribution to GDP from 8 per cent to 15 per cent by 2027. NIP implementation is expected to stimulate and encourage value addition activities on primary commodities as a means of increasing national export earnings and creating employment opportunities and ultimately transforming the Zambian economy into a diversified and competitive industrialized economy well integrated into the international trading system.

The planned cotton stalks and other biomass value addition investment projects are also in line with Zambia's Youth Development Policy which seeks to promote the economic participation of Zambian youths in national development through employment creation and entrepreneurship development. Once formalized, cotton stalks and other biomass processing provides better avenues for poverty and vulnerability reduction, offers enhanced self-employment opportunities, promotes entrepreneurship, and remains as one of the few local based enterprises with better employment multiplier effects due to higher returns on investment.

Zambia has adequate legal corpus to facilitate and nurture planned investments in cotton stalks and biomass processing into cooking and heating fuel. Primary legal frameworks include the Zambia Development Agency Act which facilitate SMEs development, investment promotion and trade; the Citizens economic Empowerment Act of 2006; the Business Regulatory Act of 2014; the Compulsory Standards Act of 2017; the National Technical Regulations Act of 2017; and the Patents Act of 2016. Current investment, contract, labour competition, environmental management, consumer protection and metrology laws are also adequate to support the planned investments in cotton stalks and other biomass processing into modern cooking and heating fuels in Zambia.

4.2.3.7 Risks and Mitigation

Success of the proposed biomass processing investments will hinge on cost-effective collection, pre-processing and delivery of raw materials to the pelleting/briquetting project. Other key success factors will include the robust product development and promotion, and the competitiveness of the proposed pellets and briquettes. The matrix below summarizes major risks which will require to be mitigated if the proposed investments are to be viable and sustainable.

Table 19: Identified Risk and Possible Mitigation Measures

Risk	Proposed Mitigation Measure(s)
1. Short supply of adequate, affordable raw materials	Diversified raw materials to include: • Soybean straws in May/June, • Maize stover and cobs starting July/August, • Cotton stalks August/September. • Use of raw materials aggregators, • Special price offers for raw materials supply
2. Raw materials transportation challenges	• Use of mobile raw materials processing/chipping • Customized pre-processed raw materials transportation and other logistics
3. Limited operation window	• Investment into affordable raw materials storage, and • Investment into raw materials driers
4. Poor demand for pellets and briquettes	• Robust pellets promotion as alternative cooking energy among households • Promotion of briquettes as heating energy alternative for industrial boiler users • Strategic alliances with energy-saving technologies promoters and environmental conservationists
5. Competition from existing pellets and briquettes	Strategic locations: • Closer to demand centres of Eastern, Southern and Central Provinces for low output transportation costs; • Within high potential cotton, soybeans and maize production areas for effective raw materials collection/sourcing; • Use of a market penetration pricing of US$ 40/MT, i.e. US$ 20/MT less than that of charcoal
6. Cost of financing	• Blended financing/investment structure of 40 per cent equity and 60 per cent debt financing • Preference for impact and other low-cost debt financing sources, • Up to six years project period.
7. Pelleting and briquetting technology challenges	• Use of tested/proven pelleting and briquetting technologies from countries leading in biomass pellets and briquetting R&D and promotion; and • Extensive technologies user trainings for maximized production efficiencies and product performance

Source: Hamusimbi 2019

4.2.4 Biomass Briquette from Cotton Stalks in Zimbabwe

4.2.4.1 Introduction

Considering the quantity of cotton stalks biomass that is destroyed through burning, a biomass briquetting is proposed. Biomass briquettes are an effective source of energy which is biodegradable and renewable. They can be a cost-effective substitute for coal, fuel oil, wood or charcoal, in selected industrial and commercial applications.

A 20 TPD capacity Briquetting project based on Patil P. G. 2017 is proposed for this investment profile in order to show its economic viability using the cotton stalks as feedstock in Zimbabwe. The proposed site for the plant is Gokwe district, north of Harare because of its high cotton production (Hove 2019). Table 20 below shows the technical specifications of the raw materials (cotton stalks) and the final products (briquettes). After cutting the cotton stalks, the material would be chipped into small pieces of about 6-8 mm and with the water content of 10-15 per cent. The chipped raw materials help in not clogging the briquette machine during the production of the briquettes. The 20 MT TPD machine will produce about 75-90mm diameter cylindrical briquettes.

Table 20: Technical Specifications of 20 TPD Briquetting Project

Items/Description	Specifications
Finished product	75 - 90 mm diameter cylindrical briquettes
Production capacity	20MT/day production capacity
Raw materials	6-8 mm chipped cotton stalks having 10-15% moisture content

Source: Hove, 2019

4.2.4.2 Capital Investments in the Briquette Project

The start-up budget for the briquetting project is estimated at US$ 200,000, comprising capital and operations expenditures of US$ 100,000. The capital expenditure includes the land, equipment purchase, a mortgage deposit, two years of mortgage payments, and site construction costs. The start-up budget includes the cost of both a pickup truck and trailer, which are necessary for both collecting the raw biomass cotton stalks and delivering the finished biomass briquettes to customers.

The initial deposit for the land on which the project is located (including two years of mortgage payments) forms part of the capital cost. Another component of the cost is the project set up, equipment and the process of briquetting itself. The first component of the operational costs is the price of buying cotton stalks from the source. For the farmer, this is an opportunity for waste disposal, so there is little cost added at this stage. Transport, both from cotton fields to the briquette project and from there to the end user, adds a significant amount to the briquette cost. Storage of the cotton stalks and packaging of the briquettes also add to the cost structure. Detailed start-up costs are as on table 21.

Table 21: Capital and Operating Expenditures for a Briquetting Plant

COST ITEM	COST ESTIMATE (US$)
Kiln	2,500
Briquetting machine	23,600
Grinder	900
Drying racks for biomass briquettes	380
Drying racks for cotton stalks	380
Plastic crates	75
Electrical cords	38
Cleaning supplies	38
Promotional materials	56
Safety equipment	150
One-year mortgage deposit plus 24-month payments	27,600
Infrastructure adaptations to operations site, adaptation of machines to local conditions	6,800
Truck and trailer (3 tonne)	11,000
Additional equipment costs (computers, etc)	16,000
Operational and labour training	5,000
TOTAL	**94,517**

Source: Hove 2019

Assumptions:

1. All costs/ prices are in United States Dollars (US$).
2. Pricing for project and equipment sourced from B2B (Business to Business) briquette project suppliers online and compared with various briquette marketplace websites.
3. Other prices are Zimbabwe market related.
4. Training includes bringing in an expert to train local personnel.

Table 22 show the percentage of profit margins and cost (capital and operational costs) to revenue accrued to the briquetting project. The results show that the percentage of gross margin is 44 per cent, 47 per cent and 49 per cent for year 1, 2 and 3 respectively. This means that 56 per cent, 53 per cent and 51 per cent of revenue is taken as capital and operational costs.

Table 22: Percentage of Cost and gross margins to revenue

Year	Y1	Y2	Y3
Cost (Capital and operational)	56%	53%	51%
Profit Margin	44%	47%	49%

4.2.4.3 Financial Analysis

Financial projections detailed in this document include start-up cost estimates, year 1 – year 3 (2019-2021) cash flow projections, and an income statement. The start-up budget, cash flow projections and income statements were created from a template created based on the Investment Profile for briquettes

report in Zimbabwe (Hove 2019). Prices were obtained from the Zimbabwean market for products which were locally available.

The income and expenditure projections for the project in Zimbabwe are for the first three years of operations. For Year 1, table 23 shows the expenditure structure for the first six months of operations, these numbers would be consistent over three years. It is assumed that the monthly production peak of 20 MT/ day, and 600 MT/ month will be considered. The anticipated production of 200 MT of briquettes will be packaged in 10,000 x 20 kg bags of briquettes per month (200 MT). Revenue estimates assume the sale of 8,000 x 20 kg bags of briquettes per month (160 MT). The estimated market entry price of a 20 kg briquette bag will be sold at US$ 10 each, aligned to the current Zimbabwean price of charcoal (Hove 2019).

It is assumed a 12-year loan of US$ 200,000 with 7 per cent interest will be accessed from a financial institution, the facility also allows for 24 months of interest only repayments to allow the business the opportunity to stabilise. Other options for raising start-up capital, could be a combination of debt and equity funding, thus selling a portion of the business to another potential investor or investing institution. The capital equipment depreciation is calculated at five years.

Table 23: Monthly expenditure for 6 months

Description of cost items		Month 1	Month 2	Month 3	Month 4	Month 5	Month 6
Cotton stalks purchase and collection (including transport)	@ 600 MT/ month	37,950	37,950	37,950	37,950	37,950	37,950
Bags	@ 10 kg bags x US$ 2.00 per bag	6,000	6,000	6,000	6,000	6,000	6,000
Cost of Production		**43,950**	**43,950**	**43,950**	**43,950**	**43,950**	**43,950**
Utilities costs	Electricity @ US$ 400/ month water @ US$ 100/ m	500	500	500	500	500	500
Admin Costs- phone, internet	@ 100 pm	100	100	100	100	100	100
Labour Costs 6 shifts/ day 1 manager	@ US$ 400 pm and US$ 1,000	3,400	3 400	3 400	3 400	3 400	3 400
Total Cost	**Operational costs**	**47,950**	**47,950**	**47,950**	**47,950**	**47,950**	**47,950**

Source: Hove 2019

Assumptions:

1. All costs are in United States Dollars (US$).
2. Raw material quantity allocation is as per Patil P.G. 2017 @ 1.3 MT per ha. Gokwe has the capacity to produce 117,000 MT (see Table13 above) of cotton stalks, of which the briquetting project would consume an estimated 10,000 MT.
3. The above calculations are based on a briquetting project whose capacity is 20 MT/ day, or 600 MT/ month (Source: Patil P.G. 2017, CIRCOT)
4. The above calculations assume paying farmers an average price for chipped stalks of US$ 43.25 per MT and an average logistics cost to deliver the feedstock to the project of US$ 23 per MT (Source: Patil P.G. 2017, CIRCOT).

5. Not included in the table (but included in the financial model) is an estimated monthly allocation of US$ 20,000 for awareness raising, marketing, sample distribution and skilled consultants. We have also catered for recruitment costs, and sundries.

According to the income statement presented in table 24, at the end of Year 1, a net profit after interest of over US$ 143,249 will be obtained. Year 2 ends with a net profit of nearly US$ 200,000, Year 3 profit is US$ 264,184. The operating profit margin, based on 20 MT/ day is slightly over 44 per cent. An additional US$ 10,000/ month of expenses has been allocated to the cost of initial marketing, distribution of samples to potential customers and overall community education on biomass briquettes. Another US$ 10,000/ month in expenses has been allocated to management and consultants.

Table 24: Financial Projections for three years (US$)

Profit and Loss Summary	Year 1	Year 2	Year 3
Revenue	960,000	1,056,000	1,161,600
Costs	-534,600	-561,330	-589,397
Gross Margin	**425,400**	**494,670**	**572,204**
Total Expenses	-268,500	-281,925	-296,021
Net Profit before Interest	**156,900**	**212,745**	**276,182**
Interest	-13,651	-12,853	-11,998
Net Profit After Interest	**143,249**	**199,892**	**264,184**

Assumptions:

1. Based on a 20 MT/day capacity plant (600 MT/ month).
2. Capital loan amount is US$ 200,000.
3. Production of 10,000 x 20 kg bags of briquettes per month (200 MT).
4. Sales of 8,000 x 20 kg bags of Briquettes per month (160 MT).
5. 20 kg Briquette Bags sold at US$ 10 each- aligned to the current Zimbabwean price of charcoal. (Zimbabwe classifieds, Zimcart www.zimcart.com as at 17 December 2018).
6. Interest is at 7 per cent for a 12-year loan with 24-months of interest only payments
7. Staffing caters for recruitment of two high level experts to launch the project.
8. Also included are company registration and other statutory costs.

The low cost of raw materials into a briquetting plant allows the project to be viable. Revenue for Year 1 is projected at US$ 960,000; Year 2 is projected at US$ 1,056,000 and Year 3 US$ 1,161,600. Contingencies have been allowed for fuel cost, which is a key component of the ongoing project cost.

4.2.4.4 Investment Viability Assessment

According to table 25, at the end of year 1, the cash-flow projection shows a cash balance of US$ 122,349. This is based on a production volume of 7200 MT/annum. However, over US$ 200,000 in start-up funding needs to be raised, of which about US$ 100,000 is set aside for capital expenditure. Positive year-end cash balances continue through year 2 at US$ 310 696 and nearly doubles in year 3

at US$ 547,638. With respect to the repayment of the loan, the cash flow projection assumes that only interest payments will be made in Years 1 and 2, with principal repayment commencing in year 3.

Table 25: Financial Analysis of the Briquette Plant Investment

Description	Year 1	Year 2	Year 3
Opening Balance	0	122,349	310,696
Loan Repay and interest	200,000	0	0
Capital Expenditure	-150,000	0	0
Cash In	800,000	1,040,000	1,144,000
Costs	-445,500	-556,875	-584,719
Depreciation	0	0	0
Expenses	-268,500	-281,925	-296,021
Interest	-13,651	-12,853	-26,318
Closing Balance	**122,349**	**310,696**	**547,638**

Source: Hove 2019.

The Financial Analysis Table shows similar results with a net income of US$143,249 in year 1, US$ 199,892 in year 2 and of US$ 264,184 in year 3 in the Financial Projection Table. The gross profit is slightly above 44 per cent. Results from the Financial Analysis Table demonstrates that increased raw materials and scaling-up production would provide a significantly higher operating profit margin, accompanied by a higher margin of safety, lower risks, and substantially greater net income.

Investment viability analysis of the proposed 20TPD briquetting plant investment project is done using the net present value (NPV). The NPV calculation was done based of 7 per cent interest rate on loan from a commercial bank. After repaying capital investments, operating costs and debt for the proposed briquetting plant has an NPV of US$23,302 after 3 years. Since the NPV is positive, this shows that the briquetting project is financially viable.

4.2.4.5 Legal Requirements and Policy Environment

Several regulations apply to the start-up of an enterprise. Before the business can commence production of biomass briquettes an Environmental Impact Assessment (EIA) need to be conducted. The Standards Association of Zimbabwe (SAZ) also needs to be engaged in order to standardisation the quality of briquettes.

Zimbabwe's political landscape has seemingly changed from the better following the resignation of President Robert Mugabe in November 2017. The indigenisation policy of 51 per cent local ownership for companies has been scrapped for all sectors except diamond and platinum mining. Zimbabwe Investment Authority (ZIA) is the country's investment promotion body, established to promote and facilitate both foreign and local investment.

To establish a business in Zimbabwe, company registration is required, followed by ZIA investment licensing, operational, residence and work permits for foreign investors. Therefore, the period required for registration has been shortened thereby making it easier to invest in Zimbabwe. The process is detailed in table 26 below.

Table 26: Procedure for Investing in Zimbabwe

Steps		No of days to process
1	Registration of Company: Fill in MOU and Articles of Association with Registrar of Companies, CR6 & CR14 Form	14
2	Issuance of Investment license by ZIA	5
3	Zimbabwe Revenue Authority: Registration for PAYE, income tax, VAT, customs duty	5
	Zimbabwe Revenue Authority: Immigrants rebate	1
4	Immigration Control Department: Investor Residence Permits	14
5	Immigration Control Department: Temporary Employment permits	4-6
6	Environmental Management Authority: Environmental Impact Assessment (EIA) Licence	30
7	Environmental Management Authority: Prospectus submission EIA Report	60

Source: Zimbabwe Investment Authority publication – One Stop Shop.

While the Zimbabwe Investment Authority will in the initial phase direct the Investor on how to go about establishing themselves as a business in Zimbabwe, line Ministries however will play the role of guiding the investor. In most cases, the Ministry of Industry and Commerce will take on the responsibility of assisting the investor in setting up their business in Zimbabwe.

Taxation in Zimbabwe is made to Zimbabwe Revenue Authority (ZIMRA) and the rates are as detailed in table 27 below. The tax rates below are as at 1st November 2018.

Table 27: Breakdown of the Tax Structure in Zimbabwe

Zimbabwe Taxes	Last	Previous
Personal Income Tax Rate	51.50	45.00
Corporate Tax Rate	25.75	25.75
Sales Tax Rate	15.00	15.00

Source: Zimbabwe Investment Authority

Zimbabwe uses a basket of multi-currencies for its trade and investment transactions. The multi-currency system was introduced in 2009. These currencies include the United States Dollar (US$), Great Britain Pound (GBP), South African Rand (ZAR), Botswana Pula (BWP), the Euro, Japanese Yen (JPY), Australian Dollar (AUD), Chinese Yuan (CNY) and the Indian Rupee (INR).

Authorised Dealers (banks) can open accounts for both individuals and corporates, in any of the nine (9) currencies in the multicurrency basket. Any of the currencies in the multicurrency basket can be used for settlement of both local and international transactions. Furthermore, Authorised Dealers can receive export proceeds on behalf of account holders in any of the currencies in the multicurrency basket (GoZ, 2018a).

Table 28: Real GDP at Market Prices (US$ millions)

Year	Real GDP, US$ millions
2013	13,572.80
2014	13,861.50
2015	14,095.71
2016	14,182.50
2017	14,551.44

Source: Economic Research Division, Reserve Bank of Zimbabwe.

Agriculture is the lifeblood of Zimbabwe's economy. Tobacco, cotton, maize and sugarcane, among others provide a livelihood for 70 per cent of the country's predominantly rural dwelling population. According to the Reserve Bank of Zimbabwe, the economy was expected to grow by 4.5 per cent in 2018, spurred by a 10.7 per cent growth in agriculture (table 28). (Source: Economic Research Division, Reserve Bank of Zimbabwe, 2018)

The government working with the private sector has embarked on a drive to develop exports across the board with focus on value addition clusters that include the Cotton to Clothing cluster as one of the main pillars of this programme. Government has also undertaken steps to improve the 'Ease of Doing Business in Zimbabwe' which is a drive at ensuring that new investors, especially foreign investors, face minimal hurdles when setting up operations in Zimbabwe (ZIA, 2018).

All the economic development indicators are anchored in the Transitional Stabilisation Programme (TSP), and it was launched by the Minister of Finance in 2018 (GoZ, 2018b). The Transitional Stabilisation Programme (TSP) outlines policies, strategies and projects that guide Zimbabwe's social and economic development interventions up to December 2020. The reforms are intended to run from October 2018 to December 2020. The vision of the Government led programme is "Towards a Prosperous and Empowered Upper Middle Income Society by 2030". Investment themes in the TSP that are relevant to investment in Zimbabwe include (among others): Ease of Doing Business, Resuscitating Industry and Industry Development.

The government of Zimbabwe recognises the cotton industry and its value chain as a pillar in the revival of the economy and has worked with its private sector as well as regional and international donors to draft the Cotton to Clothing Strategy. The strategy aims to deliver by 2019, increase in the number of smallholder farmers growing seed cotton from 200,000 to 250,000, increase by yield 71 per cent to 1,200kg/ha among others. It is been envisioned that the increase in yields and number of cotton farmers, would result in an increase of cotton by-products as well.

Zimbabwe is a member of regional groups such as COMESA and the investors can have preferential access, duty-free quota-free, to a market of 450 million people. Zimbabwe further provides investors a further access to the SADC Trade Protocol market, composed of 15 countries representing together a market of another 142 million people to whom they can export duty free.

According to the 2017 Inter-Censal Demographic Survey, conducted by the Zimbabwe National Statistics Agency (ZimStat, 2017), Zimbabwe's population is estimated at 13.6 million, of which 8 million, or 60 per cent are economically active. While the country's minimum wages are among the highest on the continent -US$ 200 per month in the textile sector and US$ 180 per month in the Clothing Sector - the quality of labour offsets this cost. The highly skilled labour force reduces the cost of engagement and training over the immediate and short term. Furthermore, the government along with other stakeholders currently lobby the worker's Trade Unions to re-assess wages.

4.2.4.6 Risk Identification

Key risks and mitigation measures have been identification for the development of the briquetting plant in Zimbabwe as shown in table 29 below:

Table 29: Risks and Mitigation Measures for the Development of the Briquettes Industry

Risk	Proposed Mitigation measure
Supply Side Issues	Due to unavailability of cotton stalks outside of the harvesting seasons, the briquette plant must invest in stockpiling raw material and also use other agricultural crop residues such as maize stover, wheat and soybeans straws in order to maintain a year-round production
Technology Issues	The machines used for this purpose have high wear-and-tear costs and parts need to be replaced frequently. Therefore, there is need to link up with manufacturers of these equipment in order to have a consistent supply. Second, there is need to build capacity with local fabrication companies in so that service parts could be manufactured locally.
Market Related Issues	Fluctuations in raw material prices are a possible risk. Once farmers realize that the raw materials have a commercial value, they may raise raw material prices to uneconomic levels. It is important for briquette plants to maintain surplus space to store enough quantities of raw material to make them relatively immune to price fluctuations.
Infrastructural Problems	The briquette plant is to be located in a rural town (Gokwe) where the cotton is grown and stalks are abundant, but power supply is unreliable. There is need to also think of improving the infrastructure in rural areas in order to attract potential investors.
Corruption	Be professional, ethical and transparent. Report all cases to the police or relevant authorities.
Liquidity crunch	Mobile money through partnering with Ecocash, Telecash, and One Money is the way to go. Innovation with technology driven payments should be prioritised. Rolling out of point of sale machines from the start will be an advantage.
Ease of doing business	Follow all due diligence procedures. There are government to government bilateral agreements between Zimbabwe and numerous countries that ring-fence investors and their private property.

Source: Hove 2019

5. Lessons Learnt from the Project

Understanding the lessons learnt from the project activities can help the implementation of future project activities and the replication of the project in other countries. Therefore, this chapter highlights the general lessons from the project activities. Specifically, it highlights the lessons learnt from the study tour to India trip that was organized for some value chain actors from participating countries. Finally, the chapter highlights the key lessons from the South-South cooperation activities from Uganda, Zambia and Zimbabwe.

This chapter is based on a review of project materials and interviews with project participants, including those who participated in the study tour to India.

5.1 General Lessons Learnt from the Project Activities

Several general lessons have been learnt since the inception of the cotton by-product project that can affect the refine the development of the project and also the design of new projects in the cotton by-product. This sub-section highlights the general lessons that were learnt from the project activities.

5.1.1 Seed cotton production, raw material and economies of scale

The first lesson is that adding value to lint or cotton by-products relies on an adequate supply of raw material. Increasing seed cotton production therefore yields more raw material from all parts of the plant, contributing to economies of scale in any value-added industries. For example, in 2011/12 agricultural season, the area under cotton was highest in a decade in all three project countries, which translated into high seed cotton production and an abundant supply of raw material to processors of lint and cottonseed.

5.1.2 Business opportunities enhanced

Since the project started, there has been enhanced awareness of the business opportunities available with cotton by-products. Apart from the cottonseed value chain, which is more developed in all the participating countries, stakeholders now know that business opportunities are also found in cotton stalks, absorbent cotton wool, and mushroom production using cotton stalks as substrate, for example. Furthermore, governments or their agencies are also preparing and making sure the environment is attractive for private investment in some of these value chains. A good example is CDO recalling the SATU cotton seed variety (short-staple fibre that is suitable for producing absorbent cotton wool) that was shelved from the market after spinners began demanding longer fibres. But now after this awareness, the CDO felt the need to start multiplying the seed variety in readiness to start growing it commercially for the growing absorbent cotton market.

5.1.3 Paradox of edible oil trade deficits and excess domestic capacity

There has been reports of trade deficit in project countries with regard to edible oils (Kabwe 2017, Chigumira, 2017, Lugojja 2017). For example, in Uganda the demand for edible oil is estimated at 120,000 MT of edible oil annually, of which local mills produce and supply about 40,000 MT. The deficit is filled up with imports. This represents a business opportunity for ginning companies and oil mills to invest in modern oil extraction equipment to replace imports with domestic production. The situation is

similar in Zambia and Zimbabwe, where imported palm oil is the main component in an edible oil trade deficit.

5.1.4 Cotton production in Africa is small-scale

Cotton is an important crop in Eastern and Southern Africa, and source of export revenue, value added and a cash income for rural population. However, only a few of them are producing sufficient quantities of seed cotton to achieve economies of scale. The size of fields for the majority of cotton smallholder farmers is less than 1 hectare and productivity is often well below 1,000 kg/ha. With these factors, most of the farmers do not reach the economies of scale necessary to produce lint that is cost competitive on international markets. Cotton production in Africa depends on small-scale farmers and therefore requires policies adapted to their needs.

5.1.5 Governments and ginners can help develop by-products

Cotton is one of the key crops identified in the project countries for industrialization. As such, governments need to provide an enabling environment for private sector investment in the value addition. As the key commercial node in the value chain, ginning companies can also help in developing cotton by-products. For example, a few ginneries in the three project countries have invested in edible oil production plants to utilize the cottonseed they produce. Furthermore, in Zambia, the ginning companies are involved in providing inputs and extension to cotton farmers. While in Uganda, all ginning companies contribute to a seed cotton production fund which is used to procure planting seed and provide extension services. Therefore, such activities may help develop cotton by-products through increased seed cotton production.

5.1.6 Cotton stalk-based fuels respond to policy priorities on forests

Fuelwood and charcoal are important sources of energy for many rural households and small industries in developing countries. Charcoal production in particular has risen in recent decades as demand has grown among urban populations and enterprises. And demand is high mainly in Sub-Saharan Africa (SSA) (FAO 2017). If this trend is not checked, the forests of many countries may be depleted. Therefore, cotton stalk-based fuels can help mitigate this environmental challenge due to charcoal production by many of Sub-Sahara African countries, including Uganda, Zambia and Zimbabwe. In Zimbabwe, tobacco production, especially the Virginia tobacco that requires wood fuel in curing, has exacerbated the situation of deforestation.

5.1.7 Relative prices of substitute fuels will determine viability of biomass briquettes/pellets

The relative prices of fuels such as charcoal, coal, fuel oil, LPG, etc, may affect the viability of biomass fuels. If for example, the price of biomass briquettes from cotton stalk is higher than the price of solid fuel substitutes such as charcoal and coal, it would be difficult to establish a biomass briquette value chain, since it may not be cost competitive. There is therefore need to conduct a detailed evaluation of biomass fuels' competitive viability and find strategies to make it more cost competitive.

5.2 Lessons from the Study Tour to India

With continued efforts of developing new opportunities of the cotton by-products for Eastern and Southern Africa, UNCTAD proposed a study visit to India in January 2019. The objective of the study trip was to improve capacity of cotton value chain stakeholders to assess the potential value, market situation and prospects for cotton by-products. UNCTAD selected the Central Institute for Research on Cotton Technology (CIRCOT) as the most relevant institution to host the study visit. This followed from CIRCOT's valuable contributions to the project's four national workshops. In addition, similarities between the cotton production model employed in India and the project countries – for example, in both cases, cotton is mainly hand-picked on small farms – meant that the value-added technologies developed at CIRCOT and commercialized in India are often well-suited to the African context. Therefore, this section highlights the key experiences and lessons learnt from the study visit by the project country participants.

Three key lessons emerged from participants' testimonials, namely: i) cotton farmers can earn extra income from the sale of cotton stalks, ii) use of cotton stalks and other agricultural biomass to make briquettes/pellets may help to reduce deforestation, which is a challenge faced by all participating countries; iii) good coordination between government research institutions and the private sector can help actualize technology development and commercialization.

Figure 8: Photo of Cotton Value Chain Stakeholders from Participating Countries and CIRCOT Staff

Photo credit: UNCTAD.

5.2.1 Cotton Stalks as an income earning venture for smallholder cotton farmers

In all the three participating countries, by law the cotton stalks are required to be burnt in order to prevent diseases from spreading to the next crop. Farmers saw cotton stalks as of no value. The introduction of the UNCTAD project on cotton by-product and especially with the study strip that was undertaken by the cotton stakeholders had helped stakeholders to view cotton stalks as a valuable product. Therefore, the lesson learnt from the study trip is that farmers can make an extra income from selling of cotton stalks for briquetting and pelleting making as asserted by all the participated that shared their visit experiences. Below are some quotes from cotton value chain stakeholders based on the Indian study trip.

*"The greatest lessons learnt was **innovation,** - turning something (crop residue – cotton stalks) which in my country our farmers throw and burn into valuable products (briquettes and pellets) was amazing" Adeva Gwezi, Communication Specialist – Zimbabwe Farmers Union.*

"A farmer can increase daily income by making a bit of transformation to the cotton they have. What is needed is to empower the farmers with the technologies appropriate to their income and environment" Thierry Kalonji - COMESA – Director of Industry.

5.2.2 Environment Preservation Technology

As highlighted earlier, deforestation is one of the key environmental problems faced in Uganda, Zambia and Zimbabwe. This is due to increase demand of biomass fuel such as charcoal, and wood fire. In Uganda 18 per cent of households depend on charcoal for cooking while another 78 per cent depend on firewood, totalling 96 per cent (GoU 2016). In Zimbabwe, the consumption of charcoal and firewood has also increased as well because firstly the majority of households are not connected to the electricity grid and depend on charcoal and firewood. Secondly, the smallholder farmers that took over commercial farms after the land reforms, use firewood in the tobacco curing process because the majority cannot afford to buy to coal for curing. Therefore, the solution to this challenge of indiscriminately cutting of trees for biomass fuel is finding alternative energy sources for urban and rural markets. Briquettes or pellets production from cotton stalks can fill up that challenge. Sentiments from cotton value chain stakeholders based on what they saw and learnt really confirms that briquettes/pellets can help ease the demand for forest biomass charcoal, which is seen as a driver of deforestation.

"Briquettes and pelleting can help us reduce the deforestation because it can be an alternative to biomass charcoal which has led to deforestation in my country". Michael Banda, Vice Chairman, Cotton Association of Zambia.

Despite that success, some value chain stakeholders raised concerns about health and safety standards observed in the briquette/pellet plants visited in India. They indicated that more needed to be done to ensure people working in those factories are protected. They recommended that for companies to start producing briquettes/pellets in the countries governments should ensure companies conform to protecting worker through providing ventilation systems and protective clothing and equipment. Furthermore, most of the participants indicated that the small-scale pellet stove mounted with a fan and powered by electricity, may not be an ideal one for Africa. This is because the majority of rural households have no access to electricity. Secondly, households in Africa use mainly carbonized charcoal, so it may be difficult to change the consumption preference of carbonized to non-carbonized briquettes/pellets. The lesson is to understand consumer preferences and then try to adapt the technology to them.

5.2.3 Organization of the Various Institutions

Another key lesson from the Indian trip that can help the development of technologies such as those seen in India was good organization among various public and private organizations. The public sector is there to develop technologies and make an enabling environmental for the private sector to commercialize the technologies that have been incubated. With good coordination and good environment, the private sector can invest and this can trigger economic development. Project country participants highlighted the key aspects of good coordination among public and private player as it was observed as a catalyst for cotton by-product development. Below are some of the quotes to emphasize that aspect:

"This mission was a success because it did not just concentrate on one commodity but focused on the entire value chain. Public and private sector have been working in the network, therefore, CIRCOT was able to know who is working where and what they are doing" Thierry Kalonji - Director of Industry COMESA

"The study trip was well organized and the content of material was rich. If I was to rate it, I would give it a 99.9 per cent" Meredieth Muchena – Zimbabwe Farmers Union.

"The epitome key lessons learnt from the study tour to India was linking researched technologies and commercialization. I was able to see with my own eyes of the different cotton by-product technologies that scientists were sharing during the workshop". (Bob-Alberto Ogen – Managing Director – West Acholi Cooperative Union Ltd - Uganda.

5.3 South-South Cooperation Initiatives (Uganda, Zambia and Zimbabwe)

South–South Cooperation is a concept that describes a system of exchange of resources, technologies and knowledge among developing countries. This is important because exchange of knowledge or resources from the country of high resources, knowledge to a less endowed country may help to solve some challenges such as low productivity, high poverty levels, climate change and high inequality faced by many people. Adoption of technologies and technology transfer among developing countries since in most cases have similarities in terms of production techniques. For example, the cotton harvest in India is handpicked, which is similar with most of countries from Africa. Therefore, technologies on issues of cotton production, processing may easily be adopted in a recipient countries. This section highlights some of the South-South cooperation initiatives that were identified during the project, for the African countries to exchange with other developing countries such as India, China, Argentina, Brazil, among others. The section also highlights the potential areas of cooperation that can enhance developments in cotton by-products activities.

5.3.1 South-South Cooperation Activities

The most recent South-South cooperation activity in the three countries (Uganda, Zambia and Zimbabwe) is the participation of CIRCOT scientists from India in the cotton by-product project countries stakeholder meetings. The scientists shared information on different technologies on cotton by-products that India has developed. The culmination of this South-South cooperation activity was the visit of project countries cotton value stakeholders study visit to India in order to learn and see the different cotton by-product technologies. This was to improve their capacity to assess the potential value, market situations and prospects of these different cotton by-products.

The other South-South cooperation identified was India's Cotton Technical Assistance Programme for Africa (TAP). This project was launched in 2012 and funded by the Ministry of External Affairs and implemented by Department of Commerce in Benin, Burkina Faso, Chad, Malawi, Nigeria and Uganda.[3] The objective of the project was to build local capacities in cotton production technologies, post-harvest handling, by-product utilization, as well as augmenting research and development capacities in biotechnological research, bio-control measure giving technologies and setting up of infrastructure to achieve the above. Uganda is a beneficiary country of both the TAP and UNCTAD projects. Under the TAP project, about 35 scientists were invited to India and exposed to various production technologies and 40 extension officers were trained on various production technologies in Uganda by Indian scientists. Under the project, a bio-pesticide laboratory was constructed in Uganda. This was aimed at screening and assessing local materials with potential to be used in bio-pesticides and for the certification and standardization of bio-pesticides.

[3] www.cottontapafrica.org

Uganda was among several East African countries that received support to enhance international trade with India through a project called Supporting Indian Trade and Investment for Africa (SITA).[4] This project is being implemented by International Trade Centre (ITC), is worth US$ 80 million and will last until 2020.

In Zimbabwe, it was reported that there is a South-South cooperation initiative with Brazil. The project aims to support smallholder cotton producer and public institutions in Zimbabwe in the commercialization of cotton by-products. The Brazilian Cooperation Agency has undertaken technical missions to Zimbabwe to discussion how the project would work with local counterparts.

In Zambia, Cotton Association of Zambia with support from ITC has organized study trips for cotton farmers to expose them to various technologies along the cotton value chain. For example, some farmers have visited some countries such Ethiopia, Bangladesh, and India to see and learn various value addition activities done to cotton lint using developments technologies. Furthermore, some farmers visited Burkina Faso and South Africa to see and appreciate Bt cotton production in African settings.

5.3.2 Potential Areas of Further Cooperation on Cotton By-Products in Africa

In Africa, average yields range from around 200-400 kg/ha, well below the world average of 700-800 kg/ha. Low productivity and production of seed cotton will have a negative impact on the development of the cotton by-product since there is often an insufficient supply of raw material to achieve economies of scale for value-added industries. Therefore, there is need to adopt productivity-enhancing technologies and techniques adapted to the rain-fed, hand-picked production model that predominates in Africa. Relevant technologies exist in other countries. For example, Brazil, Uzbekistan, China and India have developed cotton plants that can be planted more densely, i.e. more plants per unit of area, than conventional techniques. Sharing and adapting these technologies in Africa is a potential area for further collaboration or cooperation. Technology transfer will also require capacity-building for African countries, where limited technological know-how could constrain adoption.

Identifying new cotton-products is another priority area which African countries should pursue. This process may open up income sources from these other cotton by-products. Therefore, exchanges with countries and institutions that research and develop cotton by-product technologies will help African researchers learn from their peers.

In conclusion, South-South cooperation has helped countries to share knowledge, experiences, and resources in order to stimulate the development of cotton value chains and can be used to develop cotton by-products development in Africa.

[4] http://www.intracen.org/sita/

6. Conclusion and Recommendations

The interest to develop the cotton by-products in Uganda, Zambia and Zimbabwe cannot be overemphasized because CPBs have the potential to enhance income of cotton value chain actors. This report evaluated the financial viability of biomass briquettes/pellets investment profile from each country and an absorbent cotton wool investment profile from Uganda. The results of the Net Present Value (NPV) of the briquette investment plants from Uganda, Zambia and Zimbabwe are US$488,799, US$65,478 and US$23,302 respectively. Furthermore, the NPV of the absorbent cotton wool investment plant is US$3, 141,504 confirming that the business ventures can be financially viable.

The report also reviewed of the policy environment for investments in these products and found it conducive, considering that all the three countries have prioritized cotton as a key industrial crop, with value addition and job creation as priorities.

South-South cooperation will be an important channel for developing value-added industries for cotton by-products in the project countries. In general, African cotton-producing countries must prioritize increasing cotton yields, to ensure a greater supply of raw material to industry. They can also adapt value-added processing technologies from other countries to the African context. This will require technical assistance for exchanges among researchers and institutions, capacity-building for stakeholders and technology transfer, between African countries and more technologically advanced producing countries from the Global South.

The study makes the following recommendations to enhance the development of the cotton by-products in Eastern and Southern Africa:

- For sustainable development of cotton by-products, there is need to consider the development of the full cotton value chain. This is because the performance of one node of the value chain may affect the performance of other nodes along the value chain. For example, if seed cotton production is low, it may affect the development of cotton by-products. Since low availability of raw material is one key challenge facing the development of cotton by-products, countries must strive to improve the productivity and production of seed cotton. This can be achieved through introducing productivity enhancing technologies that have been developed and tested and also training of farmers in good agricultural practices.
- Secondly some cotton by-products proposed such as briquette/pellet technology, is new. Therefore, in some countries, there is need for more awareness campaigns to make sure the uses of briquettes are enhanced through demonstrations and also showing the environmental benefits the use of briquettes can offer to the general populace and the country. Farmers need also to be educated about the potential to earn additional income if they sell their cotton stalks. This way, cotton by-products may attract more farmers in cotton production and existing ones could increase their hectarage under cotton production.
- For farmers to reach economies of scale, especially in the production of cotton stalks, they have to be arranged in cooperatives. This will enable them to supply the raw materials in large quantities and enable them to reduce the cost of transportation. Furthermore, this will be an additional avenue of income generation for farmers. The organization of farmers in strong cooperatives it may assist them to venture in the actual development of some cotton by-products. This also will likely increase their bargaining power with ginning companies or millers on prices of seed cotton, cottonseed and cotton stalks.

- Exchange visits among developing countries even within Africa should be encouraged in order to share experiences, knowledge and technologies for developing cotton by-products. A good example is the India study visit that was organized by UNCTAD. Stakeholders appreciated the idea because it has helped them understand a new perspective of cotton by-products.
- For the countries to realize the development of cotton by-products, there is need to develop the appropriate skills for actors along the cotton value chain especially those on cotton by-products.
- Access to affordable finance is key for the development of cotton by-products by small and medium scale entrepreneurs. Therefore, governments should provide an enabling environment under which public and private finance platforms can be created from which entrepreneurs can access affordable finance.
- Access to foreign technology is key for the development of cotton by-products. However, for sustainability purposes and to reduce the cost of acquiring the equipment, countries should strive to localize these technologies especially through creating strategic partnerships where multi-nations can link up with local companies and start producing equipment locally.
- Countries that have not incorporated cotton by-products in their strategies are encouraged to do so in order to enhance the importance of the cotton by-products. This will also stimulate the development of cotton by-products.
- Market development is key for the long-term viability of cotton by-products. Therefore, the study recommends that market feasibility studies, especially for the new cotton by-products such as briquettes/pellets and mushrooms production, be conducted to understand consumer preferences.

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Appendix 1: Discounted cash flow statement, absorbent cotton wool plant, Uganda (US$)

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
Inflows											
Surplus/(deficit)	(295,764)	(530,109)	(437,125)	(272,208)	(92,565)	128,326	414,241	691,940	961,129	1,221,486	1,472,662
Terminal value											4,908,874
TOTAL inflows	(295,764)	(530,109)	(437,125)	(272,208)	(92,565)	128,326	414,241	691,940	961,129	1,221,486	6,381,536
Net flow	(295,764)	(530,109)	(437,125)	(272,208)	(92,565)	128,326	414,241	691,940	961,129	1,221,486	6,381,536
Discounting:											
Required rate of return	8%										
Discounting Factor	0.93	0.86	0.79	0.74	0.68	0.63	0.58	0.54	0.50	0.46	0.43
Discounted Cash flow	-273,855	-454,483	-347,004	-200,081	-62,998	80,867	241,705	373,834	480,804	565,784	2,736,931
Net Present Value	**3,141,505**										