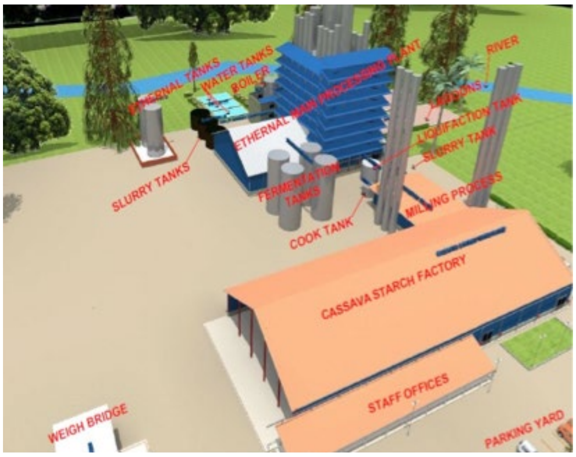
UGANDA DEVELOPMENT CORPORATION
Driving Industrial Growth

REPORT OF THE FEASIBILITY STUDY FOR THE ESTABLISHMENT OF A CASSAVA STARCH FACTORY IN THE GREATER ACHOLI SUB-REGION



August 2021

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Acknowledgement

This feasibility study report is the product of interactions with various players in the cassava sub-sector in particular and agriculture sector in general. They include actors from the government and private organisations as well as individuals involved in production, marketing and adding value to cassava. We highly appreciate the collaborative spirit displayed during the process of data collection, analysis and report-writing. We also acknowledge the contribution made to this report by the team of consultants from ACE Policy Research Institute: Jacklyn Makaaru Arinaitwe, Albert Twijukye, Apollo Segawa, Christopher Sebatta, and Colin Bitsinze.

The authors would like to thank the Government of Uganda through Uganda Development Corporation (UDC) for commissioning this feasibility study. This is an indication of the government's commitment to modernising agriculture and agro-industrialisation through adding value to key crops grown by the Ugandan farmers. It is also a sign of commitment toward the implementation of NDP III, and realisation of the industrialisation dream. Soon or later these efforts will pay off given the enthusiasm and hope displayed by officials at central and local government levels, leaders of the Catholic Church especially in Gulu Archdiocese, private sector players, and farmers. We are therefore indebted to the management of UDC for providing the required resources and a conducive working environment that made this study a reality.

The chief administrative officers, production and commercial departments staff in the districts of Gulu, Nwoya, Amuru, Kitgum, Pader, Omoro, Lira, and Nebbi are acknowledged for their efforts and assistance in ensuring that the study teams got the information they needed in time. Similarly, the cassava farmers, traders, transporters, local processors, industrialists adding value to cassava and all the people involved in the cassava value chain are highly appreciated for providing valuable information to the study team.

List of acronyms

ACPP	Acholi Cassava Processing Plant
ASSP	Agriculture Sector Strategic Plan
CAGR	Compound Annual Growth Rate
CDC	Centers for Disease Control and Prevention
DC	Development Committee
DRC	Democratic Republic of Congo
DSIP	Development Strategic Investment Plan
EAC	East African Community
EAO	African Economic Outlook
ENPV	Economic Net Present Value
EIRR	Economic Internal Rate of Return
GDP	Growth Domestic Product
GoU	Government of Uganda
HACCP	Hazard Analysis and Critical Control Points
CP	Critical Point
IITA	International Institute of Tropical Agriculture
IMF	International Monetary Fund
IRR	Internal Rate of Return
Kgs	Kilogrammes
KSH	Kenya Shillings
KWH	Kilowatt per Hour
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries
MoFPED	Ministry of Finance, Planning and Economic Development
MOW	Ministry of Works
MW	Megawatt
NAADS	National Agricultural Advisory Services
NARO	National Agricultural Research Organisation
NAROCAS	National Agricultural Research Organisation Cassava
NEMA	National Environment Management Authority
NDP	National Development Plan
NPA	National Planning Authority
NPV	Net Present Value
PPP	Public Private Partnership
TOR	Terms of Reference
TQM	Total Quality Management
UBOS	Uganda Bureau of Statistics
UDC	Uganda Development Corporation
UEPB	Uganda Export Promotion Board
UIA	Uganda Investment Authority
UNBS	Uganda National Bureau of Standards
USA	United States of America
UGX	Uganda Shillings
VAT	Value Added Tax
COVID-19	Coronavirus disease
OWC	Operation Wealth Creation
WEO	World Economic Outlook
ZARDIs	Zonal Agricultural Research and Development Institutes

Executive Summary

Cassava (*Manihot esculenta*) is one of the most important root crops in Uganda. It is suited to conditions of low soil nutrient availability and is a staple food consumed in both rural and urban areas. It is one of the ten commodities prioritised for establishment and strengthening under the Regional Agricultural Processing and Marketing Project of NDPIII's Agro-industrialisation Programme. Cassava yields the highest starch and ethanol compared to competing crops such as sugarcane, maize, and wheat. Cassava starch has wide application in industries such as baking, paperboard, plywood, animal feed, brewing, textile, and newspaper.

While Uganda has favourable conditions and is among the leading producers of cassava in te region, the low value addition has discouraged cassava farming. This has happened especially in Acholi, which produces about 28% of the country's cassava output. Consequently, the level of poverty in Acholi has remained high. Uganda has an annual surplus output of more than 9 million metric tons (MT) of cassava, yet the country still imports 3.3 million MT. This situation is exacerbated by the short shelf-life of raw cassava of two tothree days.. Past efforts at cassava processing by Kamtech Logistics Uganda Limited (Lira Cassava Factory) faced challenges related to management and ownership wrangles leading to financial problems. There is untapped potential in cassava processing. This feasibility study, whose aim was to determine the viability of establishing a cassava processing factory, was conducted by Ace Policy Research Institute (APRI) to guide UDC and indeed the Government of Uganda in making the associated investment decision.

The establishment of a cassava processing factory in the Acholi sub-region in northern Uganda is in line with Uganda Vision 2040, the Third National Development Plan (NDPIII), and the governing National Resistance Movement (NRM) Manifesto of 2021-2026. It is one of UDC's strategic projects that would enable realisation of the twin strategies of import substitution and export promotion.

The feasibility study used Multi-Criteria Analysis (MCA) and Cost Benefit Analysis (CBA) to consider three project realisation options: do nothing; investment in existing factories; and establishment of the cassava starch factory. Analysis criteria were derived from Uganda's national development goals and related key success factors focusing on sustainability and generating a return on investment. The 'do nothing' option was rejected from the technical and financial viewpoint and the option for investing in existing entities was also found sub-optimal due to the high investment cost in relation to the value generated compared to the third option of establishing the Acholi cassava processing factory.

In addition, field study findings indicate a great potential in the number of cassava farmers and the number, quality and yield of cassava varieties and thus the ability to supply and sustain cassava processing factory. Existing infrastructure — water, electricity and the availability of land — further strengthens the case for establishing a cassava processing factory. The prevailing market conditions have favoured the growing number of cooperatives, contract farmers growing cassava in the Acholi region. Establishing a cassava processing factory in Acholi will attract raw material supplies from West Nile and Lango sub-regions.

Based on study findings, Acholibur in Pader District was found suitable for establishment of the factory. It is close to catchment characterised with high cassava yield, organised farmer groups supported by Gulu Catholic Archdiocese, and it is centrally located within the Acholi sub-region. Other location factors include access to three phase electrical mains supply, availability of water, and a good road network. The proposed 25-acre site is located at 3°09'03.7"N 32°54'54.6"E 3.151040, 32.915161 and is along the Gulu-Kitgum highway. Preliminary assessment of the environmental and social aspects did not show any impediments. The study, however, recommends a detailed environmental and social impact assessment (ESIA) be conducted to concretise the environmental compliance of the proposed project.

The proposed project shall entail constructing the factory and administrative buildings and acquiring and installing factory plant for starch and ethanol processing and other related equipment, furnishing and equipping offices, recruiting and training staff, and commissioning factory operations. To offer competitive products, the proposed factory should comply with domestic and international quality standards and establish an ISO quality management system. It is proposed that a government entity, preferably a company limited by shares, with ability to conduct business, and own property shall be created with a board of directors to oversee operations and strategic direction and management responsible for the day-to-day operations. The key products from the proposed factory include starch, ethanol, technical alcohol, carbon dioxide and animal feed.

The total cost of the project is estimated to be UGX44,298,866,458. Capital cost constitutes UGX43,298,866,458 of the project cost. Total land requirement for the project is 25 acres. To reduce the project cost, the use of locally available materials and labour is suggested. Total factory plant and machinery cost is estimated to be UGX31,744,386,630, of which UGX17,075,755,314 is the cost of starch plant and UGX14,688,631,316 is the cost of the ethanol plant. The project requires pre-operating expenses of UGX135 million and a working capital of UGX1,849,980,000. The project is assumed to be financed using borrowed funds.

The project will be run at different operational capacities during different seasons of the year. During the months of November and December it will operate at an initial 80%; whereas during the months of May to June and January to February, the machines will operate at 60% of their theoretical capacities.

The study assumes that 80% of the revenues will come from sales on the local market and the balance from export market. The consumer sale prices have been assumed to be lower than the current market prices of comparable products. This has been done as part of the project's strategy to create consumer pull for the newer products. Higher margins have been offered to the distributors and retailers as an added incentive to push the product. Export prices have been kept at 10% higher than the local prices. With these assumptions, the first-year revenues of the project were calculated to be UGX22,224,000,000. The sale price growth rate has been assumed to be 6% in both local and export markets.

The project is financially viable with a positive NPV of UGX3,701,425,379, an IRR of 12.4% and payback period of 8.4 years. The project also has a positive ENPV of UGX207,589,733,246 and

an ERR of 67.6% which is an indication of the robustness of the proposed project and massive contribution to the community and economy.

The project's sensitivity to different business parameters was also evaluated. The business proposition remains viable up to an average revenue drop of around 10%. Project's viability exhibits little impact from construction and other capital costs to the level of a 40% increase in cost. Project's viability decreases with increase in operating costs up to 8%. The project is found to have sufficient capacity to absorb debt cost and remains viable even if 100% of the project cost is financed through debt.

Project Summary Sheet

Project Objective	**Cassava Processing into Starch and Ethanol**
Location	Acholibur, Pader District
Target Market	Local and Export
Project Capital Cost	UGX 44,298,866,458
Project Working Capital	UGX 1,849,980,000
First Year Revenue	UGX 22,224,000,000
Net Present Value	UGX 3,701,425,379
Internal Rate of Return	12.4%
Payback Period	8.4 years
Economic NPV	UGX 207,589,733,246
Conclusion	The project is financially viable keeping in view all the bases and assumptions used for marketing, technical and financial assessments/calculations.

01 Introduction

Cassava (*Manihot esculenta*) is one of the most important root crops in Uganda. It is suited to conditions of low soil nutrient availability and can survive drought. Cassava is considered a food security crop across most of the regions in the country. It is a staple food consumed in both rural and urban areas of Uganda. About 88% of cassava produced in Uganda is consumed by people, with the balance being processed[1]. Cassava is one of the 12 priority commodities being promoted under the Agriculture Sector Strategic Plan (ASSP) (2015/16 –2019/2020). Cassava ranks very high among crops that convert the greatest amount of solar energy into soluble carbohydrates per unit area. Among the starchy staples, cassava gives a carbohydrate production which is about 40% higher than rice and 25% more than maize, with the result that cassava is the cheapest source of calories for both human nutrition and animal feeding.

In recent years, cassava has also been transformed from being a subsistent crop to an industrial cash crop mainly as starch. Cassava starch has varied uses in the paper, textile, pharmaceutical, oil drilling and petrochemical industries. It is also used extensively in the food industry. Some of the key by-products include cassava pulp and juice. The pulp produced is a valued cattle fodder while the juice can be used as fertiliser. Globally, cassava is one of the most actively marketed food products and is the most promising in terms of growth and new market opportunities. There is also a regular surplus of cassava in most producing countries indicating an excellent opportunity for raising the production level with the expansion of industrial starch processing. Several governments in Africa have taken positive steps to promote cassava production through diversifying the market to include industrial processing.

In most parts of Sub-Saharan Africa, there is a surplus of arable land. It is projected that with increased use of cassava in industrial processes, more of this land may be used for its production as an industrial cash crop.

This report presents the details of a feasibility study commissioned by Uganda Development Corporation (UDC) and conducted in the Acholi sub-region to establish the feasibility and capacity of the sub-region to host a factory for starch and other cassava products. The geographical focus of the study was Acholi although neighbouring sub-regions such as West Nile and Lango were also explored to some extent. In this section, a study background is given followed by a review of the global, regional and Uganda country macroeconomic situation that is critical in determining the economic success of the proposed project. A review of the agriculture sector in Uganda is given in addition to a review of the cassava, starch and cassava industry performance at regional and country levels.

1 Buyinza T., Kitinoja L. (2018). Commodity Systems Assessment of Cassava in Uganda, PEF White Paper 18-01

1.1 BACKGROUND TO THE STUDY

The Government of Uganda has concluded the Third National Development Plan (NDP III, 2020/21-2024/25) that emphasises accelerated economic growth and transformation[2]. During the NDPIII implementation period, the main government focus is on, among others, agro-industrialisation, import replacement/promotion of local manufacturing, and export promotion to foster regional and international competitiveness. The NDPIII prioritises 12 commodities for regional agricultural processing and marketing under the Agro-industrialisation Programme run by the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF). One of the commodities is cassava (*Manihot esculenta*). To fulfil the government's planned cassava sub-sector development and industrialisation agenda, UDC plans to establish a cassava processing factory in the Acholi sub-region of northern Uganda. The establishment of a cassava processing factory is envisaged to promote import substitution, creation of jobs, save foreign exchange used in importing starch and related products, and improve household incomes thereby promoting socio-economic transformation.

UDC is the investment arm of the government with the primary objective of promoting and facilitating competitiveness for the industrial and economic development of Uganda. UDC engaged Ace Policy Research Institute to conduct a feasibility study for establishing a cassava processing factory in Acholi.

1.2 OVERVIEW OF THE MACROECONOMIC SITUATION

Global

The macro-economic situation at global, regional, and national levels has a direct impact on investment in various sectors. According to the International Monetary Fund (IMF)[3], global growth is projected at -4.9% in 2020, 1.9% points below the April 2020 World Economic Outlook (WEO) forecast. The negative economic growth is largely attributed to the advent of the COVID-19 pandemic. The COVID-19 pandemic has affected business activities in the first half of 2020 more than anticipated, and the recovery is projected to be more gradual than previously forecast. In 2021 global growth is projected at 5.4%. Overall, this would leave 2021 GDP some 6.5% points lower than in the pre-COVID-19 projections of January 2020. The adverse impact of the pandemic on low-income households is particularly acute, hence endangering the significant progress made in reducing extreme poverty in the world since the 1990s. The WEO reports indicate that first-quarter 2020 GDP was generally worse than expected (the few exceptions include Chile, China, India, Malaysia, and Thailand among emerging markets, and Australia, Germany, and Japan among advanced economies). Basing on the global trend of GDP from 2009 to 2021, high-frequency indicators point to a more severe contraction in the second quarter, except in China, where most of the country had reopened by early April 2021 (UN/DESA), 2020 & Statista.com[4]).

Sub-Saharan Africa

The Sub-Saharan Africa region is expected to suffer adverse effects of the coronavirus pandemic. According to the IMF[5], economic activity in 2021is projected to contract by 3.2%, reflecting a weaker external environment and measures to contain the COVID-19 outbreak. Growth is projected to recover to 3.4% in 2021 subject to the continued gradual easing of

2 National Planning Authority (2020). Third National Development Plan (NDPIII) 2020/21 – 2024/25, July, 2020. Accessed at: http://www.npa.go.ug/wp-content/uploads/2020/08/NDPIII-Finale_Compressed.pdf
3 IMF, Global Economic Outlook Report, June 2020 Updated
4 https://www.statista.com/statistics/1032199/global-growth-gdp-trade/
5 IMF, Regional Economic Outlook for Sub-Saharan Africa, June 2020 Update

restrictions. Indeed, many countries have launched plans that will help in encouraging manufacturing of basic commodities. If countries succeed in this line, the region might see an expansion of the manufacturing sector in the coming years. The signing of the African Continental Free Trade Area (ACFTA) agreement in 2020 heralds a new chapter in intra-Africa trade. This has created a large potential market for products made in the region and Uganda. The recent launch of road construction projects in eastern DRC worth $330 million further accelerates the potential of this trade and bodes well for such projects as cassava processing and value addition in Uganda.

East Africa

Six countries[6] in eastern Africa have politically, socially, and economically partnered for economic integration under the East African Community (EAC), with its headquarters in Arusha, Tanzania. The EAC bloc is one of the fastest growing regional economic blocs in the world with a GDP of $193 billion and GDP growth rate of 6.5% as of 2018. It has a population of 177 million people of which 22% live in urban areas[7]. Together, the partner states have devised grand plans to co-operate in the areas of investment and industrial development as outlined in the EAC Treaty (Chapter 12, articles 79 and 80). The investment and industrial development agenda aims at rationalising investments and full use of established industries to promote efficiency in production, harmonise and rationalise investment incentives with a view to promoting the EAC region as a single investment area. In 2011, the EAC Summit of Heads of State adopted the EAC Industrialisation Policy and Strategy to support the establishment of a competitive and efficient industrial sector. The EAC is also party to the AGOA Act and EBA Initiative and member states, including Uganda, are engaged in privatisation programmes of major government corporations. The EAC economy has equally been affected by the coronavirus pandemic and in response the secretariat earmarked $97 million for regional interventions to curb the spread and negative effects of the pandemic[8]. A UN Economic Commission for Africa Report showed that the pandemic has increased the proportion of countries in the region with debt-to-GDP ratios exceeding 50 percent. This higher debt has increased debt servicing payments, where the six EAC countries spent more than 10% of their export revenues and primary income on debt servicing (UNECA, 2020)[9].

1.3 THE UGANDAN MACROECONOMIC SITUATION

Uganda adopted a Comprehensive National Development Planning Framework (CNDPF) in 2008 ushering in the Vision 2040. This framework was meant to propel the country to a middle-income status by 2020 through a broad-based socio-economic development agenda. Despite the country's economy which grows by 3%-7% per annum, the agricultural sector employs most of the population at about 65% and there is a need to invest in agro processing to create more jobs.

According to the World Bank Group, Uganda's economy has, like others in the world, experienced a slowdown in growth due to the severe impact of the COVID-19 pandemic. This is in addition to the locust invasion and the flooding caused by heavy rains in 2020. Accordingly, Uganda's real GDP in 2020 is projected to be between 0.4 and 1.7% compared to 5.6% in 2019. There were reductions in revenues from exports, remittances, foreign direct investment, and portfolio flows during the second half of FY2019/2020 due to international trade disruptions and restrictions of movement of people. This has created significant fiscal and external imbalance

6 EAC member states are the republics of Burundi, Kenya, Rwanda, South Sudan, the United Republic of Tanzania, and Uganda
7 https://www.eac.int/overview-of-eac
8 EAC (2020). Accessed at: https://www.eac.int/coronavirus
9 UNECA (2020). Economic and Social Impacts of COVID-19 in Eastern Africa 2020. Accessed at: https://www.uneca.org/sites/default/files/SROs/Eastern-Africa/ICSOE-24/edited-_srp_english_covid-19_abridged_version.pdf

and a deceleration in growth in services primarily in real estate activities and information and communications technology.

Uganda's economy advanced 1.6% from a year earlier in the fourth quarter of 2020, following a downwardly revised 0.1% percent contraction in the previous period[10]. The main positive contribution came from the industrial sector which grew 5.9%, above a 4.3% rise in the previous period, mainly boosted by construction (10.1% vs -10.2% in Q3); manufacturing (3.6% vs 3.4%)) and mining (12.9% vs 3.2%). Agricultural activity also gained momentum (3.1% vs 1.7%), supported by cash crops (14.6% vs -1.8%); livestock (7.7% vs 7.5%), and food crops (2% vs 4.2%). The services sector continued to shrink although at a softer pace (-2.6% vs -4.6%) — in particular food and accommodation services (-16.9% vs -24%); professional, scientific and technical (-55.9% vs -63.3%); and arts, entertainment and recreation (-19.5% vs -51%).

It is estimated that the medium-term outlook is also not favourable for Uganda. The decline in Uganda's real GDP growth and the corresponding loss of jobs could even be larger if the country faces a more widespread pandemic in addition to the effects of the locust invasion, further deterring a rapid economic recovery (Table 1).

However, the recent signing of the Final Investment Decision agreements and commencement of large investments in the oil sector would see a rapid growth in the Ugandan economy which will bode well for this project.

Table 1: Summary of Uganda's Economy

	Year				
	2015	**2016**	**2017**	**2018**	**2019**
Population (million)	35.5	36.6	37.7	38.8	39.8
GDP per capita (USD)	829	835	837	867	912
GDP (USD bn)	29.4	30.5	31.5	33.7	36.3
Economic Growth (GDP, annual variation in %)	6.0	0.6	7.2	6.0	5.6
Fiscal Balance (% of GDP)	-3.9	-4.1	-3.2	-3.8	-6.7
Public Debt (% of GDP)	34.3	37.1	39.7	41.4	-
Money (annual variation in %)	5.6	13.5	15.4	6.3	16.2
Inflation Rate (CPI, annual variation in %, eop)	8.4	5.7	3.3	2.2	3.6
Inflation Rate (CPI, annual variation in %)	5.4	5.5	5.6	2.6	2.9
Policy Interest Rate (%)	17.00	12.00	9.50	10.00	9.00
Exchange Rate (vs USD)	3,372	3,610	3,645	3,715	3,670
Exchange Rate (vs USD, aop)	3,240	3,418	3,612	3,728	3,704
Current Account (% of GDP)	-6.2	-2.8	-4.5	-7.2	-9.5
Current Account Balance (USD bn)	-1.7	-0.8	-1.5	-2.3	-2.3
Trade Balance (USD billion)	-2.3	-1.6	-1.7	-2.5	-2.7
Exports (USD billion)	2.7	2.9	3.4	3.6	4.1
Imports (USD billion)	5.0	4.5	5.2	6.1	6.8
Exports (annual variation in %)	-2.1	9.5	18.1	5.6	11.9
Imports (annual variation in %)	-2.8	-8.8	14.3	18.1	11.7
International Reserves (USD)	2.8	3.0	3.7	3.2	3.2
External Debt (% of GDP)	32.5	33.0	37.1	36.6	-

Source: Bank of Uganda, 2020

1.4 OVERVIEW OF UGANDA'S AGRICULTURAL SECTOR

Uganda's economy is highly dependent on the agriculture sector. It employs about 65% of the working population and 72% of all youth. It accounts for 45% of exports and about one-quarter of GDP (World Bank, 2018; MoFPED, 2020)[11]. The economy's growth has slowed down with real GDP for FY2019/2020 recorded as 3.1%, down from 6.1% for FY2018/2019 and 3.9%

10 https://tradingeconomics.com/uganda/gdp-growth-annual accessed on 10.06.2021
11 MoFPED, 2020. Budget Speech FY 2020/21

for FY2016/2017, 24% of which is contributed by agriculture (World Bank, 2018; UBOS, 2020). In addition, the gross valued added for agriculture, forestry and fishing activities grew by 4.2% in 2019/2020 compared to the growth of 5.3% registered in 2018/19[12]. The agriculture sector has contributed between 24.7% and 22.2% of GDP between 2011/12 and 2015/16. This is a crucial macro-economic indicator for the agricultural sector, given the fact that this growth has been driven by growth in exports more than half of which are agricultural goods, credit to the private sector (some of which is invested in agriculture and agribusiness), good weather and recovery in crop production.

The government has positioned agriculture as a key economic sector in Uganda's transition into a middle-income country. In this regard, it has emphasised the importance of value addition, commercialisation, and building resilience to climate change (GoU, 2013; MAAIF, 2019). The broader agri-food system has the potential to provide significant employment opportunities for the country's predominantly young population.

The agriculture sector, however, is dominated by smallholder farmers (69% of farmers), with women making up the majority. The sector has limited mechanisation, is heavily dependent on rain, and the productivity of the relatively fertile soils is also declining due to overcultivation and low fertiliser use (UBOS, 2018a). Overall per capita agriculture production has been declining due to a high population growth rate of 3.26 % (in as much as it dropped from an average 3.2% to 3.0% per annum) leading to annual food production deficits (UBOS, 2017). This falls short of the minimum 6% annual agricultural sector growth target agreed upon under the Comprehensive Africa Agriculture Development Programme (CAADP) protocol.

It is also worth noting that Uganda's economy has experienced a slowdown in growth due to the severe impact of the COVID-19 (coronavirus) pandemic, locust invasion, and flooding caused by heavy rains. Uganda's real GDP in 2020 is projected to be between 0.4 and 1.7% compared to 5.6% in 2019 (World Bank, 2020)[13]. This may have dire consequences for food security and functioning of food and seed systems.

Uganda has a comparative advantage in agriculture production but faces several challenges including unpredictable weather changes, limited access to inputs, undeveloped value chains, limited sector investment, pests and diseases, poor soil management, land fragmentation, and limited access to extension services (MAAIF, 2019). Cognizant of the challenges affecting agriculture, and its potential to transform the economy of the country, the government is undertaking a number of interventions to improve productivity. The interventions include promoting agro-industrialisation through value addition to agricultural produce such as cassava; reforming the extension system to create a single spine extension system aligned with the relevant directorates in the Ministry of Agriculture, Animal Industry and Fisheries; and Operation Wealth Creation, which has performed in ensuring delivery of agricultural inputs to farmers. Other efforts in the same direction have been increasing the availability of improved seed varieties and animal breeds through research led by NARO through the Zonal Agricultural Research and Development Institutes (ZARDIs), rehabilitation of large-scale irrigation schemes and promotion of irrigation technologies and engaging the private sector as a dominant partner in economic growth. The Government of Uganda has also been pushing for creation of an enabling environment to ensure reduction of transport costs through rehabilitation of and expansion of the road network, expansion of the electricity infrastructure to improve access to

12 UBOS(2020). The economic performance of Uganda's economy in FY 2019/20. Accessed at: https://www.ubos.org/wp-content/uploads/publications/06_2020The_economic_Performance_of_Uganda's_economy_in_FY_2019_20.pdf

13 https://www.worldbank.org/en/country/uganda/overview

energy, research and development to improve agricultural production and productivity, and improvement of business efficiency by streamlining regulatory rules and business licensing reform.

1.5 UGANDA'S CASSAVA SUPPLY

Northern, eastern and western regions dominate cassava supply with 1.8 million MT, 1.7 million MT and 1.4 million MT of cassava supplied respectively by 2019 (Table 2). However, between 2015 and 2018, Uganda's cassava supply was affected by the cassava mosaic virus and later the Cassava Brown Streak disease that reduced output until new resistant varieties were bred and distributed among farmers. Main wholesale outlets for fresh cassava and dried cassava chips are found in Kampala markets such as Kalerwe, Balikuddembe / Owino, Kawempe, Nakawa, Ndeeba, Nakasero, Nateete, and Busega. Other key markets are Lira, Soroti, Jinja, Arua, Apac, and Mbale. Consumers prefer the sweet, soft, and red-skinned variety (NASE 13) which therefore fetches a higher price. The downside is that it is currently produced only in the Masindi area and the market supply is low. Literature is however limited to explain why there is low supply despite high preference. According to the International Institute of Tropical Agriculture (IITA)(2020), the main varieties demanded and traded in Uganda are NASE (3,14 & 19), NARO. Varieties play a significant role fresh trade and also influence quality of flour and chips.

Table 2: Uganda's regional cassava supply (2015-2020)

Region	Year						Effect on market system
	2015	**2016**	**2017***	**2018**	**2019***	**2020****	
	Volume produced/supplied (MT)						
West Nile	378,604	357,017	243,157.88	567,981	913,543	1,187,606	13%
Northern	739,374	697,215	474,861.28	1,109,206	1,784,052	2,319,267	26%
Eastern	692,428	652,946	444,710.40	1,038,778	1,670,775	2,172,008	24%
Western	563,284	531,166	361,768.10	845,037	1,359,161	1,766,910	19%
Central	378,604	357,017	1,858,666	780,568	913,543	1,187,606	13%
Uganda	2,894,000	2,728,988	3,383,163.26	4,341,570	6,983,000	9,077,900	

Source: UBOS (2020)[14]; UBOS (2020)[15]

Note: *Proportions of the 2018 annual agriculture survey applied to the regional figures.

Note: **Author calculations based on growth of 61% in production between 2018 and 2019 halved to 30% due to effects of COVID-19 on markets applied to generate 2020 figures.

1.6 MARKET SHARE AND DEMAND FOR CASSAVA, STARCH AND ETHANOL ON THE GLOBAL MARKET

1.6.1 Uganda's cassava import and export trends

Table 3: Comparison of ethanol yield from different crops

Crop	Yield ton/ha/year	Conversion rate to sugar/starch (%)	Conversion rate to ethanol (L/tonne)	Overall ethanol yield (kg /ha/yr)
Cassava	40	25	150	6000
Sugarcane	70	12.5	70	4900
Maize	5	69	410	2050
Wheat	4	66	390	1560

Source: Wang, 2007

14 Uganda Bureau of Statistics (UBOS), 2020. Uganda Annual Agricultural Survey 2018. Kampala, Uganda; UBOS

15 Uganda Bureau of Statistics (UBOS), 2020. Statistical Abstract, 2020. Accessed at: http://library.health.go.ug/sites/default/files/resources/UBOS%20Statistical%20Abstract%202020.pdf

In addition to other issues related to competing products, the Table 3 shows that under optimal conditions the starch and ethanol yield of cassava (in kg/ha or kg/a) is the highest of all the main starch and ethanol crops. Moreover, a cassava plant requires less complex processing equipment resulting in lower investments. This is due to the unique characteristics of cassava starch (Wang, 2007) and the low amounts of impurities which make the extraction of starch from the tuber relatively easy.

1.6.1.1 Imports

Local production and supply dominate cassava trade in Uganda. FAOSTAT data (2021) reveal a net decrease in the starch and ethanol imports from 19,979MT worth $0.9 million in 2015 to 3,349MT worth $0.15 million in 2019 (Table 3). Most of the imports are mainly from Tanzania and DRC although there is informal trade occurring mainly at the Mutukula, Bukoba and Kyaka border points on the Uganda-Tanzania border (Kilimo & BTC, 2020). The Table 4 shows main imports and import value of cassava. Most of the cassava imported was in form of Fresh tubers, chilled, frozen or dried chips and such facilities need to be invested in by processors or exporters. The biggest formal cassava import market for Uganda is Tanzania, DRC, Burundi, and South Sudan. There is though informal trade that is not clearly documented but occurring mainly at the Mutukula, Bukoba and Kyaka border points on Tanzania Uganda border. This informal trade influences the market but there is less data on how much the trade affects cassava market space.

Table 4: Summary of Uganda cassava imports value over the years

Description	2015	2016	2017	2018	2019
Imports (MT)	19,979	9,800	12,610	3,349	3,349
Import value (US$ '000)	901	438	575	149	150

Source: FAOSTAT, 2021

1.6.1.2 Exports

Like with imports, FAOSTAT (2021) reveals a net increase in the formal cassava exports in 2015 of 7,798 MT worth $1.72 million to 10,510 MT worth $1.97 million in 2019. Table 5 below shows Uganda's main exports and export value of cassava. According to the International Trade Center (ITC, 2021), Uganda's cassava exports are in form of fresh cassava, chilled, frozen and dried cassava chips. Rwanda used to be the biggest market before the border closure, the explanation for declining values from 2019. ITC 2021 reported that Only Kenya exported cassava starch to Uganda and this stopped in 2012.

Table 5: Summary of Uganda cassava export value over the years

Description	Unit	2015	2016	2017	2018	2019
Exports	MT	7,798	11,035	14,944	23,065	10,510
Export Value (US$)	1,000	1,724	1,742	3,367	5,199	1,968

Source: FAOSAT, 2021

1.6.2 Cassava market and product space

The cassava and cassava product market flow is made up of producers, intermediary traders/ middlemen, and travelling traders who buy fresh cassava or dried cassava chips, mill them on their premises, and then supply to processors, wholesalers, retailers or do so directly to consumers. However, some of the farmers double as retailers by selling fresh tubers, chips and flour directly to consumer segments in the category of households and local restaurants (Odongo 2018). In addition to household production and consumption, industrial use is on the increase. For example, Uganda Breweries Limited uses about 5,000MT per annum of high quality cassava flour as raw material to make local beer brands.

In Lira and Nwoya districts, ethanol distilleries were installed, although with operational challenges, each had capacity to produce 6,000 litres of ethanol thus creating a demand of requiring 10 MT of cassava chips as raw material per day. Other key industrial actors are Kakira Sugar with its planned ethanol plant which once completed will produce 20 million litres of ethanol per annum and Sugar Corporation of Uganda Ltd (SCOUL), animal feed manufactures and confectionary and baking among others. Potential markets exist with soft drink companies and biscuit companies using cassava as sweeteners (sucrose).

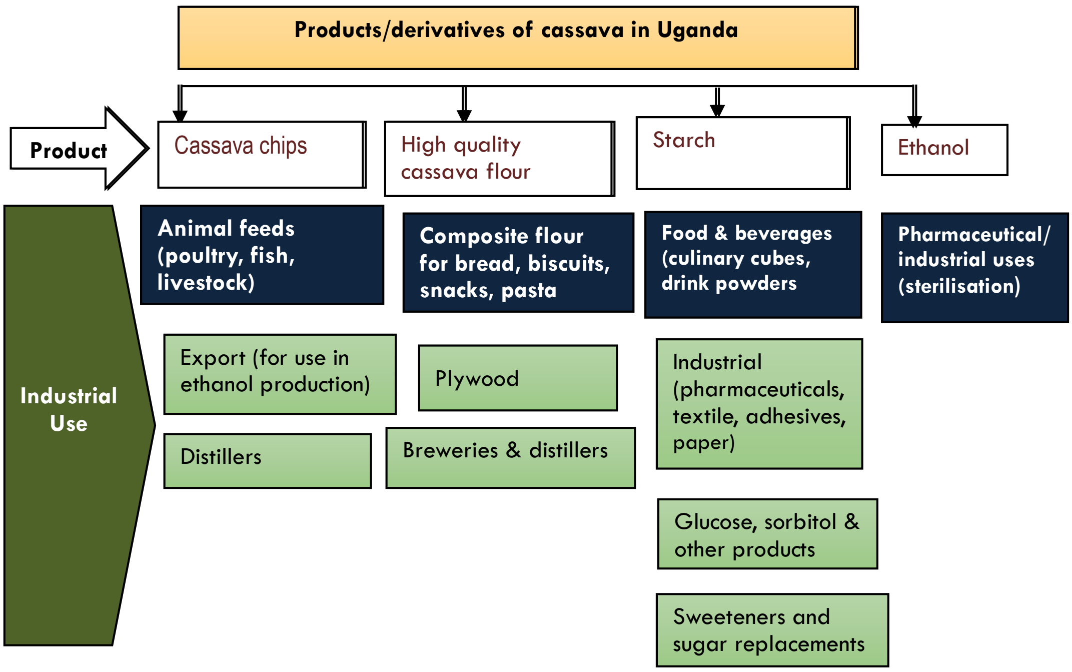


Figure 1: Cassava product flow

Source: Kilimo Trust BTC report (2020)

A Kilimo Trust and BTC (2020) report shows that cassava consumption in Uganda is driven by production. It is expected to increase because of increased consumption, potential for value addition and industrial use, population growth and efforts by the government, NGOs and research institutions that aim to improve production. The report indicates that Uganda's annual deficit of cassava and cassava-derived products stood at 40,000MT. Annual demand stood at 2.75 million MT (fresh root equivalent) in 2015 and was expected to increase by 17.5% in 2020. Production and commercialisation are influenced by derived products such as cassava chips, flour, starch and High Quality Cassava Flour (HQCF)which are in most cases less value added and do not satisfy domestic quality needs. The percentage of cassava released to the market ranges between 18% and 30% (ACET, 2015) — an indicator that the crop is considered more of a food crop. There is opportunity therefore to make it more of a cash crop.

1.6.3 Segments and characteristics of value chain products in Uganda and EAC region

The industrial demand is mainly driven by the increasing potential of substitution of more expensive products by cheaper cassava derivatives such as starch, flour in making confectionery, raw materials in breweries and distilleries and subsequent increase in demand of the finished products for instance ethanol. Industrial demand drivers for cassava, wheat and other materials are segmented as shown in Table 5 (i).

Table 5 (i): Potential for cassava substitution for industrial use

Segment	Characteristic
Biscuit manufactures	Four factories demand 10,000MT-12,000MT of wheat flour annually. Possible to substitute up to 35% of wheat flour with HQCF. Hence a potential opportunity for 3,500-4,200MT of HQCF annually.
Urban bakeries	At least 30 bakeries consume up to 80,000MT of wheat flour annually and there is potential for substituting up to 10% of wheat flour with HQCF. Composite flour: more than 700MT of cassava flour is currently consumed (80% as chips, 20% as flour) in composite flour manufacture. There is potential demand for up to 2,000MT per annum of HQCF with a willingness to replace 10% of the 20,000MT of wheat flour currently used.
Rural bakeries	Consume 200,000MT of wheat flour. Potential demand of 14,000MT per year of HQCF.
Paperboard industry (6 factories)	Consume 1,440MT of starch per year with a potential demand of 1,500 MT/year. HQCF is already used by the industry as an adhesive ingredient and there is a growing demand for paperboard products.
Plywood industry	One factory uses 468MT per year of locally available cassava flour.
Animal feed segment	At least 3 manufacturers demand 1,200MT of dried cassava per annum for fish feed and 15% of dried cassava is included in fish rations. Up to 20% inclusion rate of dried cassava is also possible in poultry feeds. 960MT demanded for animal feed with a potential demand of 8,000MT per year.
Breweries for 2 major companies & distilleries	Demand is about 3,000MT/year. Potential demand of 5,000MT/year of cassava chips.
Textile	Demand over 300MT annually.
Liquid glucose (1 industry):	Potential demand of 2,500-3,000MT per year of liquid glucose in sweets manufacture.
Newspaper (1 paper and pulp industry):	Potential demand 72MT per year of starch.
Alcohol industry	Market is rapidly expanding (10–15% per annum)

Source: KT BCT, 2020

1.6.4 Cassava as a source of starch

Cassava is one of the rapidly expanding crop sub-sectors in Uganda with an annual increment of about 83,000ha of crop per year rising from about 411,000ha in 2009 to about 1,255,107 currently (FAOSTAT, 2019). During the period 2008—2020, nine elite cassava varieties were released to replace inferior ones. Another three varieties are due for release in 2021. The varieties have been bred specifically for improved disease tolerance/resistance and for application in industry. They are superior to the benchmark variety, NAROCASS 1, for their starch content. These varieties have improved dry matter and starch content good for industrial purposes. The varieties and their properties are as shown in Table 6a.

Table 6: Cassava varieties with their dry matter (DM ranges) and starch content

Variety	DM range %	Starch content range %	Specific application
NASE 1-NASE 12	30-35	69-72	Cassava-based syrups with high fibre content. Cakes, cookies and other confectionary based alternatives. High quality cassava flour in biscuits. Glucose syrups from cassava starch. Adhesives, binders, cassava starch in road construction, new pharmaceutical-based products, production of super absorbent polymers in diapers, as a retarder in concrete.
NASE 13	35-38	70-73	
NASE 14	35-38	70-73	
NASE 15	35-38	70-73	
NASE 16	35-38	70-73	
NASE 17	35-38	70-73	
NASE 18	35-38	70-73	
NASE 19	35-38	72-75	
NAROCASS 1	36-38	74-77	
NAROCASS 2	35-38	70-75	
UG120156	37-39	75-78	
UG120198	37-39	75-78	
MKUMBA	37-39	75-79	

Source: Nuwamanya (2010;2011)

Use of cassava starch as the main ingredient in processing of industrial products gives cassava starch a high market value. Importantly, the granular structure of starch is critical in ensuring its functionality and amenability for modification to fit various applications. Thus, starch from cassava can also be used to produce modified foods, glucose syrups relevant in certain beverages like malted beers, as a source of maltose in brewing. Use in broad confectionaries such as ice cream, fruit fillings and canned fruits as a sweetener and calorie source (cassava can replace almost all starches given its high hydration potential and swelling power).

1.6.5 Cassava starch biochemical properties

Cassava starch has properties typical of other root and tuber crops. With a starch content averaging 70%, cassava starch is approximately 20-25% amylose and about 70-75% amylopectin. This differs from variety to variety with most of the current varieties having high amylose content. The high amylose content may have some effects on processing. Given the average granule size of most cassava varieties, the granules can be classified as B-type with a significant percentage of small granules. The presence of small granules in some values makes cassava highly amenable for processing in wet and hot conditions (such as food processing, ethanol production, etc, see Table 7).

Table 7: Cassava breeding material granule size ranges and granule classification

Variety/Family	Size[1]	Range[1]	Granule shape[1]	N	A%	B %	C%
Bamunanika	10.72^{a}±3.12	1.0-19.5	truncated, polygonal, oval	108	11.11	65.28	23.61
Progenies	9.06^{a}±3.09	2.0-16.0	truncated, polygonal	131	20.61	67.18	23.61
Bao	10.77^{a}±3.19	5.0-18.5	truncated, polygonal	166	8.38	68.86	22.75
Progenies	8.06^{a} ±2.86	1.5-14.5	truncated, polygonal	114	32.75	64.65	2.58
Kakwale	8.14^{a} ±2.86	2.0-15.2	truncated, polygonal, oval	118	26.95	70.21	2.83
Progenies	8.97^{a} ±3.07	2.9-15.4	truncated, polygonal oval	140	26.56	65.63	7.81
Nyaraboke	9.92^{a} ±2.66	5.0-17.0	truncated, polygonal round	105	12.28	76.32	11.40
Progenies	8.03^{a} ±2.90	1.8-14.8	truncated, polygonal	114	34.29	60.00	5.71
95/SE/00036	10.29^{a} ±3.13	3.1-19.9	truncated, polygonal, oval	185	15.91	69.89	14.21
Progenies	9.36^{a} ±3.30	2.5-18.9	truncated, polygonal, oval	107	24.29	65.42	10.28
NASE 10	8.33^{a} ±3.26	1.4-18.8	truncated, polygonal	127	30.21	61.87	7.91
Progenies	9.35^{a} ±3.21	1.4-16.7	truncated, polygonal	109	29.21	59.55	11.23
NASE 12	10.03^{a} ±2.68	3.0-18.6	truncated, oval	98	7.84	82.35	9.80
Progenies	9.11^{a}±2.49	2.4-14.8	truncated, oval	102	18.81	76.23	4.95
TME 5	8.51^{a} ±3.08	1.7-15.2	truncated, oval rounded	108	32.28	59.84	7.84
Progenies	8.73^{a} ±2.93	2.6-15.1	truncated, oval, rounded	107	29.59	61.23	9.18
TME 14	9.61^{a} ±2.22	3.5-15.5	truncated, polygonal, oval	103	7.92	84.16	7.92
Progenies	8.97^{a} ±2.72	2.1-16.2	truncated, polygonal, oval	122	21.95	69.11	8.94

^{a} Mean values of n analyses in a column with the same superscript are not significantly different at 5%; N: number of granules observed/measured in a particular size range and shape; Trimodal distribution shown as the percentage where A= small sized granules from 1-6.9 µm, B= medium sized granules of 7-12.9 µm, C= large granules of 13-20 µm.

Other important attributes of cassava starch include its low protein content ranging from 0.5-2% while generally its fibre content will depend on the extraction procedure. Because of the low protein content, starches from cassava have pasting temperatures ranging from 68-78˚C and pasting times of about 4 minutes compared to cereals which have high pasting temperatures ranging from 75-85˚C and pasting times of about 5 minutes. This makes cassava starch more amenable for industrial processing and easy extraction.

1.7 CASSAVA PRODUCTS

1.7.1 Starch

Starch is a carbohydrate extracted from agricultural raw materials. It has applications in literally thousands of everyday food and non-food products. Industrial starches are derived from various sources, including maize, potato, wheat. With the global economy gradually improving and resulting in an increased intake of processed and convenience foods, the market for industrial starch, which finds substantial usage in these food applications, is finding increased demand thereby driving the overall market for the proposed product[16]. Starch is one of the most widely available carbohydrates in nature whose use is increasing with more demand in the food and beverage processing industry as well as the non-food industry[17]. By 2020, the global starch market was about 120 million MT worth $51 billion and projections show that by 2026 the market will have expanded[18] to about 160 million MT worth $62 billion with the

16 Mordor Intelligence (2021). Industrial starches market - growth, trends, covid-19 impact, and forecasts (2021 - 2026) Accessed at: https://www.mordorintelligence.com/industry-reports/industrial-starches-market

17 Starch is used in numerous sectors like confectionery and drinks, pharmaceuticals and chemicals corrugating and paper making, processed food, feed, and other non-food. modified starch is widely used in dairy products and confectionery, bakery to enhance their texture and stability, and in the pharmaceutical industry; it operates in the formulation of tablets. Generally, the market is segmented by application, by company, and by region for the viable landscape analysis.

18 https://www.marketsandmarkets.com/ResearchInsight/starch-derivatives-market.asp

United States consuming 27% and China 28% of market share[19]. Of this starch market, cassava starch market share stands at $7.7 billion as of 2020 and will have grown to $8.1 billion by 2026.

Almost half of the world cassava consumption is concentrated in two regions, namely, America and Asia Pacific. Cassava is increasingly popular particularly in African countries due to rapidly increasing populations and the crop's ready availability. In the world cassava market, Thailand is the leading producer followed by Vietnam and Cambodia though their production level was not as high as that of Nigeria. The cassava chip and pellet industry segment, however, has stiff competition with the starches from potato, maize, and wheat[20].

Starch is also a cheap and widely available natural resource out of which excellent biodegradable plastic products can be made using existing processing equipment with little or no modification. This makes starch one of the most established alternatives to petrochemical plastics[21].

1.7.2 Ethanol

Ethanol is a flammable chemical that is also known as ethyl alcohol. It is a renewable and colourless chemical primarily manufactured by the fermentation of sugar-based materials such as starch as well as cellulose-based feedstocks including corn, barley, wood, and wheat. Ethyl alcohol is an organic solvent with high solubility owing to which it is mainly used in the various end-use applications in the industrial sector. Ethanol is another cassava product with growing global demand driven by increasing usage as biofuel and consumption of alcoholic beverages, of which it is a component. The global ethanol market size is expected to grow to $155.6 billion by 2030 from $93.7 billion in 2020. Increasing usage of ethyl alcohol as biofuel is a major factor driving growth of the ethanol market[22]. In Uganda, this can help to greatly reduce environmental degradation that is caused by wood and charcoal usage.

North America, especially the United States, commands the largest share of the global ethanol market at 30%. China, India, Japan, and Thailand are the other large consumers. The outbreak of COVID-19 has increased usage of ethanol-based hand sanitisers which is supporting global market growth. The Centers for Disease Control and Prevention of the United States recommended usage of ethanol because it is effective in killing microorganisms including bacteria, viruses, and fungi[23]. In 2020, the United States was the largest producer of fuel ethanol with 13.8 billion gallons followed by Brazil at 7.9 billion gallons and the European Union at 1.3 billion gallons[24]. The United States and Brazil have increased their ethanol production from 15.1 billion gallons and 7.5 billion gallons in 2016 to the current levels (Beckham & Nigatu, 2017) which shows that the ethanol industry is growing fast in those two largest global producers and consumers.

1.7.3 High fructose cassava syrup

High fructose cassava syrup (HFCS) is one of the key products made from cassava. Uganda imported HFCS worth $1.75 in 2019 (EPRC agro-industrialisation main report, 2019). It was proposed in the report that to meet the demand for HFCS, it would be necessary that Uganda establishes a 100,000 metric tonnes (HFCS) plant that uses 0.5 million metric tons of fresh

19 https://www.strategyr.com/market-report-starch-forecasts-global-industry-analysts-inc.asp
20 Henry, G., & Westby, A. (2001). Global cassava starch markets current situation and outlook.
21 Laycock, B. G., & Halley, P. J. (2014). Starch applications: State of market and new trends. *Starch Polymers*, 381-419.
22 Intrado (2021). https://www.globenewswire.com/news-release/2021/01/18/2160198/0/en/Ethanol-Market-Size-Worth-Around-USD-155-6-Billion-by-2030.html
23 https://www.precedenceresearch.com/ethanol-market
24 https://www.statista.com/statistics/281606/ethanol-production-in-selected-countries/

tubers annually i.e. 18 percent of annual cassava output could be absorbed as raw supply material to the plant. Such a venture would provide numerous advantages ranging from lowering Uganda's sugar imports by $1.75 million, according to URA figures, to providing employment and increasing household incomes due to increased prices of cassava.

1.7.4 High quality cassava flour

High quality cassava flour (HQCF) is yet another important product made from cassava. It also has high import substitution capacity by helping to reduce Uganda's wheat flour import bill. The current demand for HQCF is 45,000 tonnes, according to Otim-Nape and Bua in their report on the global cassava development strategy presented to Namulonge Agricultural and Animal Production Research Institute NARI. This however requires increased awareness about the value of cassava. For the country to be self-sufficient in HQCF, it requires to process 0.18 million metric tons (6.4 percent of national total output) of fresh cassava per annum-based output figures. Uganda's import bill of wheat in 2014 was $1.97 and it has grown since then. Replacing 20 percent of this with HQCF would save the country $0.398 million and better still this figure would increase to $1.159 million if all products that use wheat were required to use HQCF only (http://www.newvision.co.ug/new_vision/news/1333457/cassava-commercialisation-save-uganda-usd300m).
Thus, promoting production of HQCF will not only lead to improvement in the wheat trade balance, but would also constitute a viable avenue for increasing exports, providing employment, boosting farmers' incomes, and expanding the production of confectionary and beer brewing products. This is critical as these are not only some of the largest employers but also among the highest tax payers (http://www.ofuganda.co.ug/articles/20160228/president-museveni-names-100-multi-million-companies-paying-billions-taxes-ura).

1.7.5 Biodegradable bags

Bio-degradable bags are some of the indigenous innovations that have been developed by local scientists to further add value to cassava. Potential exists to make biodegradable plastics from cassava through bioprocessing methods. This is one of the products that scientists at NaCRRI have added to the list of industrial products that can be manufactured from processing of bitter cassava. This product is an alternative for improved human safety and minimised environment impact (Lominda Afedraru, Daily Monitor Newspaper, Aug 2014).

1.8 OVERVIEW OF THE NORTHERN REGION AS A STUDY AREA

By the year 2010, the northern region of Uganda had 38 districts, namely, Abim, Adjumani, Agago, Alebtong, Amolatar, Amudat, Amuru, Apac, Arua, Dokolo, Gulu, Kaabong, Karenga, Kitgum, Koboko, Kole, Kotido, Kwania, Lamwo, Lira, Madi-Okollo, Maracha, Moroto, Moyo, Nabilatuk, Nakapiripirit, Napak, Nebbi, Nwoya, Obongi, Omoro, Otuke, Oyam, Pader, Pakwach, Terego, Yumbe and Zombo. The region borders South Sudan in the north, Democratic Republic of Congo in the west, Kenya in the east, and the western, central, and eastern regions of Uganda. The northern region has an area of 985,391.7 km² (32,969.9 sq mi) of land with an estimated population density of 84/km² (220/sq mi).

The region is generally flat with gentle slopes with some river valleys like Nile and Aswa, but also has some mountain ranges. Agoro and Lamwo ranges, which have rich volcanic soils, extend into South Sudan. Most rivers are seasonal tributaries to the River Nile. The vegetation is characterised by woody covers and grass layers. Soil types in the region vary with location although most are well-drained sandy, clay, and loam and sand-clay. A few areas have rocky soils.

The region has dry and wet seasons with average rainfall at 1,330mm. Rain falls from late March or early April and ends in November. The rain is bimodal with peaks in April and August. December to late March constitutes the dry season, which is always hot, dry, and windy. The average monthly minimum temperature is 17°C while maximum monthly temperature is 27°C. In February and March temperatures rise beyond 30°C.

The population of northern Uganda as of March 2014 was approximated at 7,188,139 (UBOS, 2016). Out of this population, an estimated 2.3 million persons (33%) are poor, according to the 2016 Uganda National Household Survey. More than 80% of the population in the region are farmers of which over 95% are subsistence peasants who predominantly use hand hoes for production. Use of oxen and tractors for production does not exceed 5%. This has resulted into farmers cultivating small fields, which are in most cases scattered and generally giving relatively low yields. Family labour is the most common source of labour although communal labour is a traditional practice, which has been in place for generations.

The main crops produced include cassava as a key root crop. The major cassava varieties grown in the region are NAROCASS 1, NASE 3, NASE 14, and NASE 19 with yields of between 25MT/ha and 30MT/ha (NAADS, 2020)[25]. Other tubers grown are sweet potatoes, and Irish potatoes in limited areas (relatively high grounds). Other crops include vegetables, coffee, vanilla, and cereals such as sorghum, maize, millet, upland and paddy rice, and pearl millet.

The most common legumes are groundnuts, beans, pigeon peas, soybeans, cow peas, and green grams. In addition, the region is a top producer of several commercial oil crops including simsim, sunflower, and soybeans. There is also a good percentage of households growing horticultural and cassava crops like cabbage, tomatoes, onions, mangoes, oranges, and passion cassavas.

To enable farmers increase their production and engage in the most paying enterprise to eradicate poverty, the region was divided into three zones according to agro-ecological conditions. The zones are Zone A for high value crops, Zone B for general crop production of cereals, legumes and oil crops, and Zone C for other crops. Most businesses are of low investment cost because of low household income from limited resources to ensure sustainable development in trade and industry, low farm prices, lack of training and inadequate business skill in trade, commerce and entrepreneurship as well as poor storage facilities and lack of market information among others.

1.8.1 Cassava industry analysis

Cassava (*Manihot esculenta*) is one of the most important root crops in Uganda. It is suited to conditions of low soil nutrient availability and can survive drought. Cassava is a staple food consumed in both rural and urban areas of Uganda. Cassava ranks very high among crops that convert the greatest amount of solar energy into soluble carbohydrates per unit of area. Among the starchy staples, cassava gives a carbohydrate production which is about 40% higher than rice and 25% more than maize, with the result that cassava is the cheapest source of calories for both human and animal nutrition. In recent years, it has also been transformed

25 NAADS (2020). Cassava production. Accessed at: https://naads.or.ug/cassava-production-guide/

from being a subsistent crop to industrial cash crop mainly as starch. Cassava starch has varied uses in the paper, textile, pharmaceutical, oil drilling and petrochemical industries. It is also used extensively in the food industry. The by-products are pulp and juice. The pulp produced is a valued cattle fodder while the juice is used as fertiliser. Globally, cassava is one of the most actively marketed food products and is the most promising in terms of growth and new market opportunities. There is also a regular surplus of cassava in most producing countries indicating an excellent opportunity for raising the production level with the expansion of industrial starch processing. Even so, several governments in Africa have taken positive steps to promote cassava production through diversifying the market to include industrial processing.

1.8.2 Cassava production in Uganda

Uganda produced 4.3 million MT of cassava in 2018 and 6.9 million MT in 2019[26] and was ranked the 8th largest producer of cassava in Africa and 22nd in the world (FAO, 2020). Eastern region produces the most cassava at 1,061,186 MT followed by northern (983,124 MT), western with 440,189 MT and central (409,810 MT) (UBOS, 2020). Estimates show that more than 75% of farm households in Uganda grow cassava yet the last census of agriculture of 2008/09 indicated that one million out of an estimated 3,946,000 agricultural households in Uganda then grew cassava of which 200,000 households (about 18% of all households in the north) were in northern Uganda (UBOS, 2010). According to UBOS (2014), the northern region has the highest cassava yields at 3.6 MT/ha compared to 3.4 MT/ha in the western and 3.2 MT/ha in central Uganda.

Cassava is one of the main crops earmarked in NDPIII for poverty alleviation, increasing food and nutrition security27 and for agro-industrialisation through animal feed manufacturing, use in bio-fuel ethanol and alcohol industries (NPA, 2020)28. Cassava also has a huge potential to reduce the import bill on wheat, modified starch, liquid glucose and others (NAADS, 2020). In addition, about 88% of cassava produced in Uganda is consumed by people, 50% of which is processed. In addition to the starchy root, the leaves of the cassava plant are edible and rich in protein (Buyinza & Kitinoja, 2018).

In Uganda, and northern Uganda in particular, the predominant commercial products made from cassava are high quality cassava chips and flour (HQCC and HQCF), which are used in the brewing industry and for ethanol production. An ethanol production factory was established in Lira in 2014 by Kamtech Logistics Uganda Limited with mixed results. In addition, these cassava-based industries also generate large quantities of waste/residue rich in organic matter and suspended solids, providing a great potential for bioconversion into other value-added products via bio-refinery.

1.8.3 Cassava as an industrial base

Cassava is also used to produce starch, which is finding application in several industries and is becoming a multibillion-dollar business worldwide. Cassava starch can perform most of the functions where maize, rice and wheat starch are currently used. Starch is utilized in sizing and dyeing in the textiles industries to increase brightness and weight of the cloth. In the pharmaceutical industries, starch serves as a filler material and bonding agent in making tablets. It is an additive in cement to improve the setting time. It is used to improve the viscosity of drilling muds in oil wells. It is furthermore used to seal the walls of bore holes to prevent fluid loss. Starch is the main raw material in the glue and adhesive industries. In paper

26 https://www.tilasto.com/en/topic/geography-and-agriculture/crop/cassava/cassava-production-quantity/uganda#compare

27 Cassava was prioritised in the Uganda national planning agenda because of the ease with which it can be produced massively, being drought resistant and having potential for multi-industrial use and food security, as well as its ability to be stored up to two years underground after maturity.

28 National Planning Authority (2020). The Third National Development Plan (NDP III) 2020/21-2024/25. Accessed at: http://www.npa.go.ug/wp-content/uploads/2020/08/NDPIII-Finale_Compressed.pdf

production, cassava starch is currently used as glue to achieve brightness and strength. It is a key raw material for powder in the cosmetics industries. In detergent soap manufacture, starch is used to get better recovery and to improve the shelf life of detergents. While in the rubber and foam industries, starch is employed for getting better foaming and colour. Cassava starch can be converted to maltotriose, maltose, and glucose as well as to other modified sugars and organic acids (Tan et al., 1984). This starch can be used to make fructose syrups (Vuilleumier, 1993) and formulate gelatin capsules (Nduele et al., 1993).

The use of cassava as a source of ethanol for fuel is already being exploited and very promising. Recently, Roble et al. 2003 demonstrated the production of L-Lactic acid from raw cassava starch in a bioreactor using *Aspergillus awamori* (fungus) and *Lactococcus lactis spp. lactis* (bacteria). Furthermore, cassava dregs could be employed for phytase production after the addition of a nitrogen source and mineral salts (Hong et al. 2001), while activated carbons prepared from waste cassava peel (Rajeshwarisivaraj et al., 2001) are efficient as adsorbents for dyes and metal ions.

1.8.4 Cassava starch processing

Cassava starch is produced primarily from the wet milling of fresh cassava tuber and dry cassava chips. The process involves peeling, washing, grating, pressing, disintegration, sifting, drying, milling, screening and packaging of a finished starch product. Starch is the major component of cassava and is obtained from mature and good quality cassava root. Around 60% of cassava starch is obtained from the dry cassava chips. Cassava starch can be processed into sugar syrup and ethanol.

Cassava starch is used in industries ranging from pharmaceutical, paper, textile, food and furnishings. The global cassava starch market is segmented on the basis of end use such as animal feed, paper, food, textile, and cosmetic industries. Animal feed industry uses dried cassava tubers as an ingredient along with cassava pellets and cassava meal for livestock.

1.8.5 Lessons from Lira Starch Factory

The Lira Starch Factory was established in 1968 to manufacture commercial starch from cassava. Until the 1980s the factory purchased fresh cassava root from farmers in eastern and northern Uganda and sold starch and by-products both on the domestic and international markets.[29] The factory, however, was damaged during the civil strife of the 1980s and has never been rehabilitated. A group of local investors in Lira, registered under the company name Sunset International, bought the Lira Starch Factory in 1996 under the GoU privatisation scheme (Uganda Radio Network, 2006).[30] The company undertook four feasibility studies between 1989 and 2007. The results consistently showed that the project was unviable. The main reasons being the high price of raw material, the small starch market in Uganda, competition from cheap imported starch from India and Thailand. Imported starch was $809 while produced starch cost was $1,200 per MT. At the start of the new millennium the company was unable to start work because of the insecurity in northern Uganda.

1.9 INTERNATIONAL CASE STUDIES FOR STARCH PRODUCTION AND BEST PRACTICES

In considering the potential for investment in large-scale processing of cassava in Uganda it is worthwhile examining the experience of some other countries that are either major players in

29 Otim-Nape et al; Cassava Development in Uganda.
30 http://ugandaradionetwork.com/story/lira-starch-company-to-manufacture-iv-fluids (article published on 23/12/2006; accessed 29/11/2016).

cassava processing or potential players. Thailand, Brazil, India, China, Indonesia, and Vietnam are examples of countries that have succeeded in establishing successful cassava processing industries. Nigeria offers an almost mirror-like contrast to Thailand, the world's most successful producer of cassava-based products. This study focuses attention on Thailand and Nigeria as offering the most useful lessons for public and private sector stakeholders in Uganda. Nigeria is the world's biggest producer of fresh cassava root (FCR), accounting for 29% of world production with an estimated output of 52 million MT per annum in 2015-2016. Thailand accounts for 12% of the world supply of FCR with an output of 32.9 million MT in 2015-2016. Thailand has an average yield of 23-24 MT per hectare and starch content averaging 30-32%. Some farms in Thailand are achieving 45-60 MT per hectare under ideal conditions with the latest varieties and optimum use of good agricultural practices, or GAP. In Nigeria, average is stagnant at 10-12 MT per hectare with starch content of about 15%. Some farms in Nigeria are doing much better with some application of GAP leading to yields averaging 18-20 MT per hectare and starch content averaging 25%. Thailand has the world's biggest cassava processing industry with exports worth $$3.4 billion in 2015-2016. The price for native cassava starch exported from Thailand ranged from $325-$395 (FOB Bangkok) during 2015-2016. In contrast, Nigeria has no export industry for cassava and only limited large-scale processing within the country. There are four cassava starch factories operational in Nigeria. The factory gate price for Nigerian native cassava starch fluctuated between $900 and $1,133 per metric ton during 2015-2016 due to season highs in the FCR price. It is evident from these figures that Nigeria is non-competitive as a producer of native cassava starch.

1.9.1 Thailand

Thailand's cassava industry started in 1959 with large numbers of low technology processors of dried cassava chips for domestic and export sales to animal feed markets. Over a 40-year period, the government and private sector invested in the development of the industry. There have been investments in transport infrastructure, breeding of improved varieties for industrial use, and processing technologies. The livestock feed market gradually developed from simple chips to soft pellets and then to hard pellets mainly for export to the European Union. The EU offered a lucrative market for the export of chips and pellets that peaked in 1992 with exports of ~6.5 million MT to the region. However, in 1992 reforms to the EU Common Agricultural Policy started to undermine the EU market and by 2005 this export opportunity had virtually disappeared. This could have been disastrous, but the Thai industry had invested in innovative technologies to diversify production into other products including native and modified starches, sugar syrups, and industrial alcohol. Even waste pulp of the starch industries was targeted as a value-added product with export potential. The focus of primary production has been to increase yields and starch content whilst decreasing the unit cost of raw material. In processing, Thailand has moved towards a smaller number (~200 units) of much larger processing industries with outputs ranging from 500-2000 MT of product per day. The technology for processing has been optimised to improve energy efficiency, reduce waste and convert liquid and solid waste into value added materials such as biogas and animal feed. The Thai industry has shown ability to innovate rapidly to take account of changing market trends. Back in 2008 hard pellets were still an important product with exports of 1.5 million MT per annum, dried chip exports were decreasing and had fallen to just 1.2 million MT. However, in 2009 the world started to demand cassava chips as feedstock for production of biofuel. Thailand responded and by 2015 exports of cassava chips had risen to 7.2 million MT; in contrast, export of hard pellets had fallen to just 39,000 MT. Cassava chips is not the only success story for Thailand. In the area of native and modified cassava starch, exports increased from 1.5 million MT and 736,000 MT respectively in 2007 to 2.9 million MT and 905,000 MT respectively in 2015.

The success of the Thai cassava processing industry has been associated with a long-term approach to cooperation between the government and industry with the former working to create the right environment to ensure the competitiveness of Thai cassava products. The Government of Thailand has a long-term strategy known as the "Cassava Roadmap". The roadmap consists of implementing four major strategies for development. Governments wishing to invest in the cassava sector can learn from this lesson and put in place a long-term strategy and plan for cassava industrialization in the country. The first strategy recognises that Thailand only has a limited area of land for production of cassava (~1.5 million ha) and thus focuses on improving productivity from the available land. The current average yield is 23 MT per hectare, but a target was set of 31 MT per hectare by 2020. This increase in yield is being driven by a combination of GAP, dissemination of clean planting material, maintenance of soil fertility, promotion of intercropping, crop rotation, weed control and improvements in harvesting practices. Recently yields have increased by 50%, production costs have risen but farm incomes have risen by 300%. The second strategy is concerned with value addition and has focused on improving management of the industrial ethanol supply chains. Contract farming is being actively encouraged, a price guarantee scheme has been implemented to stabilise the FCR price. The government has sought to clarify its policy on biofuel to encourage investment and is supporting SME chip producers to produce high quality chips (clean chip technology). The third strategy focusses on supporting market expansion through innovation and research and development. The keys for Thailand are to increase volumes, improve quality and product range whilst remaining competitive against rival products. Thailand controls 83% of the world market for cassava-based products. The government and industry set a target of >85% by 2020. The final strategy under the roadmap is for the government and private sector to share support for research and development in the nations' universities and to ensure a supply of skilled personnel to feed into the industry. Research deals with both primary production, processing and end-user applications such as the development of cassava-based biodegradable plastics.

The cassava roadmap is not the only initiative of the government in Thailand. The ministries of commerce and foreign affairs are working with the national association of the cassava processing industry to ensure collection and public dissemination of detailed and accurate data and analysis on the industry. This strategic information system (www.thaitapiocastarch.org) is essential for guiding investment decisions and helps all stakeholders to have a clear picture of the industry and makes it easier to see where innovation is needed to remain competitive. Other interesting features of the system include the provision of soft loans for cassava production via the Bank of Agriculture and Agricultural Cooperatives. According to researchers at KU University, >50% of Thai cassava farmers (mostly smallholders) get these loans yearly to support buying of farm inputs. In 2010-2011 floods caused major devastation in the cassava growing areas of Thailand. The government responded with a farmer income guarantee scheme as an insurance against the adverse impacts of disease and bad weather. Some $79 million was allocated for the scheme in its first year of operation. Following the floods, 391,000 farms registered for the scheme and made claims for flood damage. The average payment was $206 per farmer. This may be only a token payment in real terms, but it did a lot to maintain the farmers' confidence and the production system recovered rapidly over the following two years.

1.9.2 Nigeria

Nigeria has the highest population in Africa and is also the largest producer of cassava in the world. An obvious move for Nigeria was to develop a cassava processing industry to eliminate reliance on imported starches, sugar syrups and ethanol and then to develop a competitive export industry for cassava products. This was indeed the ambition of the Government of Nigeria after independence in 1960. By 1964 a plan had been developed that resulted in 15 native cassava starch factories with a capacity of ~100 MT of starch per day for each factory. More than 50 years on only one of these factories is operating and only at ~10% of installed capacity. By 2016 Nigeria had four operational starch factories with a combined capacity of less than 100 MT per day. There is also one cassava ethanol factory (output 33m³/day) and one HQCF factory with a capacity of 90 MT per day but only operating at ~45% of capacity. Except for the ethanol factory, Nigeria's cassava processing industries are inefficient and non-competitive. Cassava starch costs between $900 and $1,133 per MT depending on fluctuations in the FCR price. Import of cassava starch is prohibited but maize starch remains competitive at $800/MT even with high import duties and taxes. Nigeria had a sugar syrup factory but production costs were close to $1,300 per MT making the factory uncompetitive against imported Chinese sugar syrups at $900/MT. Successive governments have invested in pro-cassava policies with no success and the current government announced in September 2016 that it would support development of a cassava industry to generate $5 billion per annum in profits by 2020 and employ almost 10% of Nigeria's population. Whilst this is an admirable aspiration the track record of previous initiatives indicates almost certain failure.

Nigeria's industries face numerous challenges. There is a total absence of reliable national grid electricity forcing any factory to rely on expensive diesel-powered generators. Road infrastructure is poor making transportation a costly undertaking. Production of FCR is done in an absence of any form of GAP, yields are relatively low and production costs high due to the lack of mechanisation and poor yield per unit area. Cassava is a major food crop in much of Nigeria and this impacts on pricing with root prices being subject to unexpected periods of high prices that make industrial processing uneconomic. The government's biggest success story has been the development of improved varieties, which has improved productivity to some extent. There have also been several major cassava initiatives such as the Presidential Initiative for Cassava (2002-2007) and Cassava Transformation for Agriculture Programme (2011-2015). These initiatives have sought to achieve the same impact as seen in Thailand.

1.10 PURPOSE OF THE STUDY

In line with the terms of reference (TORs), the feasibility study covered a wide scope that entailed comprehensive literature review and collection of primary data. The primary data included both qualitative and quantitative cassava market assessment surveys of farmers, traders, and processors as well as participatory institutional assessments through key informant interviews. In addition, possible factory location site visits, mapping and assessments were done. Technical and financial analyses were carried out to assess the feasibility of the proposed cassava starch and other product factory within the geographical, topographical, social, environmental, and economic context of the Acholi sub-region.
The main objective of the feasibility study is to determine the viability of establishing a cassava processing factory in Acholi sub-region. The specific objectives of the study are to:

- (i) assess the extent of raw cassava production in Uganda and the Acholi sub-region;
- (ii) establish the demand for cassava starch in the country and the region;
- (iii) identify and appraise (financial, economic, social and environmental) the best project implementation alternative for establishing the cassava starch factory;
- (iv) undertake a risk analysis of the project and identify mitigation measures;
- (v) carry-out a stakeholder analysis from the point of view of economic and social benefits and the role of different actors; and
- (vi) make conclusions and recommendations on the overall feasibility of the proposed project.

1.11 APPROACH AND METHODOLOGY OF THE FEASIBILITY STUDY

This study report is organised to align with the key requirements identified by the Uganda Development Corporation and NDPIII. Further the study methodology is cognisant of the development committee guidelines for project preparation and appraisal as provided by the Ministry of Finance, Planning an Economic Development. It consists of a market assessment and mapping of existing cassava and starch needs; development of a comprehensive problem statement, taking into consideration the regulatory reference points as well as the requirements of multiple stakeholders; development of possible alternative options for dealing with the need; and benchmarking with existing businesses and partners.

The project required extensive research as well as direct contact with key stakeholders and manufacturers, importers and users. Desk research consisted of gathering relevant market studies, reports, case studies and other useful documentation. Key stakeholders were identified and contacted directly to participate in and provide information for the project. As a result, a tool was developed for evaluating the available options as detailed in annexure 2.

During the feasibility study, stakeholders and respondents were engaged to consider the progress of the study and generate input to ensure continuous engagement, participation, and project ownership. This was key to the development of a comprehensive study report that incorporates all the views, concerns and considerations of stakeholders. A key informant interview guide is included as an annexure to this report (See Annexure 7). Participatory workshops were conducted to establish the current capacity bottlenecks and synthesise the facility, equipment and staffing needs to actively manage the identified problem. Interviews were conducted to gather valuable information from top technical people and business owners whose very busy schedule limited their active participation in other data collection activities.

To establish the potential for cassava starch in Uganda and to evaluate the feasible solutions that can address the need, a demand analysis was conducted as guided by the research objectives. The study carried out a critical analysis of the competitive landscape for cassava starch trade. The technical analysis was carried out to establish whether the proposed project is technically feasible, can address the problem and is capable of being implemented. The financial and economic evaluation of the project was carried out using a cost benefit approach and parameters such as expected cash flows, production capacity, internal rate of return, and net present value. A preliminary analysis was undertaken to choose between the project options and only the preferred option was considered for detailed analysis.

1.12 ORGANISATION OF THE FEASIBILITY STUDY

This feasibility study is made up of the following sections:

Section One: Background to the feasibility study details the project introduction, background, rationale and justification. It covers the methodology used in all sections of the document.

Section Two: Demand analysis module identifies the problem which the project aims to address and the alignment to national development strategy, elaborates the proposed project intervention and estimates, quantifies and justifies project demand.

Section Three: Explores the cassava processing situation, current production output, and demand and supply factors based on field study findings.

Section Four: Technical analysis module evaluates alternative options available to address the problem. It includes criteria for preliminary analysis of available options and detailed technical analysis for the preferred option.

Section Five: Environment module assesses the impact of the project on the environment. It sets the ground for a comprehensive EIA about the key environmental issues, impacts and mitigative measures.

Section Six: Human resource and administrative module addresses the project staffing needs, highlights key strategies to attract, motivate and retain super specialised staff with the requisite skills.

Section Seven: Policy and legal module reviews the relevant policies, legal and regulatory framework within which the project will be realised including any limitations and deficiencies in the regulatory framework.

Section Eight: Finance module identifies and analyses the possible funding options, projects the financial statements and cash flow over the useful life of the project, including financial analysis using tools like net present value, internal rate of return to determine the project financial viability.

Section Nine: Economic and distribution analysis module involves the cost-benefit analysis from the perspective of all project stakeholders. It involves the use of shadow prices to reflect the social opportunity cost of goods and services, instead of prices observed in the market, which may be distorted.

Section Ten: Risk analysis module deals with risk assessment. It identifies uncertainty which once it permeates the project would affect its viability. This section includes sensitivity analysis, scenario analysis and measures of mitigating the risks.

Section Eleven: Conclusions and recommendations module summarises key findings and recommends the course of action whether to accept or reject the project based on the feasibility study findings.

02 The Need for The Project

2.1 PROBLEM STATEMENT

Uganda is a leading producer of cassava and registered a surplus with an estimated 8 million MT in 2019 and 9.1 million MT in 2020 (UBOS 2020)[1]. Despite the potential of cassava to support a wide range of industries ranging from pharmaceuticals to biofuel, value addition to cassava in Uganda is very low (NDPIII) with most processors milling it into low quality flour for local consumption. Cassava also has the potential for import replacement of starch and ethanol if there is sufficient value addition.

The shelf life of raw cassava is 2-3 days. Therefore, produce must be either sold off or consumed immediately. The current bulk use of wheat and sugarcane, which have limited suitable land area and require more nutrients and water compared to cassava, as the main source of starch and bioethanol is inconsistent. On the other hand, cassava is high in starch content (70–85 % dry base / 28–35% wet base) and quality compared to other starch sources. Besides, the cassava crop is highly efficient in producing starch and ethanol, is available year-round, tolerant to extreme drought stress conditions, and fits well within traditional farming systems.

While the northern region of Uganda supplies 26% of cassava (UBOS, 2020), 21.6% of the population is poor and 16.6% of households in the region slipped back into poverty in 2018/19 (UBOS, 2020)[2]. Given that 86% of the households rely on agriculture, products like cassava which continue to fetch low prices due to the little or no value addition are to blame.

The demand for cassava fresh root equivalent was 2.75 million MT and 3.2 million MT in 2015 and 2020 respectively and is expected to increase by 17.5% in the coming decade (Kilimo & BTC, 2020). With cassava imports of 3,346 MT worth $0.15 million and exports of $1.97 million from 10,510 MT in 2019 (FAOSTAT, 2020), Uganda has the potential to tap benefits from import substitution and export promotion strategies revolving around the crop. If the country does not invest in cassava processing, the comparative benefits associated with it will be missed. Cassava farmers will reduce acreage and a growing amount will be spent on imported cassava products.

1 Uganda Bureau of Statistics (UBOS), 2020. Statistical Abstract, 2020. Accessed at: http://library.health.go.ug/sites/default/files/resources/UBOS%20Statistical%20Abstract%202020.pdf

2 https://www.ubos.org/wp-content/uploads/publications/11_2020STATISTICAL__ABSTRACT_2020.pdf

2.2 ALIGNMENT WITH THE NATIONAL DEVELOPMENT AGENDA

2.2.1 Linking the project to Uganda Vision 2040

Vision 2040 is conceptualised around strengthening the fundamentals of the economy to harness the abundant opportunities around the country. Accordingly, Uganda hopes to attain a GDP of $580.5 billion and per capita income hitting $9,500 based on 61.3 million people by 2040, which will require annual GDP growth rate of more than 8.2%. Realisation of the Vision 2040 requires establishment of systems and facilities that support industrialisation. Given that agriculture is the mainstay of the Ugandan economy — contributing 49% of GDP and employing 65% of the population[3] — Vision 2040 calls for investment in the sector through agro-industrialisation. Establishment of the cassava starch factory will contribute to increased production and trade, which is highlighted as one of the growth opportunities in the Uganda Vision 2040. The project will contribute to diversification of the processing mix outlined in the Vision.

2.2.2 Linking the project to the Third National Development Plan (NDPIII)

Cassava is one of the priority commodities identified in the NDPIII for regional agricultural processing and marketing under the Agro-industrialization Programme. Additionally, cassava is one of the 12 commodities prioritised by the Ministry of Agriculture, Animal Industry and Fisheries. The establishment of a cassava starch factory will promote import replacement, create jobs, save foreign exchange, and improve household income thereby promoting socio-economic transformation.

NDPIII has five strategic objectives[4]:

- **(i)** Enhance value addition in key growth opportunities
- **(ii)** Strengthen the private sector to drive growth and create jobs
- **(iii)** Consolidate and increase the stock and quality of productive infrastructure
- **(iv)** Enhance the productivity and social wellbeing of the population
- **(v)** Strengthen the role of the state in guiding and facilitating development.

The NDPIII builds on previous national development plans and has retained promoting agro-industrialisation as one of the priorities. Establishment of the cassava starch factory is linked to all the NDPIII objectives through:

a. **Enhancing value addition in key growth opportunities:** The cassava starch factory will add value to raw cassava leading to products like starch, ethanol and other products and by-products.

b. **Strengthening the private sector capacity to drive growth and create jobs:** The proposed cassava starch factory will utilise inputs from farmers and private dealers. This will guarantee market for cassava farmers and dealers across the cassava value chain. Products from the factory will increase domestic and international trade opportunities leading to increased opportunities for product users in manufacturing, farming, pharmaceuticals, beverages, and the resultant job creation.

c. **Consolidating and increasing the stock and quality of productive infrastructure**: The cassava starch factory is key to the establishment and functioning of other productive infrastructure like power generation, road and improved farming schemes.

3 Water and Sanitation Sector Performance Report, 2006.
4 Third National Development Plan (NDPIII) 2020/21 – 2024/25.

d. **Enhancing the productivity and social wellbeing of the population**: The implementation of the cassava starch factory will ensure high productivity and better varieties of cassava, improved household income, quality starch products, food security and reduced poverty that spur the well-being of the population in the project area and beyond.
e. **Strengthen the role of the state in development**: By implementing the proposed cassava starch factory, the Government of Uganda will establish a state-of-the-art agro-processing facility as an enabler for social and economic development.
f. **SDG 9 "Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation"**

The cassava starch factory is on top of the list of NDPIII agro-industrialisation core projects. Once established, the project will contribute to the objectives of the NDPIII as follows:

- **Objective 1: Increase production and productivity of agro-enterprises (page 58)**
- **Objective 2: Improve post-harvest handling, storage of agricultural products**
  - 2) Regional post-harvest handling, storage and value addition facilities will be established in key strategic locations; cassava in Gulu.
- **Objective 3: Increase agro-processing of the selected products (Page 60)**
  - 3) Establish new and expand existing agro-industries for processing of key agricultural commodities.
  - c. Establish 2 starch and 3 ethanol processing factories from cassava in Gulu, Tororo and Lira
- **Objective 3: Increase market access and competitiveness of agro-industry products**
- **Objective 3: Increase access to regional and international markets (page 118)**

The establishment of the cassava starch factory is a priority project in the NDPIII and will be an opportunity to improve the quality of products available to Ugandans and also the promotion of competitiveness for national development.

2.2.3 Linking the project to the National Resistance Movement 2021–2026 Manifesto

The project is aligned with the NRM's four-fold strategy:

a. Diversification of the economy from overreliance on agriculture: The proposed project is linked to agriculture but entails industrialisation and manufacturing of starch, ethanol and other cassava products.

b. Extensive import substitution in order to reduce the import bill: The proposed project shall involve the twin components of import substitution and export promotion. The economy will benefit from reducing imports of cassava starch, ethanol and other associated products while at the same time promoting exports of the same products.

c. Processing of raw materials to add value: The proposed project entails the processing of raw cassava into various high value products.

d. Building basic industries: The proposed project entails the establishment of a cassava starch and ethanol factory.

The NRM Manifesto identifies food products for prioritising including: "Adding value to cassava to make fortified cassava flour, ethanol, pharmaceutical grade starch and starch for baking bread to replace the unhealthy imported wheat that is costing over US$300 million annually. Biodegradable packaging materials can also be made from cassava." Specifically, the proposed project is identified as establishment of cassava processing factories (Acholi Bur) by UDC on page 60.

2.2.4 Linking the project to the Uganda Development Corporation Strategic Plan (2019/20 – 2029/30)

The proposed establishment of the cassava starch factory is aligned with the Uganda Development Corporation Strategic Plan 2019/20 – 2029/30 as follows:

Strategy 3.1: Invest in areas that have the greatest multiplier effect on the Ugandan economy, that maximise the utilisation of local raw materials as well as reduce the country's trade deficit
Actions under Strategy 3.1:
3.1.1 Invest in value addition to Uganda's agricultural commodities — tea, coffee, cocoa, cassava, grain, cotton, sugarcane to manufacture high value products.
• Set up 100MT/day cassava processing plants in Lira, Soroti, Kibuuku and Gulu to produce flour, starch and glucose.

The proposed project will be an opportunity to improve the quality of products available to Ugandans and also the promotion of competitiveness for national development.

2.2.5 Key cassava interventions in the proposed area

a. Operation Wealth Creation
Cassava has been identified as a priority crop that can produce flour, animal feed, alcohol, starches for sizing paper and textiles, among others. The MAAIF has developed programmes to promote research into high yielding and climate resilient varieties which are now being disseminated in the areas with the best production potential. In the FY2015/16 alone, NAADS/OWC programme provided support to both small holders and commercial cassava farmers in more than 60 district local governments that prioritised cassava. Some 577,219 bags of cassava cuttings were distributed. Cassava production has been growing since 2017/18.

b. Gulu Archdiocese
The Archdiocese establishes a cooperative society aimed at commercialisation and industrialisation of cassava production. The government has already spent 8 billion shillings to support the cassava production pilot study at Acholibur in Pader District in the last four years starting 2016. A total of 33 cooperatives with 10,000 farmer members have been enrolled with active cassava plots. The project is being managed by the Catholic Church under the leadership of Gulu Archbishop John Baptist Odama and supported by government through NAADS.

2.3 PROPOSED PROJECT INTERVENTION COMPONENTS

The project is intended to provide feasible options for the establishment of a cassava starch factory. The project will also work with the Acholi Archdiocese, National Agricultural Research Organisation and other private business entities involved in the manufacture and use of cassava starch and ethanol. The project interventions will involve the following:

2.3.1 Design and construction of factory building facilities

This component entails engineering and architectural design; procurement and contract management; construction of cassava factory buildings including factory floor; construction of raw materials, consumables and finished product storage facilities; construction of production, marketing and administration office space; and a parking yard. This component also includes the procurement and installation of office furniture, fixtures, and equipment. The key spaces shall include:

- o Factory floor space
- o Production and operations staff office
- o Raw materials and consumables store
- o Finished products store
- o Administration and marketing office
- o Parking yard

2.3.2 Procurement, installation, and commissioning of factory plant

This component entails the procurement, installation, and commissioning of cassava starch and factory plant and associated tools, spares, and parts. The proposed plant shall offer different plant sizes: small, medium and large and all will be open to expansion. This component also includes training and technical support for key production and operations personnel.

2.3.3 Project coordination and management component

This component describes the required project management capabilities of a well-trained and motivated team to operate and maintain the proposed starch factory. In a bid to ensure effective O&M of the project and facilities, UDC has incorporated the required skills set and staffing levels to support sustainable project management.

2.4 PROJECT DEMAND ANALYSIS

2.4.1 Global market segregation

The cassava starch market is segregated by type, form, grade, function, and application. The growth among segments within these categories helps one analyse niche pockets of growth and strategies to approach the market and determine core application areas and the difference in one's target markets.

- Based on type of starch, the market is segmented into starch hydrolysate, native starch, and modified starch. Starch hydrolysate segment is dominating the market because cassava offers high hydrolysis rate over other crops like maize, potato. Cassava starch is an organic source of rich carbon supply in food application. The growing preference for organic food is further accelerating the growth of hydrolysate cassava starch market.
- Based on form, the market is segmented into dry and liquid. The dry segment is dominating the market due to less expense on powder form for storage and transpiration operation as compared to liquid.
- On the basis of grade, the market is segmented into food, industrial and feed. The food industry is dominating the market owing to increased consumption of cassava starch in food products.
- Based on function, the market is segmented into texturizing, binding/adhesion, gelling, stabilising, thickening, moisture-retention, film-forming agents, sizing and coating. The texturizing is the dominating segment because cassava starch is majorly used in the food and beverages industry to improve the texture of the food products or beverages to create an impression on customer mind.
- On the basis of application, the market is segmented into food and beverages and industrial. The demand of cassava starches in food and beverages products is higher due to enhanced taste offered by the cassava starch with added proteins.

2.4.2 Uganda starch market segmentation and value

Uganda has a domestic native starch consumption of approximately 1,000-1,500 MT/year, a liquid glucose consumption of 1,000-1,500 MT/year, and dextrin consumption of 400-500 MT/year. These markets have a combined value of approximately $3,000,000/year. The major consumers of starch are in the pharmaceutical, food, and non-food sectors such as textile, wood processing, and cardboard-making.

2.4.3 Global cassava and starch industry

Starch $(C6H10O5)^n$, the principal reserve polysaccharide in plants, constitutes a substantial portion of human diet. Natural starch occurs usually as granules composed of both linear and branch starch molecules. However, some starches are composed only of branched molecules and they are termed waxy starches because of the vitreous sheen of a cut sheet surface. Cassava has many advantages for starch production: high level of purity; excellent thickening characteristics; a neutral (bland) taste; desirable textural characteristics; a relatively cheap source of raw material containing a high concentration of starch (dry matter basis) that can equal or surpass the properties offered by other starches (maize, wheat, sweet potato, and rice). Unmodified starch is mainly in non-food application in the naming adhesive and paper industries. Unmodified starches are used for the manufacture of gun candies because they form hot concentrated pastes that gel firmly on cooling. Heat treated starches are used in food applications to bind and carry flavours and colours. Swelling agents are made from starch by enzymatic or acid ferment. Starch derivatives like cation starch, starch phosphate and starch acetate have numerous uses. Market Survey Global starch consumption is projected to reach 133.5 million metric tons. Rise in per capita consumption, and growing demand for starch products from developing nations, translates into a bright outlook for the sector. Starch end-use applications have grown in number over the years, and now include diverse applications ranging from food and beverages to medicine, cosmetics, pharmaceuticals and more. Usage of starch by the food industry is being fuelled by the increasing number of government policies stipulating the usage of natural substances in food products. With the increasing demand for low fat and low-calorie food, many food companies are replacing fats with gums and carbohydrates such as starches and hydrocolloids. The major cassava starch and flour importers are, by order of importance, China, Japan, Malaysia, Indonesia, Singapore, the United States, and the Philippines.

2.5 UGANDA'S CASSAVA AND STARCH INDUSTRY ANALYSIS

2.5.1 Market demand and supply

Cassava supply prospects are quite good for Uganda with about 3 million MT of fresh cassava produced in 2018 (Figure 3). Short term projections show that Uganda supplies 16,400 MT of starch in the form of high quality cassava flour (HQCF) and chips while in the medium to longer term, the supply capacity is estimated at 40,000MT and 60,400MT respectively (Figure *2*). The starch is mainly used for baking, brewing, production of ethanol and animal feeds. On the demand side, within Acholi and the surrounding Lango and West Nile regions, the major actors who include traders, processors, local brewers, and ethanol factories demand about 40,000MT of fresh cassava leaving about 2.1 million MT as a surplus given the current production levels.

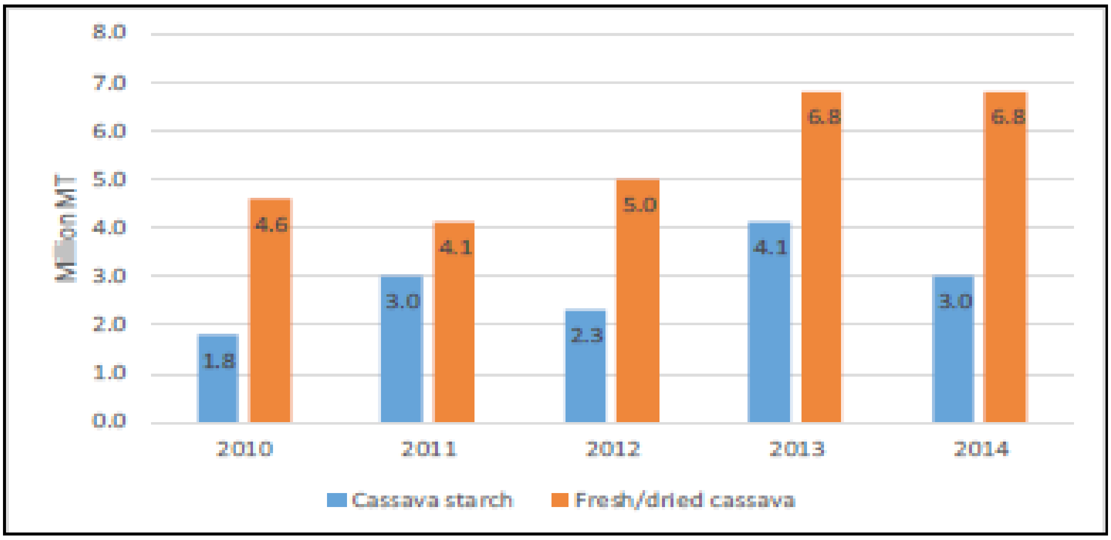


Figure 2: Uganda cassava starch and dried chips supply (2010-2014)

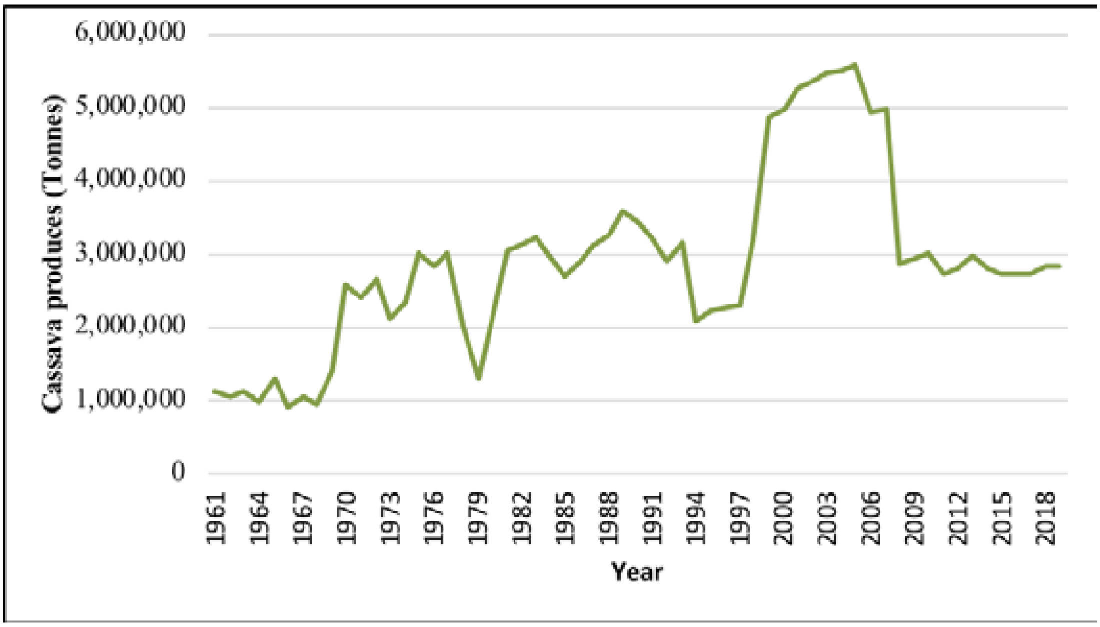


Figure 3: Uganda fresh cassava production (1961-2018)
Source: FAOSTAT (2019)

2.6 RAW MATERIAL SOURCING

Raw material for producing cassava starch is available on the local market at reasonable price. The main raw material is raw cassava. The suppliers come in form of organised farmer groups or simply as individual household farmers. Local traders can also sell cassava. Volatility in cassava prices due to farming seasons is the biggest threat facing the proposed project. This risk can be minimised by making long term supply contracts with farmers which is a common practice of large-scale industrial producers.

2.7 PRICING STRATEGY

Pricing strategies that were used on the cassava product sales were a combination of penetrating pricing and status quo pricing. It was applied to gain lower prices in accordance with the rates applied by competitors.

2.8 MARKETING CHANNEL STRATEGY

In delivering products to the consumers, the proposed entity will use direct and indirect marketing. Direct marketing will be used for delivering products directly into the hands of consumers. Marketing will be carried out using an intermediary distributor whereas the marketing in foreign countries, will be based on contracts with importers abroad.

2.9 DISTRIBUTION STRATEGY

Distribution strategy used was intensive distribution strategy where the products sold were placed on many retailers and distributor in various places. It was because tapioca products were staple goods that have high demand and levels of consumption. Beside that also used the market development strategy by expanding the distribution area and cooperation relationship with small and large traders so guaranteed product availability in the market.

2.10 DEMAND AND COMPETITION FORECAST

Demand for starch in Uganda

Based on the multiple linear regression (MLR) to predict the relationship between a dependent (output) variable and independent (input) variables using a multivariate mathematical function, the demand for cassava starch[5] was as below:

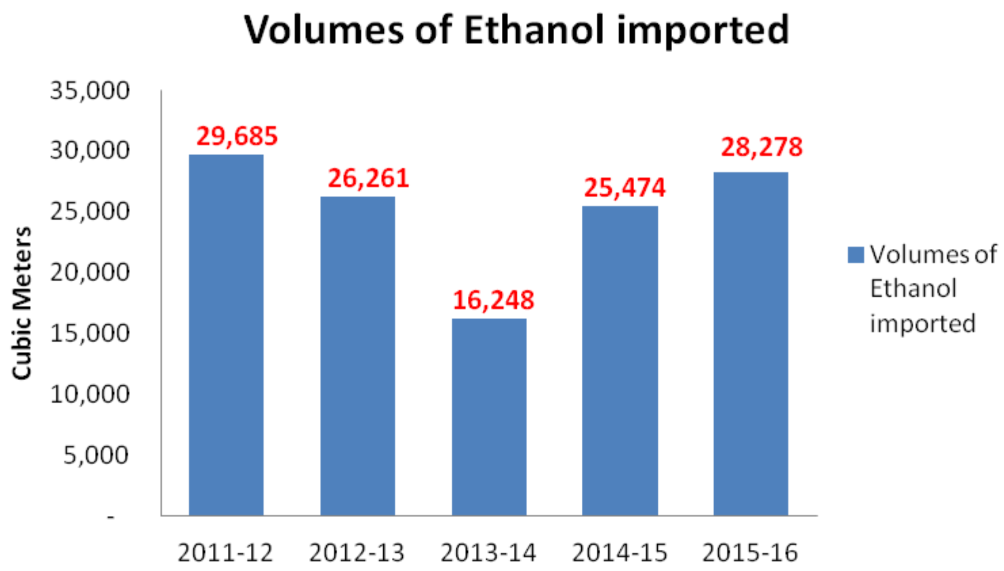


Figure 4: Uganda's ethanol imports (2011-2016)

By 2014, Africa was a net importer of cassava and cassava starch, with the East African region largely accounting for this negative trend. The East African region's contribution to Africa's net cassava imports was more than 120%. Between 2005 and 2014, net imports of cassava starch in East Africa increased by more than 20%. This is attributed to the increasing demand for starch for industrial purposes. The East African starch market has two major sources of starches — maize and cassava — with maize starch dominating. Most of the starch is imported.

The global cassava starch market size is predicted to reach $66.84 billion by 2026 (GrowAfrica, 2015), at an estimated CAGR of 6.50%. The expansion of the textile industry will aid the

5 Choosuk. N, Kengpol A. (2016). Application of Forecasting Models for the Supply and Demand Management of Cassava Products, 175KMUTNB Int J Appl Sci Technol, Vol. 9, No.3

expansion of the cassava starch market during the forecast period. The increasing applications of starches in the textile industry such as warp sizing, printing, cloth finishing will facilitate the healthy growth of the market.

Global trade in cassava products has also grown due to Chinese imports, which account for about 90% of total trade (Dalberg, IDH, and GrowAfrica, 2015) supported by 2006 restrictions on the use of molasses and maize as the primary input for ethanol production to prevent environmental effects of waste (from use of molasses) and to curb food price increases. Given the nature of fresh cassava tubers, which are highly perishable, the need for starch processing will continue to increase. While the leading exporters of cassava and its derivatives to China are Thailand and Vietnam, the implementation of a free trade agreement between Thailand and China in 2013 resulted in the abolition of a 6% tariff on Thai cassava products, which means that the market price of imported cassava starch to China became lower than the price of Chinese manufactured starch, which further increased global trade.

Uganda ranks 12th globally among cassava exporters, with exports of 9,000MT of fresh/dried cassava and 1,300MT of cassava starch in 2013 mainly destined for neighbouring countries within the East African Community, with small volumes also exported to the United Kingdom.

Trends in ethanol prices show a relatively volatile pattern implying that the ethanol sector may be somewhat risky, and that local production may be a good hedge against uncertainty in the global market. To tap into this potential, there is a need to produce starch and ethanol.

Competition

Currently, maize and cassava were the major sources of commercial starch on the East African market Graffham et al. (2000). The industries utilise both cassava and maize starch in similar production processes in the paper, printing, packaging, textile and food industries but maize starch dominated the market. Maize starch is first imported into Kenya and then distributed within the sub region. Modified starches are used in the paper and food industries in Kenya, textile in Uganda, and laundry in Tanzania.

03 Cassava Production, Processing and Marketing in Northern Uganda

This section presents the findings from a cassava farmer, trader, and processor survey in northern Uganda with particular focus on the Acholi sub-region. First, farmer socio and economic characteristics are presented, and later cassava production and marketing statistics is presented.

3.1 SOCIAL CHARACTERISTICS OF CASSAVA FARMERS IN NORTHERN UGANDA

Results indicate that 62% of cassava farmers in northern Uganda are male. Some 89% of those sampled are married. Majority of the cassava-growing households in northern Uganda (67%) have between six and 10 members of whom four are children below 18 years, indicating a high level of available household labour (Table 8). In terms of education, 58% of the farmers have a primary level of education while 27% have a secondary level. The youth made up 25% of the cassava farmers while the majority (67%) are aged between 36—60 years.

Table 8: Cassava farmer social characteristics

Characteristic	Option	Response (n=162)
Farmer sex (%)	Male	61.73
	Female	38.27
Marital status	Married	88.89
	Widow/Widower	8.02
	Separated	3.09
Household size	5 or less members	24.07
	6-10	67.28
	10 or more	8.64
Average number of children		3.85
Highest level of education	None	9.26
	Primary	58.02
	Secondary	27.16
	Tertiary/vocational	3.70
	University	1.85
Age distribution	18-35 years	25.31
	36-60 years	67.28
	Above 60 years	7.41

Source: Cassava feasibility household survey, UDC, 2021

3.2 ECONOMIC CHARACTERISTICS OF CASSAVA FARMERS

Cassava is mainly grown by farmers in the first season of the year. Results indicate that 95% of the farmers grew cassava in the first season of 2020 (2020A, which runs from March to July) compared to only 20% who grew it in the second season (2020B which runs from August to

December). Maize, beans, groundnuts, soyabean and simsim are the other five crops grown by the cassava farmers and which compete with cassava for land and labour as well as other production resources (Figure 5).

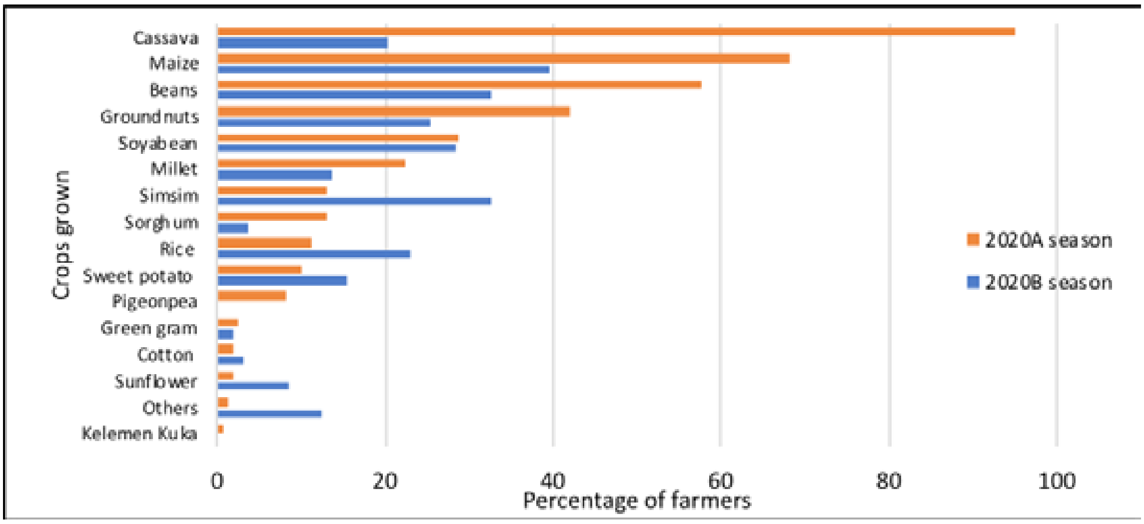


Figure 5: Percentage of farmers growing the crops by season

Source: Cassava feasibility household survey, UDC, 2021

3.3 AREA ALLOCATED TO CASSAVA

Farmers in northern Uganda allocated more land to cassava in the first season (2020A) at an average of 3.8 acres per household. In 2020B season, it was down to 2.8 acres. By district, however, households in Kitgum, Pader, Gulu, and Nebbi allocated more land to cassava, ranging between 3.4 acres and 7.4 areas (Table 9).

Table 9: Cassava area allocated per household by season

	Cassava Area (Acres) by season	
District	**2020A**	**2020B**
Kitgum	7.43	-
Pader	6.00	6.62
Gulu	3.70	2.23
Nebbi	3.36	1.71
Nwoya	3.29	3.31
Omoro	3.15	2.56
Amuru	2.67	1.38
Lira	0.36	0.31
Overall	3.76	2.75

Farmers in northern Uganda still mainly grow local cassava varieties, with 52% of them reporting growing them. Among the improved varieties, 21% of the farmers indicated growing NASE 14, some 11% grew NARO CASS-1 and 8% TME-14. Table 11 gives a detailed list of characteristics of the various cassava varieties which in a way define the farmers' preferences for them. The varieties are also seen to be spatially distributed with NASE 14, grown across the region except Omoro and Kitgum, NARO CASS-1 grown in Omoro, Amuru and Pader; NARO CASS-2 in Omoro, Amuru, Pader, Gulu and Nebbi; TME-14 in Amuru and Nwoya.

Table 10: Cassava varieties grown by households by district

	Percentage of households growing variety					
District	**NARO CASS-1**	**NARO CASS-2**	**NASE-19**	**NASE-14**	**TME-14**	**Local variety**
Omoro	33%	5%	0%	0%	0%	62%
Amuru	33%	11%	0%	33%	6%	17%
Pader	32%	9%	0%	5%	0%	55%
Kitgum	0%	0%	0%	0%	0%	96%
Lira	0%	0%	0%	9%	0%	91%
Gulu	0%	18%	0%	41%	0%	41%
Nwoya	0%	0%	0%	20%	52%	36%
Nebbi	0%	11%	7%	57%	0%	18%
Overall	**11%**	**6%**	**1%**	**21%**	**8%**	**52%**

Source: Cassava feasibility household survey, UDC, 2021

Many of the local cassava varieties such as Bao, Alado-alado (Tim-tim), Nyaraboke, Fumba chai, and Ebwanaterak have succumbed to cassava mosaic disease (CMD) and some have become extinct. Among the most recently released cassava varieties, NASE 14 and NASE 19 are not used for food but processed into flour for brewing and other commercial uses (Mukasa & Erongu, 2016). TME-14 is another variety grown and preferred by farmers for drying very fast, its tubers are soft and easy to peel, and it produces white flour with high starch level (Okao-Okuja, et al., 2017).

Table 11: Cassava varieties characteristics

Variety	Maturity period	Potential yield (MT/ha)	Tolerance to Cassava Brown Streak Disease	Resistance to drought	Starch yield in 0-2 weeks of storage %
NAROCASS-1	12-18 months	25-42	Tolerant	Resistant	18.2-22.0
NAROCASS-2	12-18 months	25-30	Tolerant	Resistant	18.2-22.0
NASE 19	12-18 months	25-41	Tolerant	Resistant	18.2-22.0
NASE 14	12-18 months	25-34	Tolerant	Resistant	18.2-22.0
TME-14	12-18 months	30-45	Tolerant	Resistant	18.5-25.3
Local variety	12->18 months	9	Fairly tolerant	Fair	14.5-22.7

Sources: NAADS (2021)[1];Abacha et al. (2021), Ntawuruhunga et al. (2006); Nuwamanya et al. (2019) & RUFORUM (2016)[2]

3.4 CASSAVA FARM PRODUCTION, CONSUMPTION AND MARKETING IN NORTHERN UGANDA

Households harvested an average of 4,440kg of fresh cassava tubers in the first season and sold 2,820kg and the rest is consumed at home. In the second season, they harvested 2,660kg and sold 2,180kg. The highest yielding varieties were TME-14, NASE-19, and NASE-14 (Table 12). TME-14 yields about 27MT/ha while NASE-19 gives about 8MT/ha of fresh cassava tubers (Table 138). What is puzzling is that the highest yielding varieties are the ones grown by fewer farmers and not well diffused geographically with fewer districts growing them.

1 https://naads.or.ug/cassava-production-guide/
2 https://ruforum.wordpress.com/2016/10/07/saving-local-cassava-varieties-to-enhance-food-security-in-uganda/

Table 12: Cassava harvests and sales by varieties and season

	2020A		2020B	
Variety name	**Harvested (kg)**	**Sold (kg)**	**Harvested (kg)**	**Sold (kg)**
TME-14	14,914.71	7,639.35	1,825.00	1,325.00
NASE-19	4,000.00	500.00	3,055.00	1,350.00
NASE-14	3,655.83	2,973.64		
Local variety	3,352.92	2,026.82	3,189.44	3,157.22
NARCOS-2	2,707.27	2,240.91	2,270.00	1,930.00
NARCOS-1	2,606.67	2,194.44	2,100.00	1,680.00
Total	**4,437.13**	**2,822.57**	**2,657.00**	**2,180.60**

Source: Cassava feasibility household survey, UDC, 2021

Table 13: Average cassava yield by variety

Variety	Yield (MT/Ha)
TME-14	26.97
Local variety	8.93
NASE-14	8.30
NASE-19	5.39
NARCOS-1	3.65
NARCOS-2	1.88
Total	9.92

Source: Cassava feasibility household survey, UDC, 2021, Akongo et al., 2021. Sustainable Agriculture Research, vol. 10. No.2, 2021

By district disaggregation, Nwoya, Amuru, Lira, Omoro, and Pader had the highest cassava harvests and sales. For instance, in Nwoya, a household harvested 16.2MT of fresh cassava and sold almost half of it. Cassava was more commercialised in Amuru, Lira, and Omoro districts where households harvested about 3MT and sold over 80% of it. Farmers in Nwoya and Lira obtain about 8MT/ha, having attained the highest yields while in Amuru and Nebbi farmers get about 4MT/ha of fresh cassava tubers (Table 14). Nwoya and Lira have the highest yields given that they adopted the highest yielding varieties such as TME.

Table 14: Average cassava yield by district

District	Yield (MT/Ha)
Nwoya	45
Lira	31
Amuru	45
Nebbi	37
Omoro	62
Kitgum	48
Pader	57
Gulu	62
Overall	31

Source: Cassava feasibility household survey, UDC, 2021

3.5 CASSAVA MARKETING IN NORTHERN UGANDA

In terms of gender and cassava marketing, results show that females sell more of their cassava harvests than males. For example, overall, females sold 61% of their cassava harvest compared to 59% by males. Farmers in Amuru, Lira, Kitgum, and Omoro sold over 70% of their cassava harvest (Table 15).

Table 15: Proportion of cassava harvest sold by farmer, sex, and district

	Percentage of harvest sold by farmer sex		
District	**Male**	**Female**	**Total**
Kitgum	68.08	86.90	73.15
Lira	79.23	75.41	76.90
Gulu	59.30	70.51	66.61
Omoro	75.24	65.82	71.55
Pader	44.10	60.16	46.20
Amuru	84.19	60.15	77.32
Nwoya	51.49	36.37	43.65
Nebbi	34.38	31.67	33.66
Overall	59.21	60.76	59.81

Source: Cassava feasibility household survey, UDC, 2021

Overall, a farmer earns about UGX1,000,000 from cassava sales a season with male farmers earning slightly higher incomes. Farmers in Omoro, Nwoya, Nebbi, Kitgum, and Amuru districts earn the highest incomes with the average take being more than UGX1,000,000. Farmers in Pader earn the lowest at about UGX400,000 per season. (Table 16).

Table 16: Average seasonal cassava incomes by district

	Average seasonal income from cassava (UGX)		
District	**Male**	**Female**	**Total**
Omoro	1,638,571.00	1,760,000.00	1,679,048.00
Nwoya	2,015,893.00	925,361.10	1,402,469.00
Amuru	1,455,077.00	1,166,750.00	1,387,235.00
Nebbi	908,076.90	433,333.30	819,062.50
Kitgum	696,176.50	1,091,667.00	799,347.80
Gulu	862,142.90	758,000.00	792,714.30
Lira	715,555.60	774,230.80	750,227.30
Pader	344,375.00	622,500.00	375,277.80
Overall	1,016,586.00	949,780.20	991,425.30

Source: Cassava feasibility household survey, UDC, 2021

Cassava farmers have a diversity of buyers. They include local traders, urban traders, processors and local consumers. More than 70% of the farmers sell cassava to either local traders or local consumers while 64% sell to urban traders who are in many cases large scale traders with larger stores. Urban traders mainly buy from farmers in Gulu, Amuru, Kitgum, Lira and Omoro. Only 25% of the farmers indicated they sell to processors although 70%, 41% and 44% of the farmers in Nwoya, Omoro and Amuru respectively sold to processors who are majorly millers who produce cassava flour (Table 17).

Table 17: Percentage of cassava farmers selling by channel

	Percentage of farmers by selling channel			
District	**Local trader**	**Urban trader**	**Local consumer**	**Processor**
Lira	100%	91%	96%	9%
Amuru	94%	94%	89%	44%
Kitgum	92%	92%	85%	19%
Nwoya	89%	37%	85%	70%
Gulu	86%	100%	77%	18%
Omoro	77%	82%	55%	41%
Nebbi	36%	25%	36%	0%
Pader	13%	9%	78%	4%
Overall	72%	64%	74%	25%

Source: Cassava feasibility household survey, UDC, 2021

3.6 THE CASSAVA VALUE CHAIN IN NORTHERN UGANDA

The cassava value chain in northern Uganda has farmers, traders, processors, domestic consumers, and exporters as the main actors. Cassava farming is dominated by the small-scale producers who make up 87% of all farmers and these have not more than 5 acres of land allocated to cassava production per year. Cassava trading has several actors who vary in size and scale of business. There are small-scale, medium scale, and large-scale traders. There also institutional players such as cooperatives and farmer groups. At the processing stage, the small and medium-scale processors who are mainly millers and brewers dominate although industrial processors who produce ethanol and sanitizers from cassava also exist (Figure 6). Consumers are mainly domestic, although products of processing such as flour, ethanol, and sanitizers are sold in supermarkets, wholesale and retail shops as well as hotels. Cassava and its products are to some extent exported to DR Congo and South Sudan.

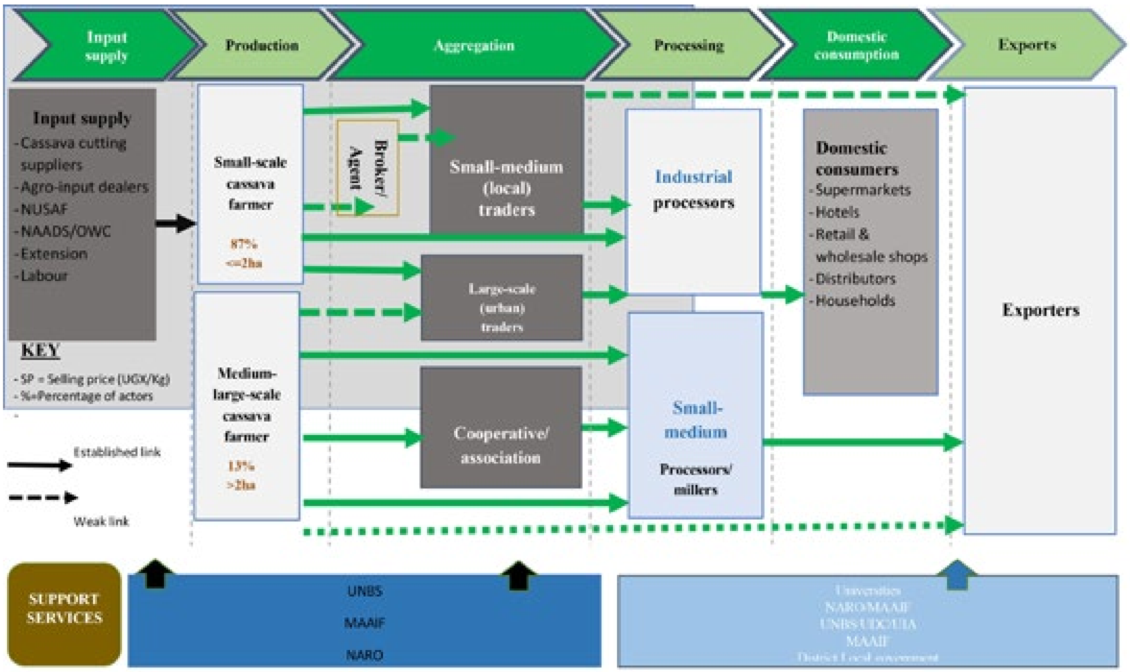


Figure 6: The cassava value chain in Acholi sub-region

3.7 CASSAVA MARKET PRICES

As would be expected, dried cassava chips fetch a slightly high farm level price than the fresh cassava tubers (Table 18). However, in Kitgum, Gulu and Lira districts, the fresh cassava tubers fetched a higher price than the dried chips, possibly because the fresh cassava has a ready market in the large towns unlike the other "rural districts". Table 19 shows that contract farmers get even lower prices for both fresh and dried cassava.

Table 18: Average cassava prices by district

	Average price of cassava (UGX/Kg)		
District	**Fresh tubers**	**Dried chips**	**Price difference**
Omoro	792.86	1,500.00	707.14
Kitgum	978.26	700.00	-278.26
Pader	303.57	700.00	396.43
Nebbi	200.00	644.12	444.12
Nwoya	343.18	610.00	266.82
Amuru	500.00	600.00	100.00
Gulu	836.36	560.00	-276.36
Lira	534.20	450.00	-84.20
Overall	611.98	693.55	81.56

Source: Cassava feasibility household survey, UDC, 2021

Table 19: Prices paid to contract farmers by district

District	Price received from contract farming (UGX/Kg) for fresh tubers	Price received from contract farming (UGX/Kg) for dried chips
Gulu	833	660
Nwoya	-	-
Amuru	-	-
Kitgum	-	-
Pader	-	-
Omoro	-	-
Lira	800	600
Nebbi	-	-
Overall	912	660

Source: Cassava feasibility household survey, UDC, 2021

3.8 SUITABLE CASSAVA VARIETIES FOR THE STARCH FACTORY

The top four cassava varieties grown in the north are local varieties, NASE-14, NARO CASS-1 & 2 and TME-14, grown by 52%, 21%, 17% and 8% of the sampled households. The local variety's potential yield is 9MT/ha. It compares unfavourably with the three leading improved varieties that yield between 25MT/ha and 40MT/ha annually with starch content of between 70% and 75%. However, TME-14, though high yielding, is only grown in two out of the eight sampled districts. NASE-14, NARO CASS-1 & 2 are grown in seven of the eight districts, which means that they are abundant and can sustain the required supply for the starch factory. With an estimated 1.2 million MT of surplus cassava available for the factory, the three leading varieties — NASE-14, NARO CASS-1 & 2 — contribute 0.6 million MT. With a factory capacity of 450 MT of fresh cassava per day, 0.2 million MT of cassava is needed annually from the three leading cassava varieties, leaving a surplus.

3.9 CASSAVA CONTRACT FARMING

Although more than 90% of the sampled farmers are interested in cassava contract farming[1], only 4% of them — all in Gulu and Lira districts — said they were doing it with companies such as Bukona Agro Processors Ltd. About 18% of the farmers belong to a farmer group engaged in cassava production and marketing. However, the districts of Amuru, Kitgum and Pader had no farmer who was a member of a group dealing in cassava (Table 20). This low proportion of cooperating farmers is a bad indicator of the capacity of collective action and farmer institutional development.

Table 20: Percentage of farmers by contract farming participation by district

District	Farmers engaged in contract farming%	Farmers interested in contract farming%	Farmer belongs to a cassava growing group/ cooperative (%)
Gulu	22.73	92.31	47.37
Nwoya	0.00	95.00	40.00
Amuru	0.00	52.38	0.00
Kitgum	0.00	100	0.00
Pader	0.00	100	0.00
Omoro	0.00	95.24	4.76
Lira	8.7	95.24	19.05
Nebbi	0.00	100	35.00
Overall	3.7	91.03	17.90

Source: Cassava feasibility household survey, UDC, 2021

Land farmers are willing to put to contract farming annually

When asked about willingness to allocate land to cassava production in case the starch/ ethanol factory is started and the market expanded, the farmers said they were willing to allocate 2ha of additional land to cassava production. Willingness to allocate more land was higher in Nebbi, Pader, Amuru, and Kitgum districts (Figure 7).

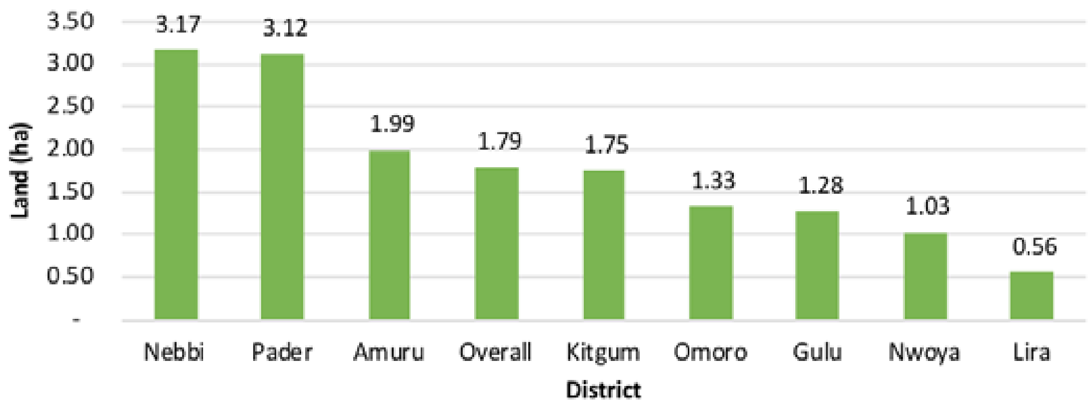


Figure 7: Average land (ha) cassava farmers are willing to dedicate to contract farming

Source: Cassava feasibility household survey, UDC, 2021

3.10 ACCESS TO CASSAVA PRODUCTION AND MARKETING-RELATED SERVICES

Overall, 54% of the sampled households had storage facilities, 41% add value to cassava by mainly drying into chips, 23% have ever received training in cassava production and marketing

1 Contract farming can be defined as an agreement between farmers and processing and/or marketing firms for the production and supply of agricultural products under forward agreements, frequently at predetermined prices.

while 30% have ever accessed a loan to finance cassava farming activities. These services were mainly accessed by farmers in Gulu, Nwoya, Lira and Nebbi districts (Table 21).

Table 21: Percentage of farmers by services accessed

District	Got loan to finance some of the cassava farming activities (%)	Received any training in cassava production and marketing (%)	Household adds value to cassava (%)	Household has a storage facility (%)
Gulu	81.82	81.82	100.00	100.00
Nwoya	74.07	33.33	33.33	37.04
Amuru	0.00	11.11	38.89	22.22
Kitgum	0.00	0.00	3.85	46.15
Pader	17.39	21.74	30.43	8.70
Omoro	9.09	9.09	27.27	27.27
Lira	26.09	30.43	47.83	91.30
Nebbi	21.43	0.00	50.00	89.29
Overall	29.63	22.75	40.74	53.97

Source: Cassava feasibility household survey, UDC, 2021

3.11 CASSAVA AGRONOMIC PRACTICES

Cassava involves several agronomic practices — land preparation, planting, weeding, harvesting, post-harvest handling. Farmers spent more on land preparation, weeding, harvesting, drying, and transportation (Table 22). Overall, 48% of the farmers say that they store their cassava after harvesting and drying although the practice is common in Gulu, Nebbi, Kitgum, and Nwoya districts. Those who don't store usually leave their cassava in the garden and harvest it piece-meal.

Table 22: Average expenses per season on agronomic, marketing, and post-harvest practices

	Seasonal expenditure (UGX)		
Agronomic and marketing practices	**Mean**	**Minimum**	**Maximum**
Land opening	85,305.08	15,000.00	480,000.00
Planting	60,115.38	7,000.00	320,000.00
Pesticides	38,000.00	38,000.00	38,000.00
First weeding	66,067.16	10,000.00	320,000.00
2nd weeding	75,815.79	8,000.00	400,000.00
3rd weeding	79,062.50	20,000.00	260,000.00
Harvesting	52,112.90	6,000.00	200,000.00
Sorting	35,111.11	5,000.00	80,000.00
Storage	13,125.00	5,000.00	20,000.00
Transportation	32,200.00	1,000.00	400,000.00
Marketing	4,463.64	500.00	14,000.00
Drying	28,000.00	10,000.00	50,000.00
Bagging materials	7,040.00	2,000.00	30,000.00
Bagging and loading	10,265.00	800.00	25,000.00

Majority of the farmers (78%) store their cassava in their own houses. This is common across all districts. Only 16% and 22% of the farmers have a granary or store respectively (Table 23). These results point to a bigger problem of maintaining the quality of produce through proper post-harvest handling.

Table 23: Percentage of cassava farmers by storage facility

	Percentage of farmers by storage point						
District	**Granary**	**Store**	**Own house**	**On Veranda**	**Pit under ground**	**In garden/rack in field**	**Silos**
Pader	0%	0%	100%	0%	0%	0%	0%
Omoro	17%	0%	100%	17%	0%	0%	0%
Kitgum	23%	15%	85%	0%	0%	0%	0%
Nwoya	0%	20%	80%	0%	0%	0%	0%
Gulu	32%	37%	74%	0%	32%	16%	5%
Nebbi	0%	32%	74%	0%	0%	0%	0%
Amuru	33%	0%	67%	0%	0%	0%	0%
Lira	0%	0%	50%	0%	50%	0%	0%
Overall	16%	22%	78%	1%	9%	4%	1%

Source: Cassava feasibility household survey, UDC, 2021

3.12 CASSAVA PRODUCTION COSTS

All agronomic practices combined with family labour input accounted for, a household spends about UGX800,000 per hectare of cassava produced. Costs per hectare are highest in Lira, Nebbi, Nwoya and Gulu districts and lowest in Pader, Kitgum and Amuru districts, mainly driven by high labour costs given its scarcity and low levels of mechanisation (Table 24).

Table 24: Average cassava production costs per hectare by district

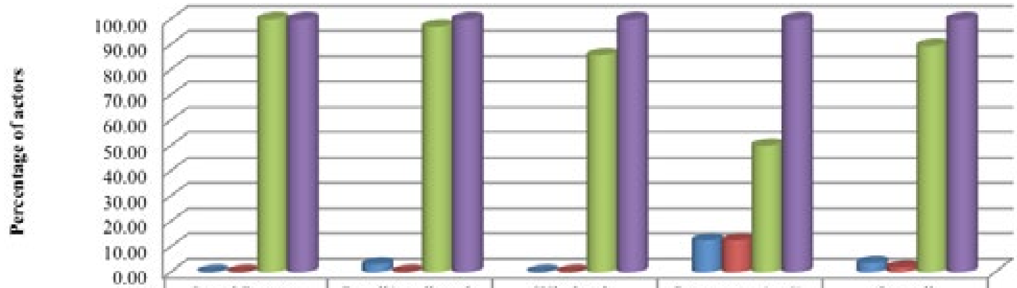
	Cassava production cost (UGX/ ha)	
District	**Mean**	**SD**
Lira	2,010,066.00	1,373,122.00
Nebbi	971,714.40	841,267.10
Nwoya	903,787.90	531,189.40
Gulu	748,586.70	293,667.90
Omoro	502,955.90	242,154.60
Amuru	319,344.40	182,397.30
Kitgum	282,576.90	442,704.60
Pader	272,243.10	198,395.30
Overall	776,455.70	843,238.90

Source: Cassava feasibility household survey, UDC, 2021

3.13 TRADERS AND PROCESSORS

Traders' and processors' characteristics

About 90% of these trader, brewer and processor businesses are sole proprietorships trading informally. However, 14% of the wholesalers and 25% of the processors were operating limited companies (Figure 8).



	Local Brewer (n=8)	Retail/small scale traders (n=34)	Wholesale traders (n=7)	Processors (n=8)	Overall
Association	0.00	2.94	0.00	12.50	3.51
Cooperative	0.00	0.00	0.00	12.50	1.75
Sole proprietor	100.00	97.06	85.71	50.00	89.47
Total	100	100	100	100	100

Figure 8: Type of cassava business ownership

The number of employees hired by a business is a good indicator of size and scale of its operations. Based on the Census of Business Enterprises (COBE) by UBOS (2011), Ugandan businesses were grouped as small scale if they employed at least an employee with annual turnover of UGX0-10 million ($ 0-2,740). The medium scale ones are those that earn more than UGX10 million but less than UGX50 million ($2,740-13,700) and employed fewer than 50 people. And the large scale earn more than UGX50 million (>$13,700) and employ more than 50 people[2]. By this categorisation, cassava businesses are all small scale given that they employ 1-10 persons as indicated in Table 25. Processors and wholesalers employed more persons compared to other businesses.

Table 25: Average number of employees by cassava value chain actors

	Mean number of employees	
	Full time	**Part time/casual**
Local Brewer (n=8)	2	2
Wholesale traders (n=7)	2	4
Processors (n=8)	3	7
Retail/small scale traders (n=34)	2	2
Overall	2	3

Numbers of traders and processors in and around Acholi

Results from the cassava trader and processor survey indicate that the 18 districts have a combined 3,900 local brewers, 1,000 retail/small-scale traders, 730 wholesale/large-scale traders, and 300 millers. There was more cassava business activity in Amuru, Gulu, Omoro, and Nebbi districts due to the high numbers of off-takers (Table 26. All off-takers aggregated about 40,000MT of cassava annually of which wholesale/large-scale traders aggregated about half (Table 27).

2 UBOS (2011). COBE 2010/2011. Accessed at
: https://www.ubos.org/wp-content/uploads/publications/03_20182010_COBE_Report.pdf

Table 26: Estimated numbers of cassava off-takers by district

	Numbers of actors by district			
District	**Local brewers**	**Wholesale/large-scale traders**	**Processors/ millers**	**Retail/small-scale traders**
Amuru	271	50	19	111
Gulu	271	89	25	64
Kitgum	600	80	19	47.5
Lira	25	15	17	31
Nebbi	271	30	5	70
Nwoya	271	26	25	20
Omoro	100	48	19	90
Pader	150	48	19	72
Adjumani*	271	30	5	70
Agago*	150	48	19	72
Lamwo*	600	80	19	48
Oyam*	25	15	17	31
Kole*	25	15	17	31
Otuke*	25	15	17	31
Pakwach *	271	30	5	70
Masindi*	271	48	19	70
Kiryandongo*	271	48	19	70
Apac*	25	15	17	31
Total	3,892	732	304	1,029

**Estimated numbers based on a sampled neighbouring district*

Source: Cassava feasibility trader and processor survey, UDC, 2021

Table 27: Estimated volumes of cassava aggregated by off-takers by district

	Volumes of cassava (MT) aggregated annually			
District	**Local brewers**	**Wholesale/large-scale traders**	**Processors/ millers**	**Retail/small-scale traders**
Amuru	131.58	2,000.52	276.12	461.98
Gulu	131.58	3,560.92	355.83	266.37
Kitgum	291.50	3,200.83	276.12	197.69
Lira	12.15	600.16	241.96	129.02
Nebbi	131.58	1,200.31	71.17	290.60
Nwoya	131.58	1,040.27	355.83	83.24
Omoro	48.58	1,933.83	276.12	374.58
Pader	72.87	1,933.83	276.12	299.66
Adjumani	131.58	1,200.31	71.17	291.34
Agago	72.87	1,933.83	270.43	299.66
Lamwo	291.50	3,200.83	270.43	199.78
Oyam	12.15	600.16	241.96	129.02
Kole	12.15	600.16	241.96	129.02
Otuke	12.15	600.16	241.96	129.02
Pakwach	131.58	1,200.31	71.17	291.34
Masindi	131.58	1,933.83	270.43	291.34
Kiryandongo	131.58	1,933.83	270.43	291.34
Apac	12.15	600.16	241.96	129.02
Total	1,891	29,274	4,321	4,284
Aggregated cassava	**40,000**			

NB: Volumes reported are fresh tuber equivalent

Source: Cassava feasibility trader and processor survey, UDC, 2021

3.14 CASSAVA SUPPLY AND PROCESSING PROJECTIONS IN THE NEXT 15 YEARS

The projections presented in Table 28 are from 18 districts from the sub-regions of Acholi, Bunyoro, Lango, and West Nile. By 2020, the districts had produced about 3.2 million MT of fresh cassava of which off-takers such as local brewers, millers and traders bought about 0.4 million MT while industrial processors such as Bukona, Britania and Riham consumed about 0.9 million MT, leaving about 1.3 million MT available for value addition (Table 28). Assuming a starch and ethanol factory that consumes about 400MT per day and working for five days a week, such a factory needs about 110,000MT of fresh cassava tubers which is only about 1.4% of the available raw material. In addition, assuming that after the establishment of the factory farmers will increase cassava acreage from the current 1ha to 2ha in the next two to five years, projections indicate that by 2025 the surplus will grow to 8.3 million MT and by 2030 the farmers will be able to supply about 9.2 million MT of fresh cassava (Figure 10). Projections are based on figures on the growth in the Uganda agriculture sector, estimated at 2% for the last five years by World Bank[3].

3 Walker,Richard Ancrum; Stucka,Tihomir; Mikulcak,Friederike; Sebudde,Rachel K..2018.Uganda Economic Update, 12th Edition : Developing the Agri-Food System for Inclusive Economic Growth (English). Uganda Economic Update;no. 12 Washington, D.C. : World Bank Group. http://documents.worldbank.org/curated/en/678231542382500879/Uganda-Economic-Update-12th-Edition-Developing-the-Agri-Food-System-for-Inclusive-Economic-Growth

Table 28: Estimated volumes of cassava available for processing and purchased per year

Year	Overall surplus (MT)	Volume bought by off-takers (MT)	Volume bought by industrial processors (MT)	Surplus for starch factory (MT)	Fresh cassava for starch half of which can male ethanol (MT)	Proportion of excess cassava converted (MT)
2020	2,146,275	40,000.00	842,500.00	1,263,775.00		
2021	8,637,845	40,000.00	842,500.00	7,755,345.00	110,000.00	1.42
2022	8,767,412.68	40,600.00	855,137.50	7,871,675.18	110,000.00	1.4
2023	8,942,760.93	41,412.00	872,240.25	8,029,108.68	110,000.00	1.37
2024	9,121,616.15	42,240.24	889,685.06	8,189,690.85	110,000.00	1.34
2025	9,304,048.47	43,085.04	907,478.76	8,353,484.67	110,000.00	1.32
2026	9,490,129.44	43,946.75	925,628.33	8,520,554.36	112,200.00	1.32
2027	9,679,932.03	44,825.68	944,140.90	8,690,965.45	114,444.00	1.32
2028	9,873,530.67	45,722.19	963,023.72	8,864,784.76	116,732.88	1.32
2029	10,071,001.28	46,636.64	982,284.19	9,042,080.45	119,067.54	1.32
2030	10,272,421.31	47,569.37	1,001,929.87	9,222,922.06	121,448.89	1.32
2031	10,529,231.84	48,758.61	1,026,978.12	9,453,495.11	123,877.87	1.31

Assumptions: 1.5%-2.5% growth in supply and demand, land allocated to cassava doubles from 1ha to 2ha after factory starts operations. Farmers are assumed to sell of 55% of fresh cassava harvest

Source: Cassava feasibility household, trader and processor survey, UDC, 2021

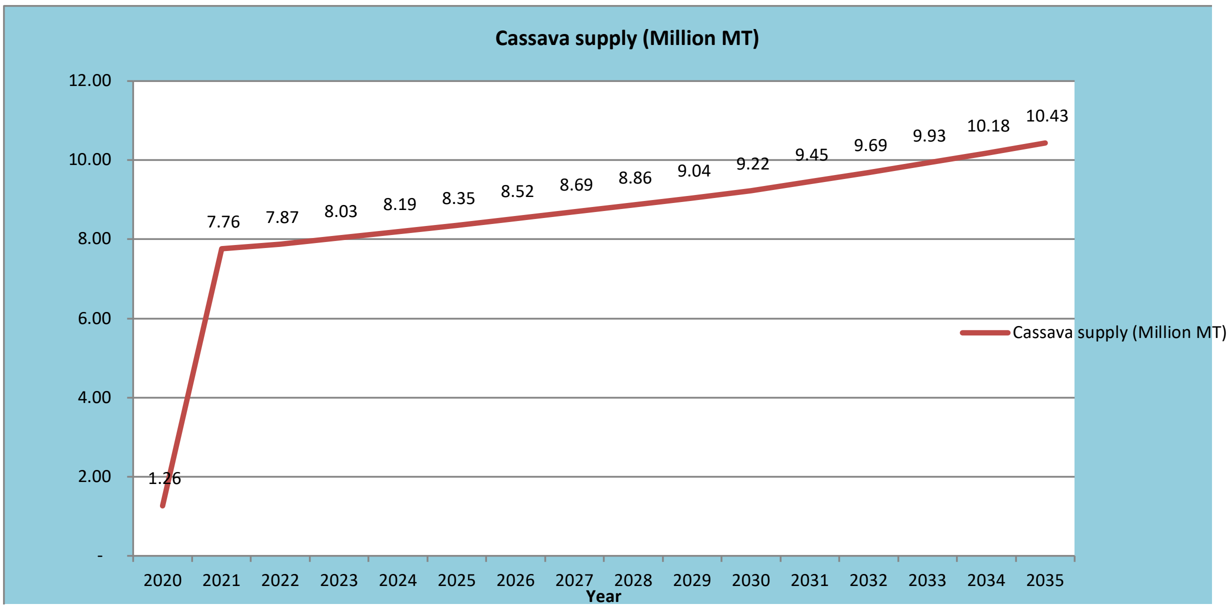


Figure 9: Projected cassava supply growth (2020-2035)

Note: The 2020 figures show the current status while 2021-2035 are consultant's estimations

Source: Cassava feasibility household, trader and processor survey, UDC, 2021

3.15 CURRENT EFFORTS IN CASSAVA VALUE ADDITION

Value addition is mainly through drying fresh cassava into chips at farm level and brewing into local gin also known as "Waragi/Lira-Lira/Arege" or milling into cassava flour. Eight processors and eight local brewers were sampled. Results show that the processors operate machines whose daily installed capacity is about 15MT of cassava. This is when operating for 7-13 hours mainly in two shifts of six hours each. The processors said that in 2019 each processed about 11.6MT of dried cassava chips while in 2020 it was about 7MT. Due to seasons, only 50% of the processors operated all year round. The other half operated for a few months. The local brewers said they use about 1.2MT of dried cassava chips annually to produce their local gin (Table 29).

All local brewers produced local gin also known as "Waragi/Lira-Lira/Arege". 50% of the millers sold ordinary cassava flour and 25% sold both high quality cassava flour (HQCF) chips and high quality cassava flour (HQCF). Some 13% also sold dry chips to buyers (Table 29).

Table 29: Aspects of cassava processing and value addition

Variable	Parameter
Number of hours of processing	
Peak season	12.50
Lean season	6.50
Number of shifts	2.00
Hours per shift	6.00
Cassava processed in 2019 (kg) per processor	11,628.57
Cassava processed in 2020 (kg) per processor	6,851.43
Daily installed capacity of machine	15,148.71
Brewers	
Cassava processed in 2019 (kg) per local brewer	1,165.00
Cassava processed in 2020 (kg) per local brewer	1,253.75
Percentage of processors operating all year	50%

3.16 CASSAVA PROCESSING IN THAILAND — A CASE STUDY OF PPPS

In 2019, Thailand had a population of 70 million of whom 50.1% lived in the rural areas, indicating that it has more persons in the rural than urban areas who depend on agriculture[1]. Rapid growth over the last two decades has transformed Thailand into a middle-income nation with one of the most developed agribusiness industries in Asia[2]. It is one of just five net exporters of food worldwide. It is the world's top exporter of rice, rubber, canned and frozen seafood, canned tuna, canned pineapple, and cassava/tapioca (FAO, 2013). In the last five years, Thailand has been exporting more cassava starch than it imports, making it a net starch exporter. In 2020, the country's cassava production was valued at $1.5 billion. In 2019, the Asian country exported 5.1 million MT of starch worth $2.4 billion and by 2020 the exports had increased to 5.5 million MT worth $2.3 billion (Table 30). By 2005, Thailand had extra demand for cassava of 11,000MT which was attributed to urbanisation and population growth[3].

Thailand is implementing a policy shift to promoting public-private partnerships (PPP's) in the agribusiness sector that are centred on research and development. The PPPs often involve

1 https://datatopics.worldbank.org/world-development-indicators/

2 http://www.fao.org/3/aq539e/aq539e.pdf

3 http://www.fao.org/3/y5287e/y5287e05.htm

government agencies carrying out policy mandates such as increasing agricultural efficiency and fostering a knowledge-based economy by helping to mitigate private firms' risks related to R&D. Public sector partners help reduce risks faced by private sector firms through various means, including financial contributions of up to 100% in certain cases, provision of scientific research services, and provision of managerial expertise (FAO, 2013). The human resources and knowledge capital of public universities are often leveraged by the private sector in research-based PPPs. As a result of the focus on relatively advanced projects, large enterprises have benefited more than smaller firms from recent public support in the agribusiness sector. The main characteristics of the PPPs that can form as lessons for the cassava starch factory are:

They involve large private sector players whose track record is tested.

Large amounts of funds are injected into the PPPs ranging between $60,000 and $120,000.

The PPPs involve high-return projects with a national priority component such as high value crops like okra and sugarcane.

The roles of the partners and expectations are clearly stated at the beginning and strategies are put in place to track performance.

Table 30: Thailand's cassava starch imports and exports

	Imports		Exports	
Year	Quantity (million MT)	Trade Value (US$ billion)	Quantity (000' MT)	Trade Value (US$ billion)
2016	0.13	0.42	6,434.29	2,236.13
2017	2.65	1.42	6,133.41	2,028.92
2018	2.49	1.36	5,686.50	2,690.13
2019	0.52	0.42	5,109.38	2,439.33
2020	9.77	5.10	5,460.26	2,281.29

Source: UNCOMTRADE[4], 2021.

3.17 CASSAVA PROCESSING IN UGANDA: THE CASE OF BUKONA FACTORY IN ACHOLI AND KAMTECH IN LANGO

3.17.1 Bukona Agro Processors factory

Bukona Agro Processors Ltd was established in 2014 to set up a sugar factory and distillery at Lapem Village, Koch Goma Subcounty in Nwoya District. The company planned to have a phased approach starting with the cassava-based distillery and then a sugar factory from sugarcane in phase 2. A cassava starch-based distillery was thus established with a capacity of 30,000 litres/day and commissioned in 2019, making it the first such factory in Nwoya. The company was set to use 75 tons of dry cassava per day from 7-8,000 acres of cassava. It entered a partnership with Gulu Archdiocese with 6,900 farmers organised as small holder suppliers. It also planned to expand into animal feed plant to make it a zero discharge facility and expand output to 40,500 litres/day in partnership with UDC.

The company has a key focus of promoting ethanol as a biodiesel to reduce deforestation in the region and is planning to import 50,000 cookstoves that use ethanol at a projected consumption of 50,000 litres per day. It also targets the blending of at least 5% of all motor vehicle fuel with 5% ethanol. It also targeted to employ up to 500 workers directly 10,000 families as suppliers (Farming without borders magazine, Acholibur Parish Project (APP), March 2020)

4 https://comtrade.un.org/data/

Despite these noble plans, the factory only functioned for a few months in 2019 and closed. Among the key problems cited was the lack of operational capital. Only a few bottles of ethanol packed as sanitizer are available for sale from the old stocks. Farmers in the area and the DPO Gulu District point to huge losses faced by farmers who had planned to sell to the factory.

Key lesson: sufficient financial planning to facilitate production and sales of the factory products need to be carefully and adequately sourced and managed to ensure sufficient operational cover for the first few years of production before break even.

3.17.2 Kamtech Logistics Uganda Limited

In 2014, Kamtech Logistics Uganda Limited established an ethanol plant worth $1.8 million at Adekowok, Lira District. The plant's annual ethanol production was set at 100,000 litres per day, which is about 10 percent of what Uganda imported at the time. This presented an area of opportunity for import substitution through establishment of similar ethanol plants in other cassava-producing districts.

As of 2016, the Kamtech facility employed 85 people producing 4,000 litres of ethanol daily with an input of 15,000 metric tons of cassava. It had a large and positive ripple effect on the communities around the ethanol plant as farmers got better prices for their cassava produce (from UGX300 per kilo of chips to UGX800 and UGX20,000 per sack of fresh tubers to UGX80,000).

The plant, however, is non-functional due to management and ownership wrangles which caused financial problems. An interview with one of the former employees indicated that the plant closed because it failed to service the loan acquired from DfCU Bank. The bank confiscated the factory equipment and sold it off to a potential new factory in Kaliro.

Key lesson: The management and shareholding structures need to be strong, versatile, and durable to ensure efficient financial management and sustainability of the proposed project.

3.18 BEST PRACTICES IN CASSAVA STARCH PRODUCTION

The consultants observed several key best practices for starch factories in Uganda and beyond that are relevant to the proposed project:

- Starch factories in Uganda also tend to use maize when the prices and supplies allow. This is an aspect that should be embraced by any new facilities because maize is sometimes too plentiful to be ignored as a starch source.

A consistent water source is essential at all starch processing factories. This is witnessed at Bukona and Bwendero (a privately owned sugar factory on the outskirts of Hoima City that also produces ethanol from cassava, maize and molasses.)

- where these facilities are all next to permanent rivers to ensure sufficient water supplies.
- Adequate investment in waste management toward zero waste is also a key practice. All affluent can be turned into a valuable by-product that can increase the profitability of the plant. Bukona has such plans when it reopens in future.

- A cheap energy source is one of the key success factors of a starch factories. Factories like Bwendero recycle energy from waste to help run the facility economically and profitably.
- Sufficient production capital should be made available to any production and processing facility to have a successful outcome as farmers must be paid upfront for products. The Bukona and Kamtech cassava factories ran into financial trouble partly because of insufficient capitalisation.
- Locally, all cassava starch processing facilities also produce ethanol as one of the main lines. This practice should be embraced in all new developments as the two facilities feed off each other for improved profitability.

04 Proposed Factory Production Operations

4.1 PRELIMINARY STRATEGIC CASE ANALYSIS

The proposed cassava starch factory facility must be a landmark and inspirational piece of infrastructure that transforms cassava farming and trade and becomes key to Uganda's import substitution and export promotion strategies. The project is not about a new factory facility. It is about creating an integrated cassava value addition and marketing system that will benefit farmers and play its part in transforming lives in the Acholi sub-region and beyond.

4.1.1 Project investment objectives

The proposed starch factory once established will play a strategic role in not only sustaining household food security but also in increasing the wellbeing of cassava farmers and other value chain actors as follows:

a. The cassava farmers will earn more from their farm output which income will lead to improved livelihoods.
b. Help to stabilise the markets for cassava and cassava products in Acholi sub-region and the country as a whole
c. Uganda's agriculture sector will be boosted as the number of cash crops and agro-processing facilities gain a boost.
d. The proposed starch products are of use in manufacturing and pharmaceuticals thus boosting downstream industrial production.
e. The resultant foreign exchange savings and earnings will boost the balance of trade position and gross domestic product thus improving economic performance and indicators.

4.2 Key Success Factors (KSF)

The following are the project key success factors (KSF) (Table 31):

KSF1: Deliver a factory capable of producing high quality starch and ethanol that meet international standards.
KSF2: Provide market for raw cassava at competitive farm gate prices.
KSF3: Create a landmark facility that attracts further industrial investment along the value chain.
KSF4: Ensure the project is sustainable in the long run.
KSF5: Produce a fundable feasibility study.

4.3 Option Analysis

During the initial stages of the study, three qualitative project realisation options of "do nothing", "invest in existing cassava processing facilities", and "establish the Acholi cassava starch factory" were considered. Each option was assessed against the project objectives and success factors to allow determination of the preferred option. This analysis is presented in Table 31.

The analysis in this section of the study is provided to help select a preferred technical option of all available project realisation options. The technical analysis has been carried out to a level of detailing consistent with the strategic nature and the objectives of the current study. The result of this analysis will be the preferred option from the technical point of view that serves as an input in the financial assessment. This feasibility study provides a suite of management responses supporting a broader strategic framework. The goals of the intervention strategy are designed to ensure that any intervention conducted is sustainable and flexible enough to meet the national development goals while also concurrently addressing the identified problem and potential project risks.

The Third National Development Plan (NDPIII) outlines a framework for the development context, which is required to be taken into consideration prior to undertaking investments. A logical outcome is that investment in a cassava starch factory should not be made unless it adds value to the economy.

Numerous alternatives were considered ranging from broad-scale approaches to alternatives for specific management responses. This section considers the following management responses:

- Business as usual / do nothing alternative
- Investment in existing factories
- Establishment of the cassava starch factory

In the beginning, a technical assessment (site visits, visual inspection and interviews with key informants) and assessment of the existing factories (due diligence, carried out by the consulting team) were carried out and the effects of the preservation of the current status were assessed before analysing other project realisation options.

Table 31: Preliminary strategic option analysis by objectives and key success factors

Description of Option	Do nothing	Invest in existing factories	Establish the Acholi starch factory
Project objectives			
Enhancing Uganda's exports	🔴	🔴	🟢
Reducing Uganda's imports	🔴	🔴	🟢
Providing market opportunities to cassava farmers	🔴	🔴	🟢
Development of the Acholi subregion	🔴	🔴	🟢
Transforming Uganda's agro-processing	🔴	⚫	🟢
Key success factors			
A factory capable of providing high quality starch	🔴	🟢	🟢
Provide competitive market for raw cassava	🔴	🟢	🟢
A landmark facility that attracts investment	🔴	⚫	🟢
Ensure project sustainability in the long run	🔴	🟢	🟢
Produce a fundable feasibility study	🔴	⚫	🟢
Summary	**Reject**	**Short-listed**	**Short-listed**

- 🔴 Cannot be delivered under option
- 🟢 Can potentially be delivered under option but uncertain at this stage
- ⚫ Can be delivered under option

The outcome of this analysis shows that the current status (the "do nothing" option) poses a great risk from both the technical and the financial viewpoints and was discarded from further assessments.

4.4 ANALYSIS OF SHORT-LISTED OPTIONS

Given the magnitude and scope of the proposed project investment, a balanced qualitative and quantitative multi criteria analysis of benefits and costs was conducted to pinpoint effective project realisation strategies at an early stage of the decision process. In this analysis, a set of relevant categories were defined to reflect a balanced analysis of the non-monetary value created by different options. Each criterion was assigned a "weighing factor" to indicate its importance in determining the success of the project. Weighing factors chosen are 1, 2, 4 and 8. The assignment of scores has been done based on the current cassava starch situation in Uganda using national development goals and consultant experience. Each option is scored against each objective to indicate the extent the option is likely to achieve the objective in question. Scores are on a scale of 1-5 (discrete integers), with 1 representing "very poor" and 5 representing "excellent". The criteria reflect the need to take on board considerations from a variety of policy fields and domains of public interest to determine the best overall option.

Table 32: Criteria and weights factors for shortlisted option scoring

Category & criterion		Weighing factor and explanation / motivation	
A. Current market and scope			
A1	Ability to utilise the existing raw materials	8	Key objective of strategic Vision 2040. Key to NDPIII agro-industrialisation needs.
A2	Provide range of products for domestic and international markets	8	Provision of starch and ethanol for industrial processing in domestic and foreign markets
A3	Provide for the comprehensive macro-market potential and local market	8	Project offers market for raw cassava and offers processed cassava products
A 4	Offer a sustainable, fit-for-purpose manufacturing options	4	UDC thrives on funds from the national treasury. Sustainability is an important objective for the development of this project
B. Accountability, governance, and participation			
B1	Minimise risk for public sector finances	8	Current issues in the state of the economy and budgets make the profitability potential of projects key
B2	Align strategy and operations of UDC with national development objectives	8	UDC invests in developments that serve as catalysts for Uganda's economy
C. Financial assessment			
C1	Cover capital and operational costs from revenue stream	4	Some investments for services are best undertaken using public resources
C2	Operate at a high level of functional efficiency	4	There will be considerable flexibility to determine performance tailored to national needs and preferences
D. Quality of products			
D1	Provide high quality products meeting international standards and benchmarks	8	There will be considerable flexibility to determine performance standards tailored to regional/national needs and preferences
D2	Meet standards and benchmark for product safety and operational safety	4	From a public interest perspective quality is more important than efficiency
D3	Achieve product user satisfaction	4	Customer / user satisfaction is a result of a complex of factors
E. Regional economy and community			
E1	Provide a basic scale of potential commercial activities	8	Outside the core objectives of the project. Activities are key to value chain improvement
E2	Provide employment opportunities for skilled and semi-skilled staff	2	The proposed intervention offers employment to a reasonable number of skilled and semi-skilled staff
E3	Provide employment opportunities through agricultural marketing value chains	8	Changes in employment opportunities will significantly affect cassava farming, transport, marketing and manufacturing
F. Quality of employment			
F1	Offer quality terms and conditions for work	4	Dependent on the terms of employment and number of staff employed
F2	Offer an attractive working environment to staff	4	Required for attracting high-end professionals and skilled staff
G. Address inequalities in income			
G1	Satisfy constraints on market proximity and competitive prices	8	Supremely important, to ensure market access in the region
H. Adaptability to change			
H1	Provide flexibility to cope with qualitative and quantitative changes in demand	4	Necessary to provide a fit-for-purpose solution and adapt to change in production capacity according to needs
I. Added value			
I1	Serve as a centre of transformation for the region	8	Very important for UDC to position as an agent of transformation in line with its vision, NDPIII and Vision 2040
I2	Offer opportunities for commercial cassava processing and research	4	Would provide a boost the country economy

4.4.1 Summary of shortlisted option analysis

Investment in existing factories

The subject of further assessments was restricted to the options of investing in existing starch factories. It is the opinion of the study team — based on the information provided by the client and the field visits carried out — that doing nothing would expose cassava farmers to limited market access. The field visits also confirmed that the technical state and capacity of the current factories are such that investments are urgently needed to address the inadequate capacity.

The main assumptions are:

- o Capital expenditure required €38.4 million. This represents an investment of 50% of the expenditures for the proposed new Acholi starch factory.
- o Investments from the year 2022.
- o EUL (economic useful life) capex: 10 years (corresponds with minimal modifications to eliminate the most acute problems).
- o Zero improvement of market access operational efficiency.

- Among problems identified at Bwendero are equipment technical deficiencies especially in the cooling towers, irregular cassava chips supply, high energy costs, and environmental challenges.

4.4.2 Comparisons of possible options for establishment of the cassava starch factory

Table 33: Comparison of possible project options (capital expenses, weighted points, and expenditures)

Options:	Investment in existing entities	Establishing the Acholi starch factory
Total capital expenses (UGX)	75,857,406,000	33,906,391,130
Weighted points (Appendices Option Scoring)	196	438
Expenditures per point	387,027,581	77,411,852

From Table 33 above, three preliminary project options are analysed based on estimated investment requirements and the weighted points to determine the dollar spent to earn a single weight score. As seen UGX387,027,581 spent for a single weight in the option for existing entities makes it the more expensive option as compared to UGX 77,411,852 spent per weight in case of the proposed cassava starch factory, which makes it the optimum option.

4.5 PREFERRED LOCATION OPTION ANALYSIS

4.5.1 Factory location analysis

Proposed location for setting up a cassava starch and ethanol factory largely depends on the availability of raw material and its transportation to the factory at low cost. However, factors like availability of workers, water, utilities, and easy access to the target markets should also be carefully examined.

The factory needs to be set up in an area where fresh cassava tubers or dry chips are readily available in the required volume throughout the year. Cassava as seen in Table 9 and Table 14 above is grown in two seasons a year with Nwoya District having highest harvested kilogrammes per household (6.4 tons in 2020 season A and B). The rest of the districts in the Acholi sub-region i.e., Amuru, Lira, Omoro, and Pader are relatively second with quantities in the region of 2 to 3 tons per household. The raw material needs to be competitively priced and hence areas with well-established alternative markets for their tubers or chips like Nwoya should be avoided because the markets will compete with the factory for raw material. Nwoya has an established 70 tons of cassava per day ethanol processing plant. Also, key to note is that the proposed plant has no farmland and therefore cassava supply will be based on organised farmer groups. The most organised and functional farmer group was found in Acholibur in Pader District. It operates under the Gulu Catholic Archdiocese. This farmer group stretches its reach to most of the northern districts.

1. Access to reliable three phase electrical mains supply. Mains electricity is way cheaper than using generator power. The proposed facility will consume on average 24,000 kWh per day of electricity at 100% starch production and 5,760 kWh per day at 100% extra neutral alcohol production. According to Energy Sector GIS Working Group Uganda[1], all the Acholi sub region districts have three-phase power supply available.

2. Access to a good road network is also key. The interconnectivity of the northern region districts with Gulu being the most central district is bituminous.

3. A large volume of clean water is important for cassava processing. Abstraction can be made from rivers, but treatment is a must to ensure product quality. There are numerous water streams and tributaries of River Aswa flowing in the northern region and ability to tap water for use is not a concern.[2]

4. Skilled labour to run the factory is readily available. While the proposed facility is the first to produce starch in Uganda in recent times, the proposed technologies and production process are not complex and will be handled with training.

From the eight districts in Greater Acholi Region:
Nwoya has yet to have a three-phase power extended fully even though the project is underway. In addition, Nwoya had a cassava processing plant, Bukona Agro Processors Ltd, that creates competition for cassava and might affect cassava supply to the proposed facility. On the other hand, Nwoya has extensive arable land at affordable rates (UGX1,000,000 to 15,000,000 per acre), surface and ground water supply, and a bituminous road network linking the district to Gulu town as well as the main bituminous highway to Nebbi, Arua and beyond.

Amuru District is located off the main highway connecting Uganda to Sudan through the Nimule border crossing. The road network is not tarmacked off the main highway. There is no dominant farmer group. In addition, the district has one of the least cassava acreages per season as detailed in Table 9.

Gulu and **Lira** are predominantly cassava collection centres with traders bringing their produce to town for sale at averagely higher prices compared to other districts. The road network is largely bituminous with the section connecting the two cities in a bad state and in need of an upgrade. These cities have easy access to three-phase electrical power. However, access to approximately 20 acres of land to set up a processing plant is costly (UGX90,000,000 to 900,000,000 per acre).

Omoro has one of the least cassava acreage allocated per household with a high price per kilogramme for dried cassava chips at UGX1,500 (***Table 18***). This is a huge challenge in making

1 The Energy Sector GIS Working Group (2017) Uganda Distribution Lines
2 Ministry of Water and Environment, Directorate of Water Resource Management (2016) Aswa Catchment Management Plan pp 19, 39, 43, 44, 70

any processing plant viable. On the other hand, its proximity to Gulu City is an advantage in tackling logistical challenges.

Pader has one of the largest and most organised farmer groups in the region. This farmer group has an identified location (3°09'03.7"N 32°54'54.6"E 3.151040, 32.915161), 25 acres, for the setup of the facility. The location has access to three- phase power, and it is close to the main Gulu to Kitgum highway. Pader is the second highest district allocating land for cassava cultivation and with the second lowest price per kilogramme of tuber as evidenced in Table 9 and Figure 8. This makes Acholibur the best location for set up of the processing facility (Figure 10).

Figure 10: The 25-acre proposed site in Acholibur with access to three-phase power, water supply from River Lanydang and just next to the main Gulu – Kitgum highway.

Kitgum is further north from Pader and the bituminous road network passes through Acholibur. The advantages of Acholibur coupled with the high cassava fresh tuber prices in Kitgum make the district unfavourable as a location.

4.6 PROPOSED TECHNOLOGY ANALYSIS

The technology of producing cassava starch and ethanol is well-developed internationally. After harvesting, the tubers are chopped into chips and transported to drying floors. The tubers are usually dried in the sun. Once the chips are dried, they can be stored for months. However, during storage, the starch yield decreases depending on storage temperature — typically 5% reduction of starch yield in eight-month storage (Abera et al, 2007). Another advantage of chips is the easy transport. A big advantage of cassava over many other traditional crops is that it can be grown and harvested throughout the year. This results in a constant supply to the production facility in contrast to more seasonal crops.

Table 34 shows the proposed factory production plant which shall entail the following components.

Table 34: Factory equipment, functions, and capacity

No	Machine/ Equipment	Function	Capacity	Units
1	Cassava cleaning and peeling conveyor machine	Wash and peel the outer skin of cassava	15 tons/ hour	2 units
2	Rasping machine	Crushing the cassava into porridge of cassava	25 tons/hour	
3	De-sanding cyclone	Separating and removing pollutant materials such as sand, dense metal, and any other pollutant that is present on the mush of starch.	120 – 130 m3/ hour	4 sets
4	Separator eco force clarifying decanter	Used to separate solids phase from the liquid phase (starch milk)		2 units
5	Centrifugal extraction sieves with direct drives	Extract the starch from starch milk using centrifugal system	10 tons/hour	4 units
6	Nozzle separators	Concentrate and clarify the starch maximally with the wash water system	350m3/hour	4 units
7	Starch hydrocyclone	Purify/wash the starch generated from the previous process to prevent dirt	10 tons/hour	1 set
8	Vacuum drum dehydrator	Get the starch into the dried form	10 tons/ hour	1 unit
9	Flash dryer	Drain the starch fast and eliminate moisture	2 – 3 tons / hour	1 set

4.7 PROJECT COST ESTIMATION

4.7.1 Construction cost estimates

The study used the equipment factored cost estimation method for estimating the cost of buildings and plant based on the current international levels of technology in engineering and design. (Table 35).

Table 35: Estimated factory construction cost

Main summary			
Proposed processing facility to be built at Acholibur			
No	**description**	**Page no.**	**Amount (ugx.)**
1	Preliminaries	3/S	547,000,000
2	Processing facility- ethanol plant	4/S	3,200,386,900
3	Processing facility- cassava starch plant	5/S	2,308,338,050
4	Ethanol storage tank bases	6/S	105,945,000
5	External works	6/S	1,338,112,500
6	Mechanical & electrical installations	7/S	506,747,078
	Sub-total		8,006,529,528
	ADD: Contingency	10.0%	800,652,953
	Sub-total		8,807,182,481
	ADD: VAT	18%	1,585,292,847
	Total		**10,392,475,327**

4.7.2 Equipment cost

Table 36 shows the proposed factory equipment and their cost.

Table 36: Estimated factory equipment cost

Cassava Starch 100tpd Starch				
ITEMS	**QUANTITY**	**UNIT**	**RATE**	**TOTAL (USD)**
U.S. dollars (Exchange rate of UGX3,750 considered)				
Land (20 acres; 8ha)	20	acre	26,667	533,333
Electrical detail (in sheet 2, transformer, LV distribution, switch gear)	1	Lumpsum	-	-
Water supply (main water pump and water treatment facility)	1	Lumpsum	156,000	156,000
Preliminaries (ethanol plant and starch plant share 50%)	1	Lumpsum	145,867	145,867
External works (ethanol plant takes 65% of works)	1	Lumpsum	124,891	124,891
Mechanical and electrical installations (ethanol plant and starch plant share 50%)	1	Lumpsum	67,566	67,566
Buildings for processing, storage, office, laboratory, garage, repair shop	2	Lumpsum	615,557	1,231,114
Process equipment for cassava starch	1	Lumpsum	-	-
5-ton wheel loader for all cassava loading needs	1	ea	218,288	218,288
4-ton forklift LPG (one for cassava starch and one for ethanol)	1	ea	66,313	66,313
Standby diesel generator 700 kVA	1	ea	140,000	140,000
Start-up expenses (cassava, acids, water)	1	Lumpsum	100,000	100,000
Installation cost (300 man-days of supervisor assistance on site for the installation of the equipment and 150 man-days of assistance and training on site for start-up and commissioning of the plant)	1	Lumpsum	593,810	593,810
Contingency (10 percent of total cost)	1	Lumpsum	1,237,888	1,237,888
Total plant investment	-	-	-	***4,615,069***

36,000 LPD Extra New Alcohol Plant (ENA)				
ITEMS	**QUANTITY**	**UNIT**	**RATE**	**TOTAL (USD)**
U.S. dollars (Exchange rate of UGX 3,750 considered)				
Land (20 acres; 8 ha) (land cost catered in starch plant)	1	acre	-	-
Electrical detail (in sheet 2, transformer, LV distribution, switch gear) (cost catered in starch plant)	1	Lumpsum	-	-
Water supply (main water pump and water treatment facility) (cost catered in starch plant)	1	Lumpsum	-	-
Preliminaries (ethanol plant and starch plant share 50%)	1	Lumpsum	145,867	145,867
Buildings for process facility ethanol production	1	Lumpsum	853,437	853,437
Ethanol tank bases	1	Lumpsum	28,252	28,252
External works (ethanol plant takes 65% of works)	1	Lumpsum	231,940	231,940
Mechanical and electrical installations (ethanol plant and starch plant share 50%)	1	Lumpsum	67,566	67,566
Process equipment ENA	1	Lumpsum	-	-
Standby diesel generator 500kVA generator	1	ea	76,000	76,000
4-ton forklift LPG (one for cassava starch and one for ethanol)	1	ea	66,313	66,313
Installation supervision & commissioning cost (with maximum 18 supervisory engineers for 20 months)	1	Lumpsum	1,078,595	1,078,595
ENA start-up expenses	1	Lumpsum	160,000	160,000
Contingency (10 percent of total cost)	1	Lumpsum	1,256,526	1,256,526
Total plant investment	-	-		***3,964,495***

4.7.3 Laboratory equipment costs

Quality assurance is an important component of the proposed factory. In fact, strict quality control is the key success factor to achieve sustainable operations and profitability. Implementing effective quality assurance requires maintaining a modern laboratory for conducting the required quality checks at raw material, in-process, and finished goods stages. List of the required laboratory equipment is shown in Table 37.

Table 37: Estimated laboratory cost

No.	Item description	Unit	Quantity	Cost (UGX)
1	Weigh scale	No.	1	2,000,000
2	Lab centrifuge machine	No.	1	20,000,000
3	Magnetic stirrer	No.	2	700,000
4	pH meter	No.	1	5,000,000
5	Auto burette	No.	2	20,000,000
6	Distillation apparatus	No.	1	2,000,000
7	Abbe refractometer	No.	1	10,000,000
8	Hand refractometer (0-32)	No.	2	2,000,000
9	Hand refractometer (20-80) or (32-80)	No.	1	1,500,000
10	Glass thermometer	No.	10	2,000,000
11	Autoclave	No.	1	6,000,000
12	Microscope	No.	1	40,000,000
13	Incubator	No.	2	40,000,000
14	Hot air oven	No.	1	20,000,000
15	Colony counter	No.	1	2,500,000
16	Stop watch	No.	1	500,000
17	Water bath	No.	1	1,000,000
	Total			**184,200,000**

Along with the above-mentioned capital items, laboratory operations also require consumable apparatus including glassware, stands, etc. The cost for this has been averaged out to be UGX 25,000,000 per annum.

4.7.4 Office equipment and furniture

Office equipment and furniture are required to carry out the routine administrative operations. These include furniture, interior decoration, air conditioners, and IT and communication gadgetry. Total cost of office equipment and furniture is UGX262 million (Table 38). Details are presented in the excel model.

Table 38: Estimated office equipment and furniture cost

Furniture	Number	Unit Cost	Total Cost
Bookshelves	5	500,000	2,500,000
Cabinet, filing	20	500,000	10,000,000
Chair, office	95	500,000	47,500,000
Chair, office, executive	20	500,000	10,000,000
Computer system, complete	30	1,000,000	30,000,000
Conference table	5	500,000	2,500,000
Desk, office	95	500,000	47,500,000
Desk, office, executive	30	500,000	15,000,000
Dining table c/w 6 chairs each	15	500,000	7,500,000
DVD Player	3	500,000	1,500,000

Executive sofa set	3	500,000	1,500,000
Heavy duty photocopier	2	500,000	1,000,000
LCD projector/screen	1	500,000	500,000
Safe	3	500,000	1,500,000
Shelves, metallic	10	500,000	5,000,000
TV	3	500,000	1,500,000
Laptop computers	20	2,000,000	40,000,000
Air conditioners	10	200,000	2,000,000
Telephone sets	50	700,000	35,000,000
Visitor's chair	30	150	4,500
Total			**262,004,500**

4.7.5 Vehicles

Twelve vehicles have been proposed in the project cost — including loading vehicles and administrative salon cars for the management. Total cost of vehicles was calculated as 1.9 Billion. Details are provided in Table 39.

Table 39: Estimated factory vehicles cost

Type	Number	Unit Cost (UGX)	Total cost (UGX)
Big trucks	2	300,000,000	600,000,000
Small trucks	4	100,000,000	400,000,000
Salon car	3	200,000,000	600,000,000
Carry van	3	100,000,000	300,000,000
Total	**12**		**1,900,000,000**

4.8 Operations and Production Plan

The proposed cassava processing plant is proposed to run for a maximum of one 8-hour single shift for the first eight months to one year. Approximate run days will not be more than 15 days in a month as the plant streamlines its cassava supply chain as well as allow for the typical start-up and commissioning failures to be addressed as highlighted in the figure below. This will allow for all equipment and civil snags to be addressed. In the second year the plant can aim to operate gradually from 8-hour single shift to 10-hour single shift and finally 12-hour single shift as the market and starch demand grows and as all processing inefficiencies are addressed by the plant production team. In year three, full plant capacity of two 12-hour shifts or three 8-hour shifts can be realised (Figure 12).

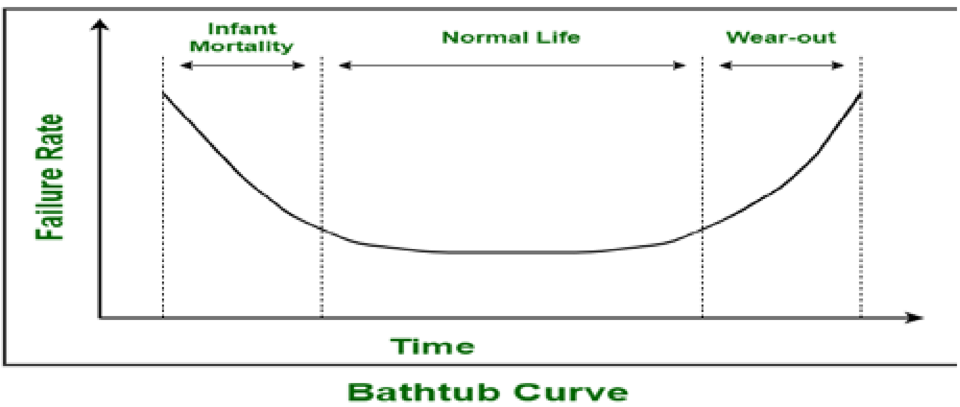


Figure 11: Equipment bathtub analysis

Cassava is not storable — it begins to depreciate two or three days after harvest. Therefore, cassava is often processed into more storable products like cassava starch, cassava flour, cassava chips, and others.

Cassava starch is prepared from either wet mash from tubers or dry chips. Starch extraction is easier and economical with wet mash. Wet mash also gives consistent and quality starch. Impurities in chips during dry milling affects particle size because of the high variability between very fine and coarse materials. This high variability in size results in constant clogging of the sieves aperture during washing of flour to obtain starch. Also, large quantity of water is necessary to drive the material through the sieve. Quality is important in starch market. Therefore, extraction from wet mash is often preferred in commercial starch extraction because of control over product quality. In cassava starch processing plant, the whole process is divided into three parts: raw material cleaning section, starch extraction section, and drying section. The equipment used includes dry sieve, paddle washer, rasper, centrifugal sieve, fine fibre sieve, desander, hydrocyclone system, peeler centrifuge, flash dryer.

The technologies for processing cassava to fuel ethanol considers the treatment of this raw material in two ways. The first one consists of the extraction of the starch contained in the cassava for converting into ethanol, which implies a previous separation of the main cassava components (peel, fibre, moisture, and starch). The second alternative is based on the use of the whole cassava for producing ethanol. Thus, all the components of the feedstock enter the production plant. Most of the cassava non-starch components are concentrated in the fibrous residue and vinasse. However, it is considered that ethanol from cassava can have better economic indicators if the whole tuber is used instead of the starch extracted from cassava, especially if small holders are involved (Sánchez and Cardona, 2008).[3] To produce ethanol from whole cassava, the feedstock should be transported rapidly from cropping areas to the production facility because of the accelerated deterioration of cassava tuber due to its high moisture content which is nearly 70%. Therefore, the cassava tubers should be processed within three to four days after harvesting. This makes dried cassava chips with moisture down to 14% and the starch content up to 65-75% the most economically viable method of handling cassava.

4.9 PROPOSED CAPACITIES INPUT AND OUTPUT FIGURES

The plant is proposed to have two primary production operations:

i) 400 tons per day (Tpd) cassava tubers processing into cassava starch producing up to 100Tpd.

ii) 50 tons per day of dry cassava chips and 50tpd of starch ethanol processing facility producing up to 36,000 litres of ethanol per day. Fresh cassava of about 120 tons may be required by farmers to produce this amount.

This will make the facility the largest cassava processing plant in the country and perhaps the region capable of attracting markets throughout the region and beyond. The proposed key output and input figures and products for the facility are illustrated in Table 40.

3 Quintero J, Cardona C, Felix E, Moncada J and Higuita J (2015) Techno-economic analysis of fuel ethanol production from cassava in Africa: The case of Tanzania. Instituto de Biotecnología y Agroindustria, Departamento de Ingeniería Química. Universidad Nacional de Colombia, pp 3083–3088.

Table 40: Proposed key input and output products of ACPP

Item (key raw materials)	Input (external and internal)	Products
1. **Fresh cassava tubers**	400 ton/day	- 100Tpd cassava starch (food-HQCF and industrial and pharma grade starch). This can also be used to make modified starches/syrups and food grade floor.
2. **Dry cassava chips (and cassava starch) or maize**	50 ton/day dry cassava chips - made from 120Tpd fresh cassava (plus 50Tpd cassava starch from the starch processing line)	- 38,000 litres of ethanol. This will produce other products such as rectified spirit-RS, extra neutral alcohol (ENA) -Other commercial by-products: CO_2, dry distiller grain with solubles (DDGS), fusel oils.

4.10 KEY STRATEGIC CASSAVA SUPPLY AND PRODUCTION STRATEGY AND CONSIDERATIONS

4.10.1 Fresh and dried cassava supplies to the plant

It is envisaged that the large proportion of the cassava supplied to the ACPP will be done through organised cassava producer groups and cooperatives in the Acholi sub-region probably taking a lead from Gulu Catholic Archdiocese (GCA) and related groups. Annual contractual arrangements between ACPP and the growers' cooperatives will be negotiated to set price and quality parameters at farm gate. The farmers cooperatives will also be empowered to produce high quality cassava chips to encourage value addition at parish and village levels. This will be a means of empowering farmers and ensuring that the plant focuses on the core business of processing cassava. Some key features of the cassava supply chain will be set as follows:

i. The bulk of the fresh and dried cassava processed at the facility will be supplied by organised cassava producer groups like GCA and cooperatives from the different districts in the region. However, the produce may also be sourced from other regions and even eastern DR Congo if there is a failure by the core region to supply sufficient raw materials to the facility.
ii. ACPP will enter a supply contract with the producer cooperatives for quantity, quality and price as required by the plant. The cooperatives will consist of well-trained cassava farmers and dryers and will form the core of the cassava supply to the facility. GCA, a key organised player in the region with more than 10,000 cassava famers, may be the leader.
iii. If plant capacity allows, individual farmers will also be welcome to supply so long as they meet the quality and price considerations.

4.10.2 Cassava Processing Strategic Considerations

There are five major strategic considerations for ACPP cassava processing operations.

i. At maximum capacity, the starch plant will run three shifts of eight hours each during the key harvesting seasons. For fresh cassava tubers, the supply peaks are in the two rain seasons of March–June (main season) and September-January (minor season). This will ensure maximisation of bulk cassava starch production.

ii. Dry cassava chip supplies for ethanol production are expected to peak in the dry seasons of January-March and July-September when there is sufficient sunshine to dry the cassava. The ethanol line is expected to run at maximum capacity during this period.
iii. However, in the event of insufficient cassava production in the region, supplies may be sourced from other regions including Bunyoro, Lango, Teso, and West Nile, or even across the border in DR Congo.
iv. In case of poor cassava supplies, the ethanol plant may use maize as a substitute.
v. Employment of qualified personnel from the cassava-growing community will be a primary strategy especially from mid to lower-level positions. Lower-level positions will be filled with local community members after receiving adequate training. This is to encourage full community participation, local job creation, and sense of ownership of the project.

4.10.3 Cassava yields compared to other feedstocks

Cassava has a high starch content and is a high-yielding ethanol crop. A distinction has also been made between yields from dried cassava chips and fresh cassava tubers. For one kilogramme of cassava chips, approximately two kilogrammes of fresh cassava roots/tubers are required. One litre of ethanol can be produced from:

- 5-6kg of fresh tubers (containing 30% starch)
- 3kg of cassava chips (14% moisture content)

On a per tonne cassava basis:

- 1 tonne of fresh cassava tubers yields 150 litres of ethanol
- 1 tonne of dry cassava chips yields 333 litres of ethanol

Cassava tuber has the following composition:

- Peel 10-20%
- Cork layer 0.5-2%
- Edible portion 80-90%, of which:
  - Water 62%
  - Carbohydrate 35%
  - Protein 2%
  - Fat 0.3%
  - Fibre 0.1%
  - Ash 0.1%

The quality of starch and ethanol depends on the production technology employed and impurities associated with the raw materials used. One major problem with cassava as feedstock in production is its availability. This depends on geographical location and varies significantly from season to season. The price of the raw materials is also volatile, which can highly affect the production costs because feedstocks typically account for greater than one-third of the production costs. Therefore, using the right technology to maximise yield and quality of output product with the ability to use complementary feedstocks is imperative. In the case of the proposed factory, maize is an alternative feedstock that can be used.

Table 41: Ethanol and starch yield/ton of different feedstocks[45]

No.	Material	Cost/kg or ton	Ethanol yield/ ton	Starch content (%)	Comment
1	Maize	Current UGX700 Range (300-1,000)	365-385	55-65	-Very good alcohol -Low yield -Difficult to process -Price fluctuations
2	Cassava dried chips	Current UGX600 Range (300-800)	380-400	65-79	-More alcohol yields -Fairly stable prices -Drying difficult in wet season
3	Sorghum (white)	Current UGX1,000 Range (800-1,000)	350-400	65-75	-Good alcohol -Rare material
4	Rice	Current UGX3,000 Range (2,500-3,500)	400-500	70-79	-Easy to process -More alcohol -High prices
5	Molasses	Current UGX150,000/ton Range (100,000-800,000)	230-260	Nil	-Good raw material for biogas plant -Effluent has high COD -Easy to handle in process -Fairly stable prices

From Table 41 above, ethanol yield is more in starch raw material than molasses because of the simple mono sugars that are easily digestible by yeast. Although more alcohol yield is realised from starch raw material, it's food and diverting it to make other industrial products other than food can result into food insecurities. It is therefore recommended to use starch raw material in areas where it's in plenty. Cassava is plentiful in Acholi sub-region and is therefore recommended for use.

4.11 Proposed Core Products

The proposed factory will start with two major products: high quality cassava starch and ethanol. Key commercial by-products will be carbon dioxide, animal feed-dry distillers grains with solubles (DDGS), and fusel oil. Specialised starches and syrups may be added to the product portfolio during the expansion phase of the facility. Methane from the distillation unit will also be produced but used as a key energy source for running the boiler steam production (Table 47).

4 Patni N, Pillai G, Dwivedi H, (2013) Wheat as a Promising Substitute of Corn for Bioethanol Production. Department of Chemical Engineering, Institute of Technology, Nirma University, pp 356–357.

5 Mojovići1 L, Sinisa M, Pejin J, Rakin M (2009) Progress in the production of bioethanol on starch-based feedstocks, Article in Chemical Industry and Chemical Engineering Quarterly, pp 214–215.

Table 42: Proposed starch and starch products, maximum output, factory prices, and target market

	Product	Average price (UGX)	Expected max yield quantity/day	Target market
1.	Cassava starch (yield at 25% from fresh cassava at moisture content <12%	1,000-2,500	100ton	· Beverage companies e.g. Uganda Breweries Ltd (UBL) (Engule), Nile Breweries Ltd (NBL) · Starch industries e.g. pharmaceuticals starch-Cipla etc. · Timber and paper industries · Food grade starch packed and sold for human consumption.
2.	Ethanol/Alcohol - RS (Rectified Spirit)	4,250	36,000L	· All portable alcohol-blending companies e.g Legend Waragi. · Used to make absolute alcohol, extra neutral alcohol (ENA). · Other industrial applications e.g. sanitiser, sugar, pharmaceuticals, hotels (RS for food warmers) etc.
3.	TA- (Technical Alcohol)	2,250	1600L	· It's an industrial spirit.eg in pharmaceuticals · Biofuel for home cooking, boilers, turbines. · Hotels
4.	Carbon dioxide	1,000	8.1Tons	· All beverage companies like soda, beer, water (Pepsi, Coca-Cola, Riham) · Hotels, fish factories, welding, drilling extinguishers, cement industries e.g. Tororo, Hima
5.	Distillers Dry Grains with Solubles (DDGS)	600	6.25ton	· Animal feed, fertilisers e.g. large fattening farms and all animal feed producers
6.	Fusel oils (corn oils if maize is used)	N/A		· Paint industries, insecticides, perfumes, and fuel · Soap, edible as a cooking oil etc

*Maize product output is largely the same for all products other than DDGS with a double the yield

4.12 PROPOSED PRODUCT PACKAGING

The products of the ACPP will be packaged for commercial sale as indicated in Table 43;

Table 43: Proposed product commercial packaging and costs

	Product	Proposed commercial packaging	Unit cost of packaging (UGX)
1.	Cassava starch	Bulk 50kg bags	1,000
2.	Alcohol - RS (Rectified Spirit)	Bulk special customer tanks or 60L drums	35,000
3.	TA- (Technical Alcohol)	Bulk special customer tanks or 60L drums	35,000
4.	Carbon dioxide	-Cylinders 27kg and bulk tank 17ton mobile tank. -Solid blocks 5kg (fish and beverage cooling)	Returnable cylinders (100,000 per cylinder)
5.	Distillers Dry Grains with Solubles (DDGS)	100kg bags	1,000
6.	Fusel oils (corn oils if maize is used)	(Market to be developed)	

4.13 PROPOSED CORE FACILITY LAYOUT, PROCESSING FLOWS AND EQUIPMENT

As already indicated, the ACPP will be one of the biggest such facilities in the east African region. The plant is proposed to be procured on a turn-key basis for both civil and equipment installations. The key facilities and process flow that will ensure the production of these products are illustrated as follows:

4.13.1 Detailed proposed plant layout

The facility will occupy approximately 27,702 square metres for the starch and ethanol processing area as detailed in Figure 12.

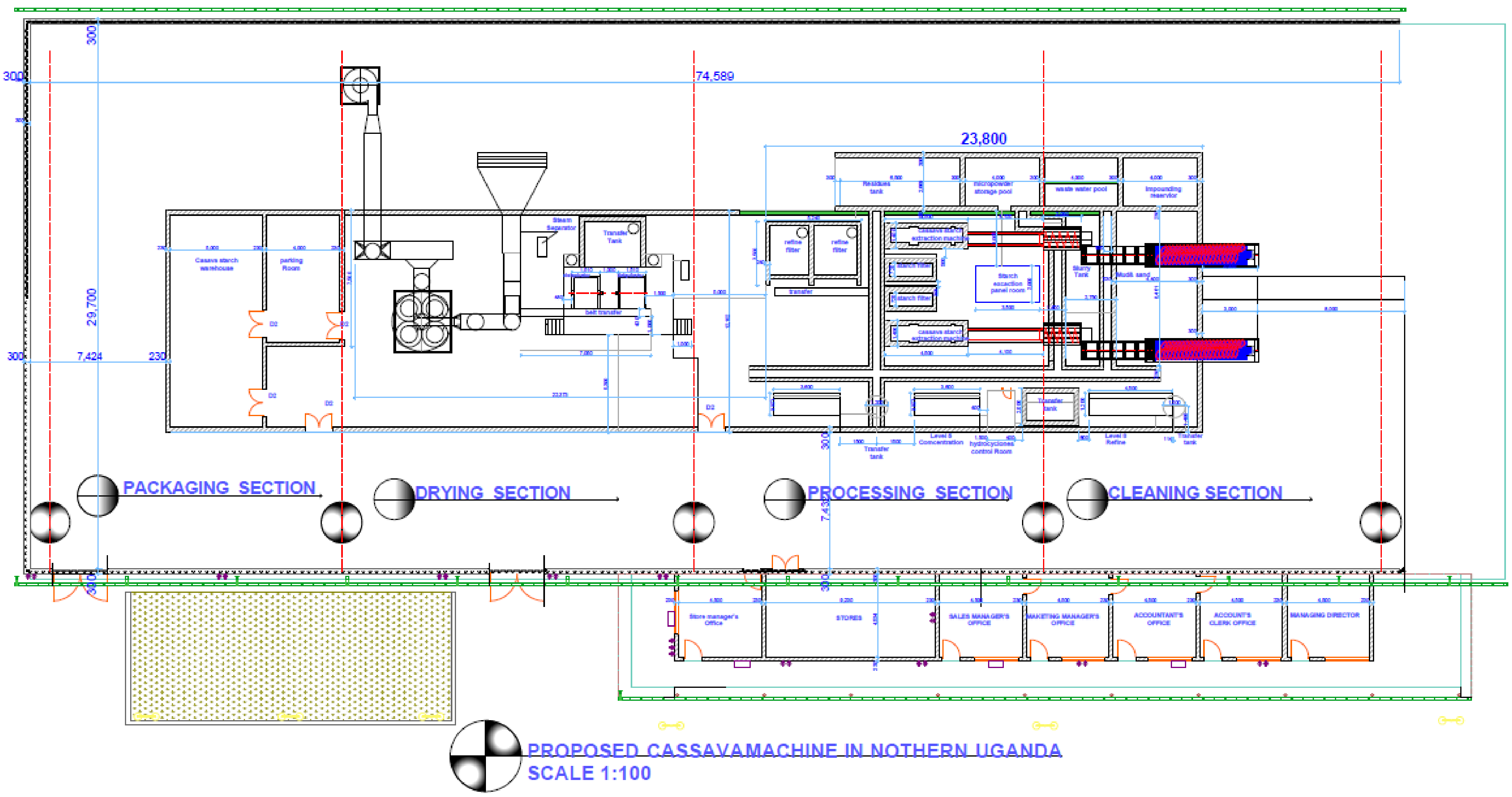


Figure 12: Starch processing area detail.[1]

1 Cassava Starch Processing Detail June 2021

The facility will occupy an area of 80 metres in length and 60 metres in width for the starch processing area as detailed in Figure 13.

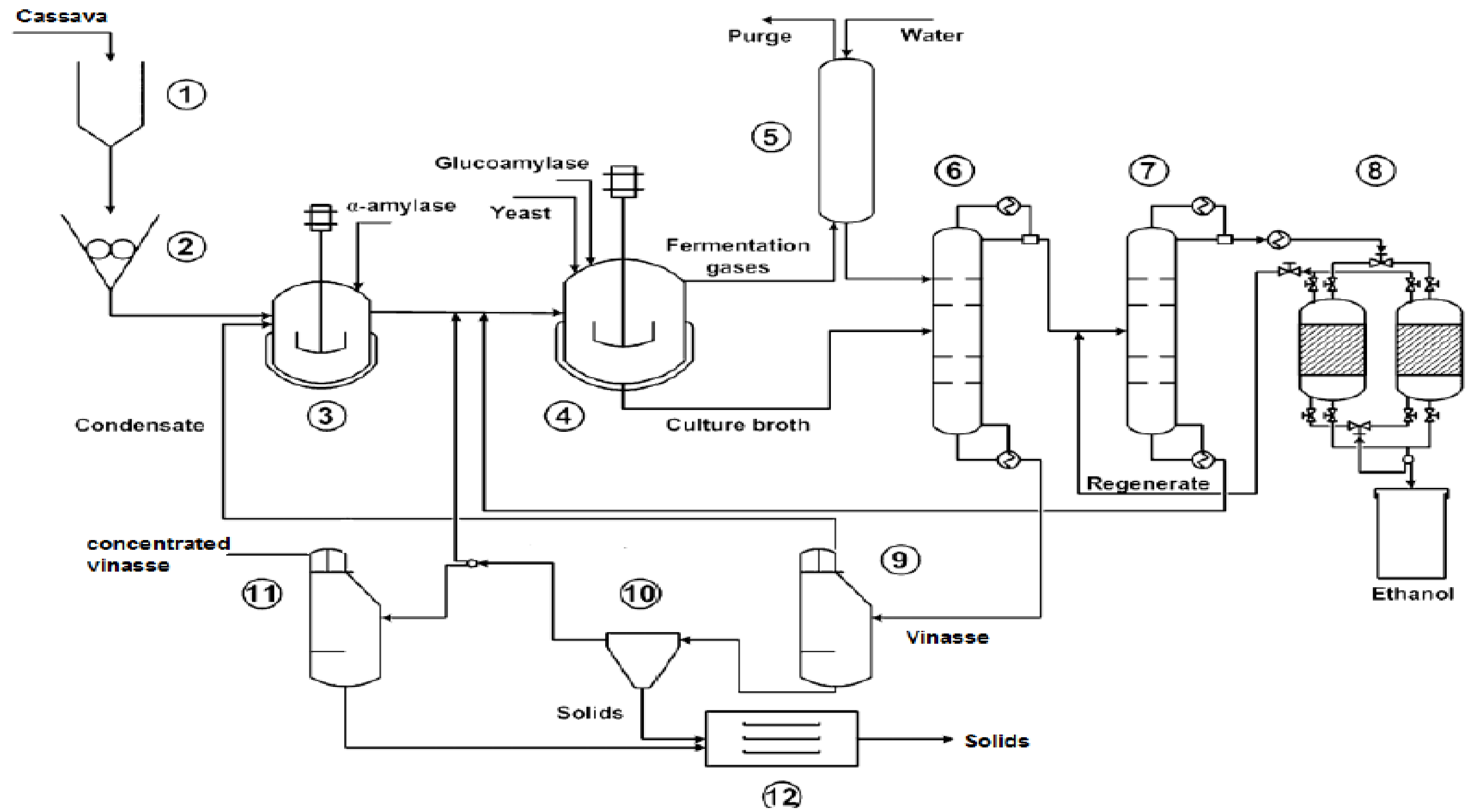


Figure 13: Cassava processing area detail.[1,2]

1 Cassava Starch Processing Detail June 2021

2 Quintero J, Cardona C, Felix E, Moncada J and Higuita J (2015) Techno-economic analysis of fuel ethanol production from cassava in Africa: The case of Tanzania. Instituto de Biotecnología y Agroindustria, Departamento de Ingeniería Química. Universidad Nacional de Colombia, pp 3083–3088.

The ethanol processing is as detailed below:
Fuel ethanol production from cassava. 1, washing tank; 2, crusher; 3, liquefaction reactor; 4, SSF reactor; 5, ethanol absorber; 6, concentration column; 7, rectification column; 8, molecular sieves; 9, first evaporator train; 10, centrifuge; 11, second evaporator train; 12, dryer.

4.14 PRODUCTION PROCESS DESCRIPTION: CASSAVA STARCH PRODUCTION

Several technologies are used in the processing of starch and ethanol from cassava. Some processes make use of fresh cassava and others use dry cassava chips. However, the most employed commercial process to produce high quality cassava starch is wet milling as illustrated below. It is, for example, used in almost all cassava plants in Nigeria.

For ethanol production from cassava starch, most commercial processes use both milled dry cassava chips and ready-made cassava starch. Technologies exist for making ethanol directly from wet milled cassava.

4.14.1 Proposed high quality cassava starch production process

The production process flow for making high quality cassava starch from fresh cassava tubers has four major stages as illustrated below:

1. **WASHING AND PEELING.** The cassava tubers supplied to the plant are (after weighing and sample-taking) unloaded in the storage area. The first step is the removal of adhering soil and foreign matter in a dry process. The pre-cleaned tubers are then thoroughly washed in water for the removal of residual soil and peel. In the peeling section the roots are intensively agitated with paddles and rinsed with water. The agitation loosens the peels from the roots. The peels are separated by a screen and are discharged by a belt conveyor. The rinsing water together with the overflow water from the washing section maybe pumped to a de-gritting cyclone and is returned to the roots wash water recycle tank. The cleaned and peeled roots are discharged from the washing/peeling machine to the inspection belt. Stems and other impurities that might still be present are manually removed from the belt. The roots are passed through a weighing belt before discharge to the next section. Soil and dirt not removed in the washing station may cause problems later. High quality washing improves refining because many impurities resemble starch in specific weight and size. So efficient washing is the key to getting rid of impurities.
2. **RASPING/DESINTEGRATION.** Washed and clean roots are disintegrated on high-speed raspers. The rasping contains a mixture of starch granules, juice, and fibres (cell walls).
3. **STARCH EXTRACTION**. The fibres are separated from starch and juice and washed on a multi-stage extractor with centrifugal screens. The resulting fibres are dewatered to a drip-dry pulp with 12-14% dry matter.
4. **CONCENTRATION.** The starch is concentrated on a multi-stage hydrocyclone unit and the major part of juice is discharged as is or diluted with spent process water.
5. **REFINING.** The crude starch milk is purified by washing in counter current with fresh water on a multi-stage hydrocyclone unit. This ensures the production of pharma grade high quality cassava starch.
6. **DRYING AND PACKAGING.** The purified starch milk is dewatered on rotating vacuum filters and eventually dried in hot air in a flash dryer. The starch is cooled and screened ready to transfer to the bagging station or to optional storage silos or bulk discharge to road tankers.

4.14.2 Ethanol production process description

1. STARCH MILLING (from dry chips): Cassava chips with moisture content less than 12% are milled into a fine flour.
2. GELATINISATION/STARCH PROCESS: The cassava starch (from chips or starch line) is mixed with water in a ratio of 1:4 and preheated to 80°C with constant stirring until a smooth gel or porridge is formed.
3. MARCH, ENZYME TREATMENT/ LIQUEFACTION: Alpha amylase enzyme is then added to the gelatinised starch porridge at 80°C and allowed to stand for 60 minutes.
4. SACCHARIFICATION: Amylo-glucosidase (glucose-amylase); is then added to liquefied starch at 60°C and incubated for 240 minutes (pH balance is also done during this process); filtration of the mix is then done prior to transfer into the fermentation tanks.
5. FERMENTATION PROCESS: Yeast inoculum of saccharomyces cerevisiae is then added and the mix is incubated at 28-34°C) for 24 hours. The mix is then filtered and sent to the distillation tanks. DDGS is filtered off here.
6. DISTILLATION: Distillation using distillation towers of the fermented mix is then done and all the different ethanol are extracted and made ready for sale.

4.14.3 Process flows for starch and ethanol

Table 44: Line A — starch processing line

Raw material	Fresh cassava
Processing capacity	400tons/day of fresh cassava tubers
End product:	Cassava starch
Moisture content	<12%
End package	50kg bags or bulk bag loads
Output	100Tpd of starch

Table 45: Line B — ethanol production line

Raw material	Cassava chips and cassava starch
Processing capacity	100MT of cassava starch (from the wet process 50MT or milled cassava chips 50MT)
Output 1	Ethanol/Alcohol - RS (Rectified Spirit)- 36,000L
Output 2	TA- (Technical Alcohol)- 1600L
Output 3	Carbon dioxide - 8.1 tons
Output 4	Distillers Dry Grains (DDGS) 6.25ton (animal feeds)

4.15 PROCESS FLOWS FOR THE KEY PRODUCTS

The general production flow diagram that the processes will follow is illustrated in Figure 14 for the two key products.

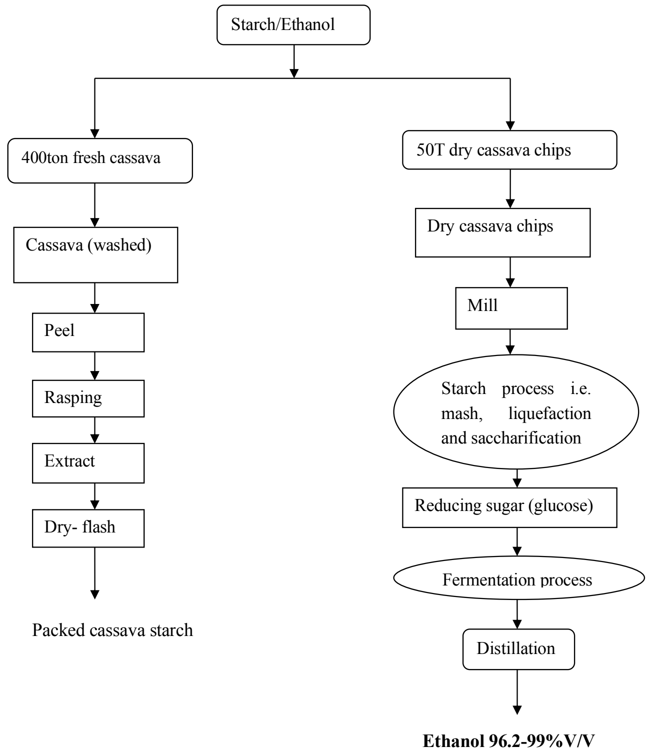


Figure 14: Process flowchart for the production of high quality cassava starch and ethanol

4.16 KEY PRODUCTION INPUT PROCUREMENT PLAN

Processing at the proposed factory must be supported with a number of crucial inputs. The key inputs should be sourced at least 3 months in advance to avoid stock out costs. All these inputs are related to the ethanol production line.

1. **Enzymes (alpha and gluco amylases) and yeasts**

These enzymes are mainly obtained from China and India although a few local suppliers may be identified. Yeast may be sourced locally from numerous local suppliers.

2. **Sulphuric acid / lime zinc sulphate, magnesium sulphate, urea, phosphoric acid**

All these chemicals may be bought from local suppliers like DESBRO in Kampala's Industrial Area.

4.17 TOTAL QUALITY MANAGEMENT SYSTEM RECOMMENDATIONS

4.17.1 HACCP and quality management at ACPP

A well-developed Hazard Analysis and Critical Control Points-HACCP system that anchors all national and international quality management systems in the food industry (Global Food Safety Initiative-GFSI) will form the backbone of the plant's TQMS. A HACCP system requires that potential hazards are identified and controlled at specific points in the process and this includes biological, chemical, or physical hazards. The Global Food Safety Initiative, GFSI, has benchmarked several food safety management systems certification programmes, all of which are HACCP-based. A well implemented HAACP system will ensure compliance to the late ISO22000:2005 standards that ACPP will require for local and international standards compliance. Quality certification is one of the key activities that the proposed factory will undertake at the inception of its production operations. Two important control points are involved in HACCP:

- CCP-Critical control points that must be closely monitored and controlled as any variation or violation to set parameters could result into a harmful product unsuitable for consumption.
- CP-Control points that must also be monitored to ensure a quality product but whose violation can be mitigated effectively by the next step in the process and may not result into a harmful product to the consumer.

4.17.2 HACCP and ISO 22000: 2005 certification

International Standards Organisation-ISO 22000:2005 specifies requirements for a food safety management system where an organisation in the food chain needs to demonstrate its ability to control food safety hazards to ensure that food is safe at the time of human consumption. The products of the cassava plant will require at least a UNBS certification to trade effectively in all markets. The ISO 22000:2005 certification that is recommended for the cassava plant and can be acquired when an effective HACCP system is in place will enable ACPP to:

- Plan, implement, operate, maintain, and update a food safety management system aimed at providing products that, according to their intended use, are safe for the consumer.
- Demonstrate compliance with applicable statutory and regulatory food safety requirements.
- Evaluate and assess customer requirements and demonstrate conformity with those mutually agreed customer requirements that relate to food safety, in order to enhance customer satisfaction.
- Effectively communicate food safety issues to suppliers, customers, and relevant interested parties in the food chain.
- Ensure that the organisation conforms to its stated food safety policy.
- Demonstrate such conformity to relevant interested parties.

Seek certification or registration of its food safety management system by an external organisation, most importantly UNBS for a Q mark, and also allow for a self-assessment or self-declaration of conformity to ISO 22000:2005. (www.iso.org)

4.17.3 Pertinent critical control points (CCPs) in cassava processing for starch and ethanol production

A HACCP system which is based on the critical process flow of the production system will be employed at the plant. Thus, a detailed process flow diagram for the proposed factory provides the key backbone required to have and install a quality management system. Some pertinent CCPs, policy and procedures in cassava processing industry are elaborated below and are marked on the detailed processing flows as follows:

4.17.4 Cassava tuber and cassava chips reception (CCP1)

This is an area where the factory will receive fresh cassava from the field/farmers. It's a critical point where hygiene, foreign bodies, and cleanliness will be monitored with a standard policy procedure and record sheets. Hazards to monitor include damaged and out of specs cassava tubers and/or chips, physical (dirt, stone, and organic rubbish) and biological (microorganisms, insect/rodent droppings).

4.17.5 Quality inspection

Cassava tuber inspection is a critical control point in the process. A standard policy and procedure will be developed and installed at this point. Key quality parameters to be checked for fresh tubers at reception will include cassava tuber quality defects against set variety and standards, rodent damage, freshness and crushing damage and other non-conformances. Cassava chips will be assessed for moisture content, colour, dirt and stone contamination, insect infestation, rodent dropping, among others. Accept/reject decisions will be made based on set criteria.

a. Sorting (CP)

The cassava tubers and dry chips will be sorted to remove the non-conforming tubers and stems from an accepted lot before processing. This is a simple quality control point set to determine which tubers or chips are best suitable for processing according to set specifications.

b. Fresh tuber washing (CP)

Washing the tubers is a control point that ensures the quality of the final product. It helps to remove all soil and dirt. High quality washing improves refining because many impurities resemble starch in specific weight and size. Washing is the only way to get rid of them. The efficiency of rubbing in the washing machine is a most important quality factor. The quantity of impurities adhering to the surface upon delivery depends to a great extent on weather conditions and the soil texture. Farmers will be encouraged to deliver only pre-washed tubers as part of the quality training.

c. Rasping (CCP)

Rasping (grating) is the first step in the starch extraction process. The process opens all the root cells and releases all starch granules. The slurry (rasping) obtained can be considered a mixture of pulp (cell walls), cassava, and starch. Here, food grade sulphur dioxide gas or sodium bisulphite solution may be added to produce a quality product. The great reduction potential of the sulphite prevents discoloration. Thus, this process is a CCP as the quantities added must be carefully controlled and it has an effect to the quality of the product and can be potentially harmful to consumers.

d. Starch extraction (CP)

Powerful flushing is needed to release the starch granules from the cells. The cells are torn apart in the rasper and form a filtering mat retaining the starch. Water has previously been used for the extraction, but today the extraction takes place in closed systems allowing the use of the juice itself or process water from the refining step. Because it occurs in a closed system, this process doesn't allow for any contamination. It is thus not a key CP in the proposed process.

e. Flash drying (CCP)

Drying and refining the starch into a final product suitable for pharmaceutical use or consumption as food is a CCP. Here, any failure in the process will lead to a product which is not fit for purpose and may even be harmful. The key aspect to control is the final moisture content which must be below 12% to ensure a high value, long lasting product.

f. Packaging

The final product that will be made and packed by the starch processing line is high quality cassava starch. This product is now ready for use in the food chain thus any contamination at this point may be extremely harmful. Hazards may mainly include contaminated packaging bags and poor seals. Monitoring is important and it is a CCP in the process.

4.17.6 Ethanol production CPs and CCPs

There are several CPs and CCPs in ethanol production and control parameters. These are illustrated in Table 46.

Table 46: Ethanol process flow CP and CCP in the production line

Flow section	Material	Parameters	CP/CCP
Milling for ethanol	Screen for cassava, maize	Sieve size (1.5-2.0mm 1.0-1.5mm)	CP
For cassava starch. Wet milling (pulveriser through a grater)		Particle size, cyanide content	CCP (cyanide levels can be very dangerous if not monitored)
Starch process	Liquefaction Saccharification	PH.6.5-7.0, temp 80°C minimum, brix 18-20 optimal temp. 95°C. pH. 4.0-4.5, temp. Range 58-62°C, optimal temp. 60°C	CP, critical for quality and yield
Fermentation	Media. Culture vessels (CV_1, CV_2, CV_3) and pre fermenters. Fermenters	pH. 4.0-4.5, temp. Range 30-36°C optimal temp. 34°C, brix 10-12, nutrients macro and micro, oxygen saturation. pH. 4.0-4.5, optimal temp. 34°C, nutrients macro only, resaturation, alcohol content in beer and brix18-20°C.	CP, critical for quality and yield
Distillation	Beer heaters	Beer heater temp. 65°C	CP
Atmospheric plant pressures are positive and the multi-pressure plants some columns have negative pressures-under vacuum	Mash/ analyser Analyser column Rectifier column Recovery column (FOC) fusel oil column. Feed rate	Maintain temp. and pressure in each column Top temperatures = 85-90°C Bottom temperatures = 105-109°C Pressure dependent on diameter Top temperature =78-79°C, Middle temperature = 90-95°C Bottom temperature = 104-107°C Pressure dependant Top temperature = 78-79°C, Bottom temperature =104-107°C Dependent on capacity	CP for safety and yield

Flow section	Material	Parameters	CP/CCP
Laboratory tests	Raw material, dry cassava Water (process) Water for boiler Products like RS, TA Spent leese $ spent wash Spent wash Methane gas Carbon dioxide DDGS	Starch content 70-78%, moisture content < 14%. Biological analysis (mouldy) Physical tests and adulterations Ph 6.5-7.0, TDS aprox.1000mg/l, colour, and conductivity. Hardness should be zero. Strength – 95-96.2% Op 69.0-69.2 Sg 0.8042 for RS, 0.79 for ENA Ppt /PRT for RS<30mins, ENA>30mins. Physical tests, GC analysis. Alcohol loose, dichromate test COD-9-80000-90000mg/l,TVA Methane percentage 65-78%, carbon dioxide percentage 20-25% (gas analyser) Physical tests, number of foreign matter/particles. Purity 99.9999% Moisture content <0.2-0.8% Moisture content wet 60-65%, dry is <12%. Freshly prepared, dried and packed. Ph.4.0-4.7, Mould free (biological test).	CCP, must be within set limits

4.17.7 TQM Policy, SOPs and Quality Management System Recommendations and Guidelines

Several standard operating procedures (SOPs), record forms and documents will be developed as part of the Acholi cassava processing plant quality management system manual that would be certifiable for UNBS and ISO 2002; 2005. Provided here are some recommendations of key policy documents and procedures to manage the facility, CPs and CCPs as contained in the proposed ACPP HACCP. Outlines of the key TQM procedures which will have to be documented to implement the system are presented in Table 47.

Table 47: Analysis of designated TQM procedures

Procedure	Purpose
Control of documents	To ensure proper maintenance of generated records and ensure that the control of both document and data is handled in a manner that guarantees quality.
Control of records	To ensure proper maintenance of generated records to demonstrate conformance to required specifications and effective orations of the quality system.
Procedure for customer complaints handling and focus	To ensure that customer expectations are met and all complaints are effectively addressed.
Management review	To ensure proper handling of major changes and determine the suitability and effectiveness of the company's quality system, this may be an annual exercise at ACPP.
Competence awareness and training	To ensure that employees are equipped with adequate knowledge to improve their skills, competence, and performance.
Process control maintenance	To ensure maintenance of company infrastructure, including vehicles and electrical equipment, to facilitate proper running of activities.
Machinery and equipment installation	To ensure that machinery or equipment are properly installed in required locations and all items introduced to the premises are recorded, installed, and removed from production sites.
Planning and realisation of quality products	To ensure that product and production requirements are well planned to meet customer needs.
Customer-related processes	To ensure that customer needs and expectations are met, satisfied and to necessitate planning in time.
Purchasing of materials, goods, and services	To ensure that goods bought match with company specifications, receiving of purchased materials and all is done in good time to prevent critical stock outs.
Maintenance and cleanliness of working environment	To ensure that the entire working environment and personnel are maintained in sound condition to avoid cross-contamination of products.
Identification and traceability	To ensure appropriate product identification and traceability of all products into and out of the ACPP facility.
Calibration control of monitoring and measuring equipment	To ensure that equipment used in monitoring and measuring processes and product quality are properly controlled and regularly calibrated.
Handling customer complaints	To ensure that external customer complaints are addressed in the most appropriate manner.
Measurement of processes	To ensure that measurement of processes is carried out to maintain conformance to requirements.

Measurement of products	To ensure that inspection and testing done on incoming items during production is conducted in a manner that enables production of quality products.
Control of non-conforming products	To ensure that non-conforming products are prevented from un-intended use.
Data analysis	To ensure that relevant data is collected and analysed to provide information that can be used to identify areas of improvement.
Continual improvement	To ensure continuous improvement of the quality system.
Corrective action	To ensure non-conformances are identified, their cause is investigated and worked on so that they do not recur.
Preventive action	To ensure that preventive action is carried out to facilitate for the proper running of equipment, services, and infrastructure.
Internal quality audits	To ensure that quality activities and related results comply with planned arrangements and to determine the effectiveness of the quality system.
Cleaning and sanitisation of equipment	To ensure effective cleaning of the equipment used in production processes.
Cleaning and sanitisation of production area	To ensure effective cleaning of production and its processes-related areas.
Product mixing/blending processes	To ensure effective blending of the product.
Handling and measuring of ingredients	To ensure effective handling and measuring of ingredients for product blending.
Monitoring of production process	To ensure effective monitoring of production process.
Inspection of non-food raw materials	To ensure only good quality raw materials are received.
Inspection of food raw materials	To ensure only good quality raw materials are received.
Inspection of finished goods/products	To ensure only conforming finished products are released to the market.
Handling, cleaning, use and storage of PPEs	To define and ensure proper handling, cleaning, use and storage of PPEs.

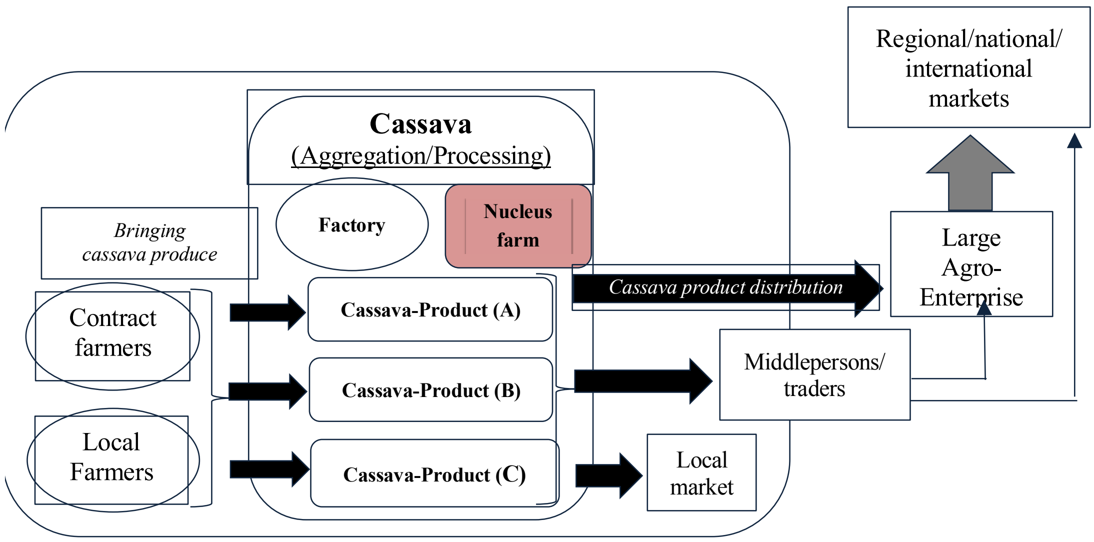
4.18 TQM RECOMMENDATIONS

It's strongly recommended that a quality management manual and forms including all operational SOPs be developed for the plant before production commences. The required training for the implementation application and use of the manual should be done to ensure that the factory starts with a compliant TQM system that can be certified by the UNBS and ISO.

4.19 THE NUCLEUS FARM MODEL

In this model, the cassava starch factory works as a market for many local farmers who supply raw materials (fresh cassava produce) as individuals or as groups and or cooperatives. However, the factory also establishes a nucleus farm on the side that produces a certain proportion of fresh cassava for processing as illustrated in the figure below. In addition to stabilising raw material supply to the starch factory due to fluctuations in seasons and prices, the nucleus farm also acts as a demonstration site for promotion of good agricultural practices (GAPs) for farmers in terms of cassava agronomy and contributes to transforming farmers from subsistent to market-oriented producers. Since, the average cassava yields for improved varieties are estimated at about 30MT/ha and the factory will operate at annual capacity of 0.2 million MT, a nucleus farm that produces 5% of that capacity needs to produce 10,000MT from 330ha. As a baseline, it would be proposed that the farm size considered is not below 300ha.

Proposed cassava factory aggregation/processing model (multiple products)



Source: Consultant's visualisation based on data and field observations

05 Environmental Analyses

This section presents the analysis of the factory in relation to the environment. This is analysed at three levels: location, production, and product utilisation within the environment.

5.1 PRELIMINARY IMPACTS ASSESSMENT

The overall impact of an activity of the project has been established based on a combination of considerations such as magnitude of its impact, duration, and permanency. These have been related on a continuous scale between extremes of "very large positive impacts" and "very large negative impacts". Such highly valued areas when affected by little impacts will have overall impact assessment of minimal/no impact or small negative impact depending on the specific characteristics as summarised in Table 48.

Table 48: Impact assessment scale

Scale	Narrative
++++	Very large positive
+++	Large positive
++	Medium positive
+	Small positive
0	Minimal/no impact
x	Small negative
xx	Medium negative
xxx	Large negative
xxxx	Very large negative

Table 49: Summary of Analysis of Impacts

#	Project Activities	Project Phase	Nature of Impact		Permanency of Impact		Magnitude of the Impact				Duration of Impact			Overall Impact	Mitigation Cost
			Direct	Indirect	Reversible	Irreversible	H	M	L	N	L	M	S		
ENVIRONMENTAL AND SOCIAL IMPACTS DUE TO LOCATION OF THE PROJECT SITE															
1	Displacement of people and loss of livelihoods	Construction & operation	Direct		Reversible			M				M		X	Relocation
2	Generation of large quantities of spoil	Construction	Direct		Reversible			M				M		X	Included in works contract
3	Increase in surface runoff	Construction	Direct		Reversible			M				M		X	Included in contract
4	Soil erosion	Construction	Direct		Reversible				L			M		X	
5	Noise pollution	Construction & operation	Direct		Reversible				L			M		X	Included in works contract
6	Disposal of construction waste	Construction & operation	Direct		Reversible			M				M		XX	Embedded in works contract
7	Road safety	Construction	Direct		Reversible					N			S	X	
8	Public health, human safety and environmental management	Construction	Direct		Reversible		H				L			XXX	To integrate management plan
9	Construction deviation	Construction	Direct		Reversible			L					S	X	Embedded in works contract
10	Disturbance to the public (noise, workers)	Construction	Direct		Reversible			M					S	XX	To advance mitigation plan
11	Uptake of land areas	Construction	Direct		Reversible			M				M		X	
12	Air quality issues from construction works.	Construction	Direct		Reversible				L			M		X	
13	Loss of aesthetic value	Construction	Direct		Reversible			M				M		X	
14	Health and safety concerns due to asbestos roofed buildings in the neighbourhood	Construction & operation	Direct		Reversible		H				L			XX	To be addressed by appropriate construction methods
ENVIRONMENTAL AND SOCIAL IMPACTS DUE TO DESIGN															
15	Increase in project running costs	Construction & operation	Direct		Reversible			M				M		X	

16	Inconsideration for safety and health of workers and occupants	Construction & operation	Direct		Reversible			M				M		X	
ENVIRONMENTAL AND SOCIAL IMPACTS DUE TO MOBILISATION OF PERSONNEL AND EQUIPMENT															
17	Traffic flow impairment	Construction & operation	Direct		Reversible			M				M		X	To be addressed by roads authorities
18	Waste management concerns especially solid and effluent in the camp site	Construction	Direct		Reversible			M			L			XXX	Embedded in works contract
19	Occupational safety and health concerns for the work force	Construction & operation		Indirect		Irreversible	H				L			XXX	To develop management plan
20	HIV/AIDS	Construction		Indirect		Irreversible		M			L			XXX	Education awareness
21	Gender mainstreaming			Indirect	Reversible				L				S	X	
22	Induced uncontrolled urban sprawl	Operational phase		Indirect	Reversible				L		L			X	
23	Hazardous waste during operation	Operation phase	Direct		Reversible		H				L			XXX	To develop appropriate disposal plan
ENVIRONMENTAL AND SOCIAL IMPACTS DUE TO DESTABILISATION OF EXISTING ACTIVITIES															
24	Disruption of public utility services		Direct		Reversible			M			L			X	
25	Air pollution		Direct			Irreversible			L		L			X	
26	Improper handling and disposal of solid wastes		Direct		Reversible			M			L			X	
27	Physical hazards and accidents		Direct		Reversible			M			L			X	
ENVIRONMENTAL AND SOCIAL IMPACTS DUE TO PROJECT CONSTRUCTION															
28	Loss of flora and fauna		Direct			Irreversible		M			L			X	
29	Destruction of archaeological resources		Direct					M					S	X	

30	Increase in volume of stormwater and soil erosion		Direct		Reversible			M			L			X	
31	Traffic flow impairment		Direct		Reversible		H				L			XXX	
32	Inadequate occupational safety and health for workers				Reversible		H				L			XXX	Training & awareness
33	Accidents and injury		Direct		Reversible		H				L			XXX	HSSE plan
34	Sourcing and transport of materials		Direct		Reversible			M					S	X	
35	Noise and vibration nuisance		Direct		Reversible			M					S	X	
36	Light nuisance		Direct		Reversible			M					S	X	
37	Air pollution		Direct			Irreversible		M			L			XXX	Management plan
38	Improper handling and disposal of solid wastes		Direct		Reversible										
39	Disruption of public utilities		Direct		Reversible										
40	Non-compliance with the recommendations in this report and/or NEMA certificate		Direct		Reversible			M			L			XXX	Site meetings and compliance
ENVIRONMENTAL AND SOCIAL IMPACTS DUE TO PROJECT OPERATION															
41	Illegal change of land-use		Direct		Reversible			M					S	X	
42	Increase in volume of traffic		Direct		Reversible			M					S	X	
43	Improper handling and disposal of solid wastes		Direct		Reversible			M			L			XXX	Disposal management plan
44	Improper occupational safety and health provisions		Direct		Reversible			M			L			XXX	Mitigation plans
45	Risk of fire		Direct		Reversible				M			S		X	

5.2 SUMMARY OF ANTICIPATED POSITIVE AND NEGATIVE ENVIRONMENTAL IMPACTS

5.2.1 Positive environmental impacts

The expected positive benefits include employment opportunities and household income, potential to stimulate development around the proposed factory location and the Acholi sub-region.

5.2.2 Negative impacts during construction

a. Noise and vibration impacts

Noise results from construction activities in general but particularly from operation of heavy machinery. Other operations generating significant noise include concrete mixing plants and excavation. Sustained noise levels during construction are expected to be much higher than the ambient noise level in the project area. Noise stemming from construction can be characterised by its suddenness, randomness, discontinuity, and high intensity. The contractor shall closely monitor sound sources resulting from the construction activities like material transportation, knocking, striking and shouting during the construction. The heavy plant equipment and noisy activities shall not be permitted during the night. Mitigation measures proposed will include:

- Protecting people's health from environmental risk and pollution through measures such as routine sprinkling of water on dust surfaces to suppress dust, providing workers with personal protective equipment (PPE) —masks, helmets, hand gloves, boots, and earmuffs, reflector jackets;
- Restricting construction to daytime hours to minimise disrupting sleep.
- Trucks carrying fine construction materials (sand, lime, gravel, and soils) that can easily be blown by wind should be covered with tarpaulins.
- All these concerns shall be addressed in the contractor's health and safety programmes which shall detail plans of managing noise, dust and safety in the workplace.

b. Soil erosion

The earthworks will expose land surface with the potential for erosion. Given the topology of the project site, this phenomenon can render the gullied landform at some sections worse. The runoff in turn could transport sand, silt and clay and deposit the transported material along the low-lying area interfering with the established drainage and sewerage systems leading to floods. The mitigation measures to reduce erosion and siltation shall include installation of appropriate drainage facilities.

c. Disruption of the local economy

The project will likely lead to loss of businesses and properties as well as temporary disruption of public utilities and their services which may eventually lead to the disruption of the local economy. The accompanying stress will result mainly from the loss of accommodation, landed assets, income and livelihood. There could also be loss of businesses leading to relocation and relocation disruption.

As a mitigation, current occupants will be given sufficient notice to relocate from the site.

d. Management of cut to spoil

The setting out of the project and its general civil works is anticipated to generate cut to spoil materials that will need to be disposed of. To mitigate cut to spoil concerns, the following mitigation measures are proposed:

- The cut to spoil materials should be stored and used in borrow pit restoration activities.
- No dumping of such materials should be encouraged in undesignated areas.

- The contractor will have to acquire dump sites where the cut to spoil materials will be deposited. No dumping of such material should be done in wetlands or other ecological sites; and it is important to note that no dumping of such materials should be done in ecological areas (wetlands/forests).

e. Social conflicts and crime issues

The increased influx of workers is likely to lead to conflict over housing, water sources and related social services. These could also lead to increased crime rate in the areas among other negative behaviours. The thefts could include property of the contractor thereby impacting on the progress of the project. This is likely to be a large negative impact of long-term nature. The following measures have been proposed:

- Where necessary and feasible, the local labour force from within the immediate communities should be recruited to minimise housing pressures as well as social conflicts.
- To recruit the local labour force, the contractor should work closely with local council leadership to identify suitable persons for employment.
- The contractor should establish a project labour force policy to address all matters relating recruitment and disciplinary measures of the workers.
- The contractor needs to work closely with the existing law enforcement agencies in the areas of the project (local councils and the police) to help address potential issues of crime.

f. Waste management

An estimated 100-200 workers will be recruited in this project. These people will generate human and associated waste such as polythene bags, water bottles. This is likely to be a large negative impact with potential far-reaching cumulative impacts considering that the project construction will take about 24 months.

Proposed mitigation measures will include:

- The contractor shall be required to have a clear plan to manage waste and ensure general cleanliness at the camp site and throughout the project generally.
- Camp site measures to recover and reuse some of the waste generated shall be instituted.
- Separate toilet facilities for males and females and these be clearly marked with standard signage.
- Routine cleaning of camp site and its associated facilities such as toilets and bath areas.
- The workers responsible for cleaning given areas like toilets should be provided with appropriate gear (hand gloves, gumboots).
- The contractor shall institute appropriate measures to dispose of hazardous waste which shall be regularly audited and improved according to findings.
- There should be clearly marked out containers for collecting used/waste oils and should be picked and disposed at regular intervals.
- There is need to acquire a dump site for the disposal of any excess excavated soils and associated wastes that are not likely to be re-used in the project.

g. HIV/AIDS concerns

During construction of the project, there will be increased influx of people to the area leading to changes in social dynamics and these may affect the HIV/AIDS prevalence. Some of the likely negative social behaviours include increased consumption of alcohol which could lead to promiscuity amongst the workers and the community and subsequent increase in the prevalence of sexually transmitted infections and HIV/AIDS. This represents a very large negative impact of permanent nature. Terms of reference on HIV/AIDS for service providers in Uganda shall be used to enrich the project.

h. Issues of people with disabilities of (PWDs)

The proposed project shall follow guidelines for mainstreaming concerns of PWDs and the elderly into its plans and activities.

i. Management of accidental spills and risks for fires

There is very strong potential for environmental damage from the accidental spillage of chemicals at construction sites. The contractor needs to develop plans to deal with such emergencies. Such plans should include guidelines and measures for reporting spills, training, resource allocation, and supervision of containment and restoration. This ESIA proposes some pertinent steps that could be put in place.

Mitigation measures include:

- Spills of flammable/combustible liquids should be immediately reported to the police 999 and the Fire Brigade. Emergency preparedness will include critical examination of each of the construction phases to identify potential hazards.
- Hazardous compounds should be stored on site in secured enclosures. Compounds used in the curing of concrete, lubricants, and fuel for small equipment will be present on site and kept tidy especially after work.
- There is need for an internal alerting system in case of spills. This is because timely and accurate reporting of accidental spills can help to ensure quick and efficient response. Alerting system/plan should include clear and detailed information regarding sources and location of such risks.
- The purpose of such a response plan should be to initiate an immediate response with trained personnel and equipment to clean up and ensure containment, disposal, and monitoring.
- Finally, the plan should contain a commitment for restoring the contaminated site to its state before the accidental spill.

5.2.3 Negative impacts during operation

a. Cassava waste

The most used part of the cassava plant is the tuber, which is primarily eaten and employed for industrial and commercial purposes and as feedstock for bioethanol production. Cassava stems and rhizomes are not typically used and thus end up as waste. By weight, the cassava stem and rhizome comprise 9% and 20% of the cassava plant respectively. Typically, 20% of cassava stem residue is collected for use as planting stock, 29% is employed as fertiliser, and nearly 10% is lost during harvest. As a result, almost 41% of total cassava stem production remains unused. Similarly, the rhizomes of the cassava plant are not employed for any practical purpose because their hard shells contain a high percentage of silica, making them difficult to break. Farmers normally dispose of cassava rhizomes by ploughing them into the soil (23%) or burning them in situ (66%).

b. Cassava processing (environmental pollution)

Studies conducted in other parts of the world show that cassava processing could affect the environment. Environmental pollution from cassava processors may be more difficult to deal with. Financial and technical resources are needed to deal with such environmental waste. When cassava peels are left to litter, ground fermenting can make the affected roads

impassable. This is not new to those living in the village but not good for the sales.
Cassava pulp (root cake) which remains after the extraction of starch from the ground root consists of fine particles and can be easily digested for biogas production.

Mitigation:

- Process dried peels to animal feed to reduce these cassava wastes.
- At the laboratory level, waste water from cassava will be treated.

c. Cassava processing effluent

Significant amounts of waste are generated during cassava processing. Cassava waste waters contain suspended solids about 15,000 mg/L and if not handled appropriately could contaminate nearby water sources. The release of waste products and contaminants into surface runoff get into rivers through drainage systems, leaching into groundwater, liquid spills, wastewater discharges, and littering. Soil contamination occurs when drains from cassava processing factory are released by spill or underground leakage. Cassava processing effluents have serious environmental impacts causing acidification due to the hydrolysis of cassava cyanogenic glucoside, linamarin and lotaustralin (methyl linamarin) producing hydrogen cyanide, which is also toxic to household animals, fisheries, and other organisms. This wastewater from cassava processing released directly into the environment before proper treatment causes pollution. It is sometimes discharged beyond the factory wall into roadside ditches or fields and allowed to flow freely. Eventually, this will percolate into the subsoil or flow into streams. This causes serious environmental pollution and a foul odour leading to contamination of surface and underground water and soil. Sometimes cassava roots are fermented in streams and ponds, upstream of drinking water points. The smaller the particle size, the greater the surface area per unit mass of particle, and so the greater the pollutant load that is likely to be carried. This organic matter that flows out of this grated mash during dewatering generally consists of carbohydrates and exists both in suspension and in solution. Effluent discharged from the distillation process, during ethanol production, commonly known as spent wash, stillage, distillery pot ale, distillery wastewater is the aqueous by-product from the distillation of ethanol following fermentation of carbohydrates. It is one of the most polluting effluents with high values of BOD and COD. For each litre of ethanol produced, up to 20 litres of stillage may be generated[1].

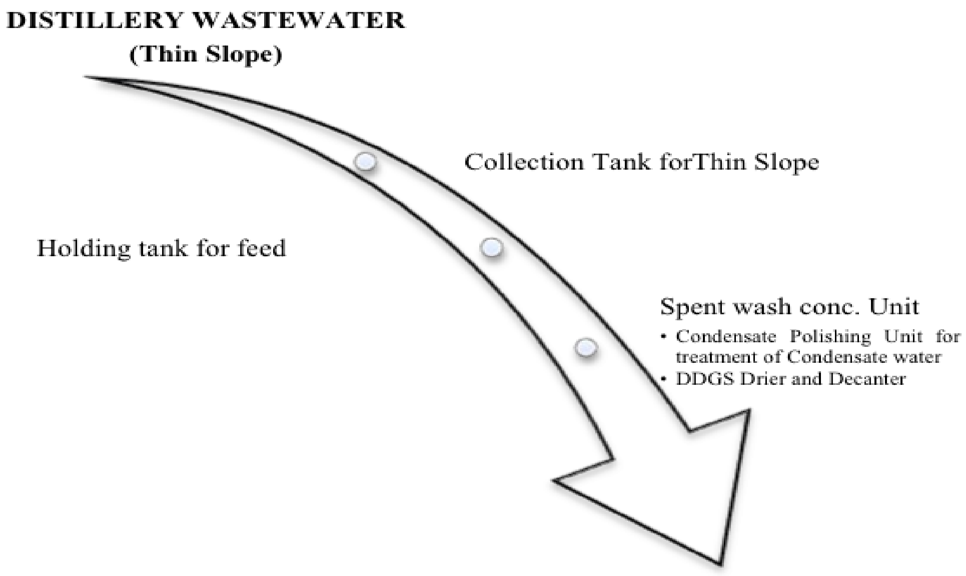
Mitigation:

- The water generated during evaporation may go to a condensate polishing unit for treatment to be reused. This water can go through several stages like filtration, sand filtration, reverse osmosis and then used as recycle water to achieve zero liquid discharge in ethanol production.

- Anaerobic treatment is the first treatment step for distillery wastewater. A significant portion of COD can be converted to biogas by anaerobic digestion and has a prospect of financial return from methane production.

1 Kuiper L, Ekmekci B, Hamelinck C, Hettinga W, Meyer S, Koop K (2007) Bio- Ethanol from Cassava, Ecofys Netherlands BV Project number: PBIONL062937, pp 11–18.

Figure 15:Flow diagram of waste management treatment



d. Wastewater

Pollution occurs when wastewater discharged from cassava processing is allowed to percolate into the subsoil or flow into streams or when cassava roots are fermented in streams and ponds, upstream of drinking water points. The smaller the particle size, the greater the surface area per unit mass of particle, and so the greater the pollutant load that is likely to be carried. Cassava effluent has a negative effect on plants, air, domestic animals, soil, and water. If cassava wastewater arising from processing ends up with domestic waste, or percolates into the soil, the result can be ill health or death due to contamination of drinking water. If the release of waste products and contaminants from the factory into surface runoff get into rivers through drainage systems, leaching into groundwater, liquid spills, and wastewater discharges, and littering, the result is a negative effect on the environment. Soil contamination in our case occurs when drains from cassava processing factory are released by spill or underground leakage.

e. Gaseous pollution

Carbon dioxide emission from fire and internal combustion engines is a problem. If the combustion from the proposed processing plant is not managed, the resultant fumes and gases in form of more carbon dioxide or other greenhouse gases are an environmental danger. The equipment noise and gases transferred to the atmosphere after combustion introduce contaminants into the environment. These contaminants cause instability, disorder, harm, and discomfort to the physical systems of living organisms. Common air pollutants produced by industry and heat engines include carbon monoxide, sulphur dioxide, chlorofluorocarbons (CFCs), and nitrogen oxides. Photochemical ozone and smog are created as nitrogen oxides and hydrocarbons react to sunlight. Adverse air quality can kill many organisms including humans. Ozone pollution can cause respiratory disease, cardiovascular disease, throat inflammation, chest pain, and congestion.

Proposed mitigation:

- Conduct a detailed combustion analysis of different fuel and technology scenarios with a view to minimise the effects.
- Invest in gases management infrastructure and systems in order to minimise the impact.

5.3 PROPOSALS FOR ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

A detailed environmental and social impact assessment should be conducted on the proposed site and proposed processes. In line NEMA Act, this will identify possible environmental conflicts in detail and suggest solutions and mitigative measures. Key considerations during the pre-construction phase of the project will be concerned with two aspects:

- Confirming that the appropriate environmental protection clauses have been included in the contract documents to allow control of actions by the contractor that are potentially damaging to the environment.
- Checking whether the project designs and specifications incorporate appropriate measures to minimise negative impacts and to enhance beneficial impacts.

5.3.1 Construction phase monitoring

To realise the desired environmental mitigation measures, the following should be monitored during the construction phase, namely:

- Review of the contractor's plans, method statements, temporary works designs, and arrangements relating to obtaining necessary approvals from the engineer so as to ensure that environmental protection measures specified in the contract documents are adopted, and that the contractor's proposals provide an acceptable level of impact control.

- Systematic observation on a day-to-day basis of all site activities and the contractor's offsite facilities as a check that the contract requirements relating to environmental matters are in fact being complied with and that no impacts foreseen and unforeseen are occurring.

5.3.2 Operation phase monitoring

During the operation phase, the environmental monitoring activities will focus on:

- Noise management plans and procedures will be instituted with periodic sound level monitoring.
- Categorising and disposal of hazardous factory waste shall be undertaken.
- Procedures for dealing with emergency environment issues.
- Periodic review of materials and methods unpalatable.

06 | Human Resources Operations Analysis

6.1 INTRODUCTION

Workforce is a valuable asset for an efficient outcome of any project. This is especially true in case of the proposed factory project. This section proposes the project staffing structure and other administrative and operational support needs for effective project implementation. The proposed project is complex and meeting completion schedules will be challenging given finances and technical skills availability. The project will base on management structures of similar undertakings as aligned with the needs of the Uganda Development Corporation (UDC) as the responsible entity for project realisation and execution.

6.2 PROJECT MANAGEMENT AND POLITICAL SUPPORT

The establishment of a coordination body for the institutional networking of the proposed project is essential for national and international market penetration and the achievement of the overall project goals. The overall operational oversight and administrative support for the operation of the cassava starch factory project will be provided by UDC in line with its mandate and functions. The UDC will establish a board of directors/ steering committee (BOD/SC), which will offer project conceptualisation, oversight and political support to the factory project management team (FPMT) which will be responsible for immediate day-to-day technical coordination and supervision of the project operations.

6.3 BOARD OF DIRECTORS / STEERING COMMITTEE

At the helm of the proposed project will be the board of directors or steering committee responsible for the strategic oversight and coordination. The board/ steering committee has a strategic, advisory and oversight role for the proposed project management, agro-processing, starch manufacturing, quality management, and marketing. The UDC will constitute a board / steering committee which shall provide policy guidance and oversee quality assurance, standards, training of staff, and research support.

6.4 COMPOSITION OF PROJECT BOARD / STEERING COMMITTEE

It is proposed that the steering committee be made up of a team of professionals responsible for each of the project thematic areas: cassava starch value chain, factory operations, marketing and promotion, project finance. Given the multitude of stakeholders, the steering committee is proposed to be constituted from the following institutions and groups:

- Uganda Development Corporation
- Ministry of Finance, Planning and Economic Development

- Ministry of Trade, Industry and Cooperatives
- National Planning Authority
- National Agricultural Research Organisation
- Gulu Catholic Archdiocese
- Uganda Manufacturers Association
- Private Sector Representative
- Member Starch Private Dealers

6.5 FACTORY MANAGEMENT TEAM

The UDC will oversee recruitment of technical and other senior staff for the proposed project. The factory project management team (FPMT) will be in charge of daily operations, staff capacity building, planning, monitoring of results, reporting, and coordination with other stakeholders.
The proposed functions of FPMT include:

(i) Monitoring, collection, and compilation of product usage data.
(ii) Design and implementation of sales drivers.
(iii) Scheduling and undertaking product promotion and marketing campaigns.
(iv) Instituting product stock management and distribution networks for market access.
(v) Enforcement of environmental and social impact mitigation measures
(vi) Coordination of private sector development initiatives.

a. General manager
The general manager shall be responsible for the day-to-day and operational management of the proposed project.

b. Departments/ units
The departments/units are mutually dependent, while keeping their autonomy and responsibility as far as technical and corporate services are concerned. The departments are as presented in the organogram.

6.6 ORGANISATION STRUCTURE AND ORGANOGRAM

This section presents the organisational model for the proposed project embodying involvement of the proposed board and factory management team in decision-making, according to their respective areas of responsibility. There are decisions to be made about the project's institutional arrangements which will be important for its performance and success, but which do not need to be made at feasibility study stage. The choice between integration and separation of functions and project autonomy will be made after determination of the project funding structure and wider consultation with key stakeholders. In an absolute sense and for the long term, UDC will decide the appropriate structure for each facility. The choice of facility structure is not likely to affect the feasibility of the project because it is possible to modify the organisation structure to suit the needs of the entity.

The proposed generic functional departments of the proposed factory will be designed in line with the typical assumptions for an agro primary processing and marketing entity. The structure and key functional offices proposed below are based on best practice in the agro-processing sector. The key operational management offices and departments are:

Table 50:Proposed functions for ACPP organisation structure

Function	Rationale
General Manager's Office	The office of the GM offers overall oversight of the facility and communication with all stakeholders.
Finance and Administration	This office oversees all financial management, procurement, human resource management, general administration, and legal aspects of the factory and is to be headed by manager, corporate services. Each of these key roles to be supervised by a dedicated head of section at assistant manager level. Legal services to be outsourced as and when required.
Production and Technical Services	All technical and production aspects of the plant are headed by the manager, production and technical services , supported by production supervisors and quality control officers with capacity to manage 3 shifts per day when necessary.
Marketing	Management of the marketing of the cassava products of the factory to the national and regional markets is headed by the manager marketing and sales, supported by a complement of senior marketing officers assigned products; and promotions and marketing and sales officers assigned market segments/ areas.

It can be anticipated that the first year of production at the ACCP facility will entail a single shift processing operation. However, the staff capacity will have to be scaled up when operational expertise and wider markets for the products are opened. Then the complement of the staff directly associated with production and processing shall be increased to match the demand. Production staff numbers will be substantially increase when a three-shift production cycle is adopted from year two onward. The proposed organisation and management plan of this core human resource team is illustrated in figure 17 and 18 below.

Figure 16: Proposed ACPP macro-structure

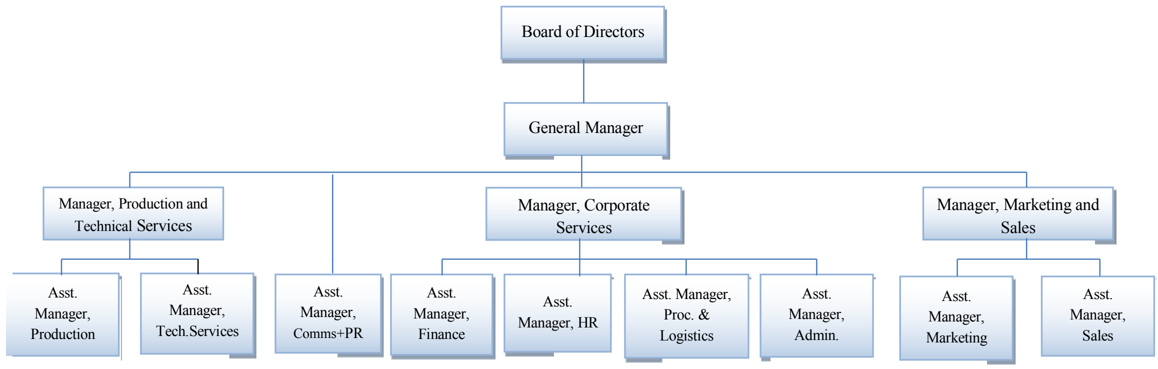
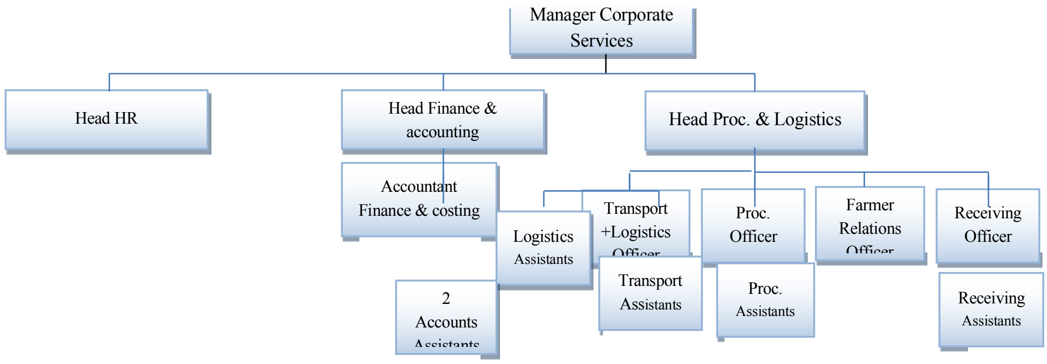


Figure 17: Proposed corporate services micro-structure



6.7 MANAGEMENT PLAN

The project is proposed to be implemented by the management team (Table 51). The team will be composed of the following:

Table 51: Proposed core organisation and management plan

Department	Position	Years				
		2021	2022	2023	2024	2025
		Yr1	Yr2	Yr3	Yr4	Yr5
General Manager's Office	General Manager	1	1	1	1	1
	PA to GM	1	1	1	1	1
	Internal Auditor	1	1	1	1	1
	Sub-total	**3**	**3**	**3**	**3**	**3**
Finance, IT and Procurement	Finance Manager	1	1	1	1	1
	Assistant Cashier	1	1	1	1	1
	Stores Officer	1	1	2	3	4
	Storekeeper	2	2	2	2	2
	IT Manager	1	1	1	1	1
	Procurement Manager	1	1	1	1	1
	Sub-total	**7**	**7**	**8**	**9**	**10**

Production and Engineering	Production and Plant Manager	1	1	1	1	1
	Ass. Production and Manufacturing Manager	1	1	1	1	1
	Engineering Manager	1	1	1	1	1
	Quality Assurance Manager	1	1	1	1	1
	Shift In-charge	2	2	4	4	4
	Packaging Operator	3	3	3	3	3
	Packaging Assistants	4	8	12	12	12
	Plant Operators	6	6	8	8	8
	Plant Helpers	6	8	10	12	14
	Quality Assurance Officer	2	2	2	2	2
	Lab Assistant	2	2	2	2	2
	Electrician	2	2	2	2	2
	Electrician Helpers	1	2	2	2	2
	Boiler Engineer	1	1	1	1	1
	Boiler Operator	3	3	3	3	3
	Storage In-charge	1	1	2	2	2
	Store Operator	3	3	3	3	3
	Weigh Bridge Operator	2	2	2	2	2
	Fitter/Welder	4	4	4	4	4
	Workshop Helpers	4	4	6	6	6
	Unskilled Workers	15	20	25	30	30
	Sub-total	**65**	**77**	**95**	**102**	**104**

HR and Admin	HR Manager	1	1	1	1	1
	HR/Admin Officer	1	1	1	1	1
	Public Relations Officer	1	1	1	1	1
	Drivers	5	5	5	5	5
	Cleaners Messengers Guards	5	10	10	10	10
	Sub-total	**13**	**18**	**18**	**18**	**18**
Marketing and Sales	Manager, Marketing and Sales	1	1	1	1	1
	Sales Officers	4	6	8	10	10
	Corporate and International Sales Officers	1	1	1	1	1
	Retail, Branding and Marketing Officers	2	2	2	2	2
	Sub-total	**9**	**11**	**13**	**15**	**15**
Total		**97**	**116**	**137**	**147**	**150**

6.7.1 Personnel recruitment and deployment

This section analyses the institutional arrangements proposed to enable attraction and engagement of a team with the required skills, experience, and motivation for the successful implementation of the project.

It is proposed that during inception and construction phases, the UDC will explore, allocate and deploy some of its existing personnel to specific project tasks especially in line with core project functions. Employee numbers are set to grow from 97 to 150 by year five.

6.7.2 Operation and management stage

In the project operation and management stage, UDC will ensure the availability of the necessary technical and financial resources needed for the operation of the factory. The roles of the UDC during this stage are to:

- Liaise, undertake and organise procedures for dealing with cassava farmers and households.
- Control and co-ordinate the quality and quantities of raw cassava available.
- Strengthen community engagement and risk management planning.
- Identify and address community and project challenges that affect cassava farming.
- Promote the usage of cassava starch and ethanol.
- Report all concerned activities.

It is proposed that the Governmental of Uganda will strengthen policies focusing on the substitution of starch imports and promotion of cassava starch use targeting increasing the export, distribution, and local production.

Farmer support: The project will seek to support cassava farming through the distribution of quality farm inputs and investment in storage and transport infrastructure to ensure output from farms accesses the factory.

Private sector promotion: Support to private sector development will take a multi-dimensional approach and should be limited in time i.e. a phase-out scenario should be elaborated at the start. Existing and potential industry participants will be encouraged to start and grow leading to the promotion of cassava starch use.

Potential partnerships: After the project period, the focus should be on strengthening partnerships. Without any doubt, it is anticipated that the project will receive support for publicity and marketing both from national and international organisations and local social development associations, farmer groups, and other household promotion agencies.

Quality assurance: The project will focus on production of quality products that meet international standards and the needs of the market. Standardisation and quality control will be of utmost importance for the project to realise massive market and long-term sustainability. Successfully implementing the above strategies will ensure project access and utilisation of cassava starch products in Uganda and beyond.

07 Project Legal and Institutional Context

This section sets out the legislative, regulatory, and policy context within which the proposed project must operate and comply. It also lists the relevant lead agencies and departments that will administer and monitor issues related to the proposed project.

7.1 POLICY FRAMEWORK

The policies relating to construction of the proposed cassava starch factory include:

1. **The Uganda Vision 2040 and national development plans**: Uganda's national development agenda as articulated in the Vision 2040 and the national development plan framework identifies the proposed cassava starch factory as a key project in agro-industrialisation. The Uganda Vision 2040 — whose goal is "A Transformed Ugandan Society from a Peasant to a Modern and Prosperous Country within 30 Years" — aims at transforming Uganda from a predominantly peasant and low-income country to a competitive upper middle-income country. The Vision 2040 guides strategic thinking and policymaking which are done through five-year national development plans (NDPs). Therefore, the proposed factory plays a key role in the achievement of Vision 2040 blueprint.

2. **Uganda Development Corporation Act, 2016:** The objective of the Uganda Development Corporation (UDC) is to promote and facilitate the industrial and economic development of Uganda. The corporation, therefore, has powers to:
    a. Establish subsidiary and associated companies.
    b. Enter into public private partnerships with any commercial, industrial or agricultural undertaking or enterprise.
    c. Through public private partnerships, assist in the financing and management of undertakings promoting industrial or economic development.

    The proposed project will acquire funding and support from UDC. In the performance of its functions, UDC follows the policy on industrial and economic development of the Government of Uganda.

3. **National Environment Management Policy, 1994:** The overall goal of the National Environment Management Policy is the promotion of sustainable economic and social development mindful of the needs of future generations. ESIA is one of the vital tools NEMA considers necessary to ensure environmental quality and resource productivity on long-term basis. The policy calls for integration of environmental concerns into development policies, plans and projects at national, district and local levels. Hence the

policy requires that projects or policies likely to have significant adverse ecological or social impacts undertake an ESIA before their implementation. This is also reaffirmed in the National Environmental Act (Cap 153) that makes ESIA a legal requirement for "Third Schedule" projects. Concepts under these instruments provide the premise under which the ESIA study will be conducted.

4. **National Land Use Policy, 2006:** The overall goal of the National Land Use Policy is: "To achieve sustainable and equitable socio-economic development through optimal land management and utilization in Uganda."

   The specific goals are:

   1) To adopt improved agriculture and other land use systems that will provide lasting benefits for Uganda.
   2) To reverse and alleviate adverse environmental effects at local, national, regional and global levels.
   3) To promote land use activities that ensure sustainable utilization and management of environmental, natural and cultural resources for national socio-economic development.
   4) To ensure planned, environmentally friendly, affordable and well-distributed human settlements for both rural and urban areas.
   4) To update and harmonize all land use related policies and laws, and strengthen institutional capacity at all levels of Government.

5. **National Land Policy, 2013:** This policy provides a framework for articulating the role of land in national development, land ownership, distribution, utilization, alienability, management and control in Uganda. The key issues addressed by the policy include: historical injustices and colonial legacies, which have resulted in multiple rights and interests over the same piece of land; dispossession and loss of ancestral land by some communities; border disputes arising out of tribal, ethnic groupings and trans-state border disputes; and the ineffective dispute resolution mechanisms, which have resulted into illegal evictions.

7.2 LEGAL FRAMEWORK

The legal framework relating to the construction, operation and management of the cassava starch factory includes:

- **i)** The Constitution of the Republic of Uganda, 1995.
- **ii)** Uganda Registration of Titles Entities
- **iii)** The Companies Act, 2012.
- **iv)** The Land Act (1998), Cap 227.
- **v)** The Registration of Titles Act (1964), Cap 230.
- **vi)** The Land Acquisition Act (1965), Cap 226.
- **vii)** The Survey Act, Cap 232.
- **viii)** The Building Societies Act, Cap 108.
- **ix)** The Physical Planning Act, 2010.
- **x)** The Occupational Safety and Health Act, 2006.
- **xi)** The National Environmental Act, Cap 153.
- **xii)** Building Control Act, 2013.

1. **Environmental Impact Assessment Regulations, 1998:** This document stipulates the procedures for conducting ESIAs and guidelines for ESIA practitioners and regulatory bodies. The regulations require a detailed study to be conducted to determine the

possible environmental impacts and measures to mitigate such impacts. The UDC has the legal obligation to undertake a comprehensive ESIA in accordance with the law and seek the views of the public, persons that may be affected by the proposed project, as well as all other stakeholders. In this case, key stakeholders will be consulted in the course of the ESIA study and their views integrated before the establishment of the proposed factory.

2. **The National Environment (Wetlands, River Banks and Lake Shores Management) Regulations, 2000:** This regulation, consisting of 4 parts, describes management policy and directions for important wetlands, riverbanks and lakeshore areas that exist in Uganda. Any development projects within those registered areas need ESIA studies and permission to be granted by NEMA in accordance with Regulation 34 of this law. Regulation 23(1) stipulates that a person who intends to carry out any of the following activities shall make an application to the executive director of NEMA if the developer intends to:
   - **i)** Use, erect, reconstruct, place, alter, extend, remove or demolish any structure or part of any structure in, under, or over the river banks or lake shore
   - **ii)** Excavate, drill, tunnel or otherwise disturb the river bank or lake shore.

   The executive director grants such permission based on and after submission of an ESIA report. The regulations provide principles for sustainable use and conservation of wetlands, riverbanks and lakeshores.

3. **National Environment (Waste Management) Regulations, 1999:** These regulations apply to all categories of hazardous and non-hazardous waste and to the storage and disposal of hazardous waste and its movement into and out of Uganda. The regulations promote cleaner production methods and require a facility to minimise waste generation by eliminating use of toxic raw materials, reducing toxic emissions and wastes, and recovering and reusing waste wherever possible.

4. **National Environment (Standards for Discharge of Effluent into Water or on Land) Regulations, 1999:** Section 6 (2) details maximum permissible limits for 54 regulated contaminants, which must not be exceeded before effluent is discharged into water or on land

5. **National Environment (Noise Standards and Control) Regulations, 2003:** Section 7 of these regulations requires that no person shall emit noise in excess of permissible levels unless permitted by a licence issued under these regulations. Section 8 imparts responsibility onto noise generators to use the best practicable means to ensure that noise does not exceed permissible levels.

6. **International agreements / Conventions ratified by Uganda:** Uganda has signed and / or ratified several international agreements and conventions relating to the environment both at regional and global level. Agreements or conventions of potential relevance to the proposed project include:
   - **i)** The Convention on Biological Diversity (CBD): The convention's main objective is to ensure the conservation of biological diversity and sustainable use of its components. The ESIA study process will investigate the project sites and come up with lists of biodiversity.
   - **ii)** The Conservation of Migratory Species of Wild Animals (CMS): The convention is aimed at conserving species of wild animals that migrate across or outside

national boundaries. None of the species belonging to this category will be affected by the proposed project or any of its activities.

iii) The Convention on Wetlands of International Importance (Ramsar Convention). Uganda, which joined the convention in 1988, now has 11 Ramsar sites covering a surface area of 354,803 hectares. The Ramsar sites in Uganda include Lake Bisina Wetland System, Lake Mburo-Nakivali Wetland System, Lake Nakuwa Wetland System, Lake Opeta Wetland System, Lutembe Bay Wetland System, Mabamba Bay Wetland System, Murchison Falls-Albert Delta Wetland System, Nabajjuzi Wetland System and Sango Bay-Musambwa Island-Kagera Wetland System (SAMUKA). None of the 11Ramsar sites will be directly affected by the planned project activities.

iv) Uganda ratified the African Convention on the Conservation of Nature and Natural Resources (1968), and also signed the Protocol Agreement on the Conservation of Common Natural Resources (1982).

UDC will take into consideration the relevant provisions contained in these agreements and/or conventions during the ESIA study and at all stages of project implementation.

7.3 INSTITUTIONAL FRAMEWORK

This section reviews the roles of various institutions that may have involvement in the proposed cassava starch factory project. These institutions include:

1. **The proposed project company:** The factory will be run as a legal entity established under the laws of Uganda, promoted by the Uganda Development Corporation, and with ability to own property, sue and be sued. The proposed company should be incorporated under the Companies Act, 2012. The types and number of shares shall be agreed by the key stakeholders and the formation process undertaken in compliance with the relevant requirements.

2. **Uganda Development Corporation:** The project will be executed by UDC which is to undertake procurement of consultancy services and materials suppliers, recruitment of civil works labour force, and provision of funding for the project. The UDC will also supervise the contractors during the project implementation to ensure provision of quality construction, equipment, and related infrastructure for the operationalisation of a state-of-the-art cassava starch factory. As the project proponent, UDC will also fulfil all environmental requirements for every aspect of the project that could bear socio-environmental impact.

3. **National Environment Management Authority**: NEMA is under Ministry of Water and Environment and has a cross-sectoral mandate to review and approve ESIAs. According to the Third Schedule of the National Environmental Act Cap 153, construction of houses and associated pieces of infrastructure fall under projects that require mandatory ESIA to be conducted before they are implemented. Furthermore, NEMA, as the principal agency in Uganda on matters of environment management, is empowered by the law to manage, coordinate, and supervise all activities in the field of environment. The actual implementation of ESIA is however the responsibility of the lead agencies, the private sector, and the public. NEMA is responsible for undertaking enforcement, compliance, review and monitoring of the ESIA. In that regard, NEMA facilitates the public participation for the environmental decision-making, and exercises general supervision for all environmental issues. Therefore, NEMAs role in this project will be to

review and approve the Environment and Social Impact Assessment (ESIA) report. It will also undertake environmental monitoring during project implementation.

4. **Pader District Local Government:** Given that the proposed site is located in Pader, this project will work with the district to comply with local planning and development programmes and ensure local partnerships and buy-in. The district operates under a five-tier system of local government. The highest level is the Local Council Five (LCV) headed by a district chairman, followed by the LCIV, LCIII, LCII, and LCI all headed by the respective local council chairpersons. This hierarchy is the political wing of the district administrations, while the chief administrative officer (CAO) heads the technical wing inclusive of the district engineer. The CAO heads all civil servants in the district and is therefore the chief executive officer. Within the district, the Resident District Commissioner (RDC) represents the central government. The sub-counties are headed by sub-county chiefs, who co-ordinate all the district and central government development programmes at that level. Parish chiefs head the lowest administrative units, namely the parishes.

5. **Local environmental committees:** The proposed project will work closely with the committees during the planning, construction and implementation phase of the project. Committee members are appointed at the local government level on the advice of the district environment committee and they examine the environmental matters including environmental and social considerations for any development projects. Specific roles and functions of this local environmental committee are introduced in Section 16 Part III of National Environmental Act (Cap. 153) of 1995.

6. **Ministry of Finance, Planning and Economic Development:** The ministry ensures mobilisation of public resources for the government. It is further charged with overseeing how these resources are accounted for as they target to benefit all Ugandans. The ministry is also concerned with matters of achieving the fastest rate of economic transformation in the country. It targets to formulate sound economic policies that lead to sustainable economic growth and development. MoFPED's role in the proposed project will be to help in the mobilisation of funds for the project and overseeing how the funds will be used.

08 Project Financial Analysis

8.1 INTRODUCTION

This section evaluates the financial feasibility of the proposed cassava starch factory project of the Government of Uganda. It presents the sources of project funding, projected revenues, projected expenses, cash flow and financial feasibility analysis, debt service and financial conclusions. The financial benefits shall be in form of sales revenue out of operations both domestic and foreign sales. The financial feasibility analysis is based on the project development technical analysis and implementation plan consistent with industry practices for similar starch manufacturing entities.

This section describes the model for evaluating the financial feasibility of the starch manufacturing project as presented in the Microsoft Excel Workbook model attached. The model is based on some assumptions regarding the investment as shall be outlined. The variability of future events is considered and addressed in the project risk analysis section. For purposes of this study, project costs, budgets and business plans have been combined to set out a financial model based on prevailing market conditions and augmented with assumptions and economic parameters. Project construction is expected to be complete within two years with the other project investment components like plant set-up, training and commissioning spread over the next one year.

In a typical year, total revenue and costs are captured together with the resultant operational results based on industry and consultant experience. The financial model and its underlying assumptions were subjected to critical evaluation. The assessment has been guided by the development of assumptions and have been subjected to further detailed examination using cost benefit analysis (CBA) approach. The analysis is conducted based on market prices, discounting net benefits over a specific time horizon and testing financial viability indicators for sensitivities to key parameters. The key components driving activity and the financial model in form of revenues, costs, assumptions and parameters are examined in section 8.2 below.

8.2 FINANCIAL ASSUMPTIONS

The financial aspects of the project, activities and risk depend on its operating and management model which is expected to run as a government corporation with the key assumptions and parameters for analysis as follows:

8.2.1 Project Life

The appraisal considers the financial costs and benefits over the project operational period. Based on experience from similar projects, the estimated lifetime of the proposed starch and ethanol factory building is expected to top 50 years while the factory plant and technical installations are expected to last 20 years. This time period has been used for the appraisal although a factory of the project magnitude is expected to be in use for much longer than this. Hence the appraisal covers the period 2022/23 from commencement to 2072/73. However, for project modelling, a period of 30 years has been used to match with the existing Government of Uganda long term vision plans.

Although the physical building assets may last significantly longer, our forecast will not cover the entire period. Instead, a residual value will be added at the end of the appraisal period to reflect their potential resale value or continuing use value. The number of revenue-generating years was a proxy for the life of the project and could be input as any value between 30 and 50. If the opening year is set at 2022 and the number of revenue-generating years was set at 30, the life of the project was assumed to be from 2022 to 2052 (after which major capital investment would be required to continue operation). The revenue stream across those years was then used to calculate financial output. Financial inflow is expected to be generated from starch and related products and by-products like ethanol, carbon dioxide and animal feeds. Financial costs: construction costs, vehicles, factory production line, equipment and furniture costs, personnel, reagents, out-sourced services necessary to run the structure. For technical analysis, the project is divided into three stages as shown in Figure 18.

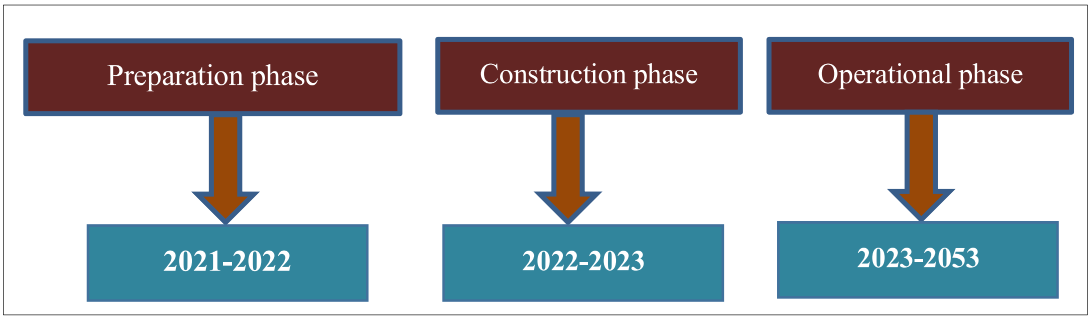


Figure 18: Project phases

8.2.2 Project finance options

As with all projects of a similar magnitude, there are two possible funding options: the traditional public sector (TPS) procurement contract and the public private partnership (PPP) procurement. The financial modelling for the proposed project was performed for the considered alternative and was based on an independent financial inspection of the present cassava starch market, risk, technical analysis, and analysis of comparable interventions.

8.3 PROJECT COSTS

a. Land and building costs

Capital costs associated with the construction of facilities include project development costs, construction costs, statutory consents (planning permission and building regulations, etc.), fixtures, fittings, and equipment (IT and digital, instruments, furniture, etc.), professional fees, and costs of project management. Contingency allowance of 5% has been added to the construction costs and project management costs respectively. Professional fees also include contingencies. Other costs include engineering supervision and cost of contractor. These costs have been determined based on consultant experience and engineering and technical study, existing technical information, and industry benchmarks.

b. Plant and machinery

These are costs associated with procurement/acquisition, transportation, layout, installation, set-up, testing, training, commissioning and handover. The plant and machinery include cassava starch processing plant, syrup making plant, and starch drying equipment. In addition, the factory will acquire forklifts, trucks, spares and parts (for details refer to technical analysis section). Plant and equipment cost include all the capital needed to ready a plant for start-up. The cost of equipment was attained by direct quoting from manufacturers. The main items of capital cost or fixed investment include the following:

- Direct project expenses include equipment f.o.b. cost, material required for installation, and labour to install that equipment and material.
- Indirect project expenses include freight, insurance, and taxes, construction overhead and contractor engineering expenses.
- Contingency and fee includes contractor fee and overall contingency.
- Auxiliary facilities include site development, auxiliary buildings and off sites and utilities.

c. Operating costs

The appraisal considers the working capital costs associated with running the factory. These have been estimated using a detailed financial model developed during the study. The operating costs have been estimated for a steady state operating year as well as the years pre- and post-opening. A detailed financial model was developed based on existing cost base and industry benchmarks and is attached. These costs are assumed to remain the same in real terms across the appraisal period. Operational costs of production are obtained from the calculation of the raw materials cost, utilities cost, labour costs and insurance as well as marketing costs and overhead costs. These costs are calculated during the year when the factory operates. They comprise raw materials and logistics expenditure; direct expenditure, including direct labour expenditure; office inventory; transport; indirect salaries expenditure; and marketing, administration and overheads.

d. Raw cassava costs

A large number of cassava raw materials will be required to manufacture the diverse range of products included in the proposed product line. Cassava exists in many varieties in the Acholi sub-region. The costs of raw materials will depend on the season but it is expected that with the factory established, stable prices will guarantee increased cassava farming and the result will be a stable cost of raw materials.

Other packaging materials cost

The basic costs of packaging materials are shown in Table ***52*** below.

Table 52: Packaging material costs

	Product	Proposed commercial packaging	Unit cost of packaging (UGX)
1.	High quality cassava flour	Bulk 50kg bags	1,000
2.	Alcohol - RS (Rectified Spirit)	Bulk special customer tanks or 60L drums	35,000
3.	TA- (Technical Alcohol)	Bulk special customer tanks or 60L drums	35,000
4.	Carbon dioxide	-Cylinders 27kgs and bulk tank 17ton mobile tank. -Solid blocks 5kg (fish and beverage cooling)	Returnable cylinders (100,000 per cylinder)
5.	Distillers Dry Grain (DDGS)	100kg bags	1,000
6.	Fusel oils (corn oils if maize is used)	(Market to be developed)	

8.3.1 Working capital

Initial working capital requirement has been worked out with the approach that marketing efforts will be required to penetrate the export markets. The biggest component of working capital includes the cost of raw cassava, which must be procured to ensure consistent production operations. The raw material requirement for working capital calculations has been assumed for two months. Tetra Pak paper and other packaging materials constitute the other raw material cost. A two-month basis has been used to calculate the cost of packaging materials for working capital calculations.

A similar approach has been adopted for other processing costs. Two-month operating costs of chemicals have been included in the working capital. For utility and human resource costs, a time period of two months has also been considered. An allocation of 2% of the machinery cost has been made for spare parts. Upfront insurance payment has also been included in the working capital. Insurance cost has been calculated at 5% of machinery and 3% of vehicles cost. A higher insurance rate has been used to provide for comprehensive insurance for Tetra Pak machines and processing lines have been used in the project. Initial working capital requirements have been calculated for 55% capacity utilisation as per the assumed capacity utilisation schedule. An initial cash balance of UGX500 million has been included in the working capital.

8.3.2 Funding required

The total funding required is UGX44,298,866,458. It is proposed that the Government of Uganda provides the amount needed for immediate start-up. Also, the government can get a loan to finance the project. This government-sponsored loan is typically a cheaper source of money. However, the extent to which this source of funds can be leveraged for a particular project depends on the government balance sheet and availability of willing lenders. However, an equity arrangement can also be explored.

8.3.3 Loan maturity and interest rate

If loan financing is the desired option, the maturity of the loan is based on the assumed project lifespan and previous government funding practice for related projects. The loan duration is estimated to be 27 years with a five (5) year grace period. While the building construction is assumed to have a lifespan of about 50 years, it is not expected that the financing partners will fund such a long duration. Therefore, it is assumed that the maturity of the loan will be 27 years.

Loan interest rates are expected to match the rate of return required by the source of funding. It is anticipated that the government will access funds at 3% on top of the LIBOR rate (London Interbank Offered Rate) for US$.

8.3.4 Tax rates

We have assumed that the project company is an income taxpayer. According to the Income Tax Act, Cap. 340, in force in Uganda, the rate of the income tax is 30%. Tax losses can be used evenly over a period of four years following the year when the loss was made. Investment costs do not include VAT. Because of the nature of its business, the project should be eligible for VAT exemption.

8.3.5 Capacity utilisation

The project's revenue will be obtained by selling the products to the distributors and users. It has been assumed that 80% share of the total production will be sold in the local market. At 100% capacity, operating 312 days a year and basing on 400 ton per day capacity of which 25% starch can be generated, the plant can produce 31,200 ton of starch per year. However, the plants do not run at the same capacities round the year and for all years. Seasonality was incorporated in the capacity projections.

An important market parameter in estimating production is the difference in demand of the local and export markets. National imports and balance of trade data has also been used in the estimation of demand. This difference in local and export demand must be incorporated while taking production decisions and calculating the project's revenues. Proposed products serve different purposes and thus have different markets. To accommodate this factor, the production of starch and ethanol has been considered as the basis and the other products have been linked to it. To incorporate the seasonality factor, it has been assumed that the plant will run at full capacity for six months — March, April, July August September October and November —with the remaining period being below capacity (Table 53). It will be 80% in the two months of November and December, whereas during the remaining four months of May, June, January and February, the machines will operate at 60% of their theoretical capacities. Capacity utilization and number of operational days during different months of the year is shown in the assumptions table below.

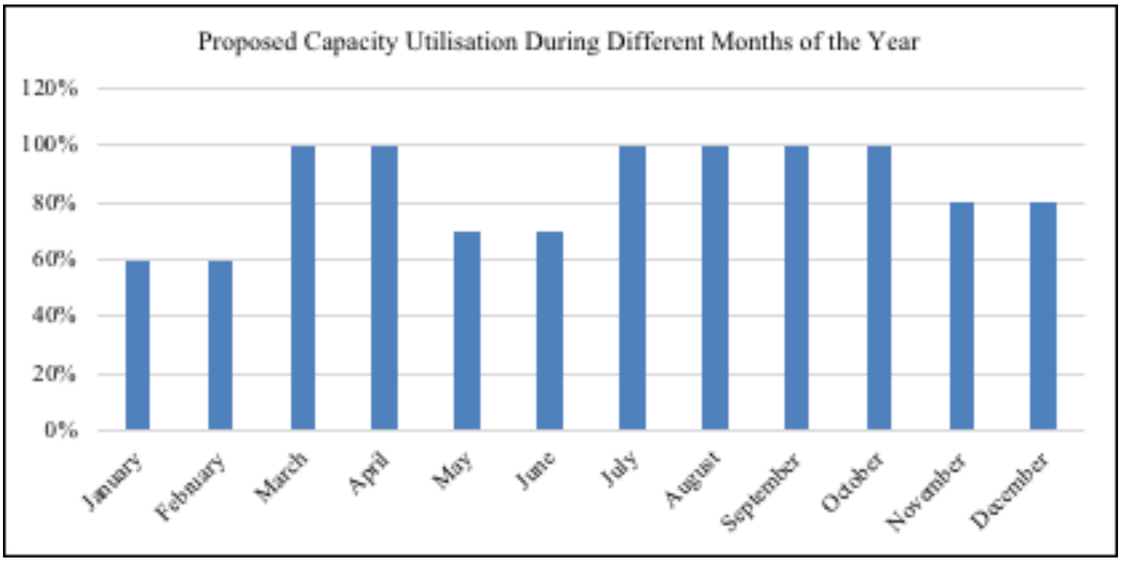


Figure 19:Proposed production capacity utilization

Table 53:Proposed capacity plan during the year

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Percent operational	60%	60%	100%	100%	70%	70%	100%	100%	100%	100%	80%	80%	85%
Total days	31	28	31	30	31	30	31	31	30	31		31	365
Days operational	12.4	11.2	31	30	12.4	12	31	31	30	31	18	18.6	312

However, the plant will not start running at full capacity from the first year. It is assumed that during the first year, the plant will attain 55% of the planned capacity utilization that will increase by 5% in each of the following years stabilizing at 95% starting in year nine of operation. A conservative approach has been adopted in assuming capacity utilization. Table 54 shows the proposed schedule.

Table 54: Proposed schedule

Year	Yr1	Yr2	Yr3	Yr4	Yr5	Yr6	Yr7	Yr8	Yr9	Yr10	Yr11	Yr12
Percent operational	55%	60%	65%	70%	75%	80%	85%	90%	95%	95%	95%	95%

8.3.6 Chemicals and lab cost

Chemicals are required both for process and for laboratory tests. Major use of chemicals during the process is for CIP of the plant once in every 24 hours. Caustic soda and nitric acid are the two main chemicals required for this purpose. Average consumption of caustic soda has been estimated to be 10kg per day for the machines. Total consumption during the first processing season (at 70% capacity utilization) will be 3,120kg which translates into a total cost of UGX31,200,000 at a rate of UGX1,000 per kg. Average consumption of nitric acid is 6kg per day. Total consumption of this chemical during the first year will be 1,872kg. At a rate of UGX1,500 per kg, total cost of nitric acid comes out at UGX 28,080,000.

The other use of chemicals is for conducting tests in the quality assurance laboratory. An annual cost of UGX50,000,000 has been assumed for those chemicals.

The other input for carrying out laboratory work is the consumable apparatus. It is assumed that all the apparatus will be consumed during a year and new apparatus will be procured each year. Thus the apparatus cost of UGX25,000,000 has been included as the operating cost; growing at 5% per annum. Detailed chemicals and lab cost calculations are shown in excel model. On this basis, the total cost of chemicals and lab for the first year of the plant's operation at 55% capacity utilization was worked out to be UGX80 million.

8.3.7 Pre-operating expenses

Pre-operating expenses are the costs incurred before the start of the routine operations. These include the costs of utility connections, machinery installation, registrations/licenses, salaries of the personnel that have to be hired before the start of plant operations, necessary administrative expenses like travel, office management, etc. Total pre-operating expenses for the proposed business were calculated to be UGX135 million. Summary costs of different heads of pre-operating costs are provided in Table 55.

Table 55:Summary costs of different heads of pre-operating costs

Pre-Operating Expenses			**Estimated Cost**
Government Fees			50,000,000
Transportation			15,000,000
Marketing			20,000,000
Training			50,000,000
Total Cost			**135,000,000**

Brief description of the categories included under pre-operating costs is as follows:

- Registration and licences cost includes the costs paid to different government departments for registration of the business. Consultancies for the civil construction, at the rate of 5% of the total civil construction cost, are also included under this head. Associated operational expenses are also covered under this cost.
- Utility connections and installations include the cost of electrical connection and installation cost of water tube well.
- Erection and commissioning cost has been considered as 1% of the total machinery cost.
- The human resource cost includes the salaries of the persons who will have to be hired before the start of the operations. These include general manager, plant manager, finance & accounts manager, engineering manager, admin officer, procurement officer, fitters/welders, driver, office boy, sweeper and security guards. It has been assumed that these persons will be hired three months before the start of plant operations.
- The admin expenses under the pre-operations costs include travelling and office expenses for three months.
- Marketing expenses is the largest head of pre-operating costs. Since the project will be selling its products to users, it will require advertisement and promotion at the start of the project to create awareness and promote its brand. The marketing head includes the costs of outdoor marketing, TV commercials, cost of promotional materials, and website development.

Detailed calculations of pre-operating costs are shown in the excel model.

8.3.8 Electricity cost

Electricity cost has been calculated based on overall electricity connection of 500 KVA as per the capacity utilization assumptions during each year. UMEME industrial supply tariff has been applied to calculate the electricity bill. Total electricity load of the sections of the plant and the number of kilowatt hours are provided below.

Table 56: Estimated electricity costs

Section	Load KW	Hours/Day	KWH/Day
Processing	170	20	3400
Packing	90	20	1800
utility	60	20	1200
Cold Store	150	8	1200
Total	**470**	**68**	**7600**

Annual increase in electricity costs is estimated at 6%.

8.3.9 Depreciation

Straight line depreciation method has been applied to calculate the associated costs. Different rates applied to different types of assets are shown in Table 57. Depreciation and amortization calculations are shown in in the Ms Excel model.

Table 57:Estimated asset depreciation costs

Asset	Depreciation Rate
Land	0%
Building and Civil Works	5%
Packing Machine	10%
Processing Plant	10%
Utility Machinery	10%
Cold Store Machinery	10%
Laboratory	10%
Office Equipment & Furniture	10%
Vehicles	10%

8.3.10 Human resource costs

The project will require human resource in all important functions. Staff will be placed at the location of the processing facility. Overall management will be carried out by the general manager who will manage the business operations through his procurement, production, quality assurance, marketing, administration, finance & accounts and engineering teams. Qualified personnel will be engaged to operate the plant; whereas semiskilled labour will be engaged in processing and packaging activities. Total HR needs of the proposed business has been calculated to be 95 persons.

The project's HR cost for the first year of operations is calculated to be UGX1.97 billion. Consolidated human resource cost and split between direct (operations) and indirect (non-operations) staff is as presented below.

Table 58: Projected cassava factory staff numbers

Projected Staff Numbers						
Job Title	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**
Indirect Employees						
General Manager	1	1	1	1	1	1
Finance Manager	1	1	1	1	1	1
Accountants	5	5	5	5	5	5
Sales and Marketing Manager	1	1	1	1	1	1
Sales and Marketing Staff	7	7	7	7	7	7
Human Resource Manager	1	1	1	1	1	1
Human Resource Officer	1	1	1	1	1	1
IT Manager	1	1	1	1	1	1
Internal Audit	2	2	2	2	2	2
Procurement and Disposal Manager	1	1	1	1	1	1
Procurement & Disposal Officer	1	1	1	1	1	1
Drivers	6	6	6	6	6	6
Administrative Support Staff	2	2	2	2	2	2
Direct Employees						
Production Manager	2	2	2	2	2	2
Engineer	1	1	1	1	1	1
Quality Assurance Manager	1	1	1	1	1	1
Plant Operators	40	40	40	40	40	40
Packaging Officer	1	1	1	1	1	1
Packaging Assistants	5	5	5	5	5	5
Quality Officer	4	4	4	4	4	4
Lab Officer	2	2	2	2	2	2
Electrician	3	3	3	3	3	3
Boiler Engineer	1	1	1	1	1	1
Boiler Operator	3	3	3	3	3	3
Weigh Bridge operator	2	2	2	2	2	2
Wielder	2	2	2	2	2	2
Group Workers	10	10	10	10	10	10
Forklift Operators	2	2	2	2	2	2

The projected staffing costs are as follows:

Table 59: Projected cassava factory staff costs

Projected Salaries and Wages									
Job Title	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**
Indirect Employees									
General Manager	75,600,000	72,000,000	72,000,000	72,000,000	72,000,000	72,000,000	72,000,000	72,000,000	72,000,000
Finance Manager	50,400,000	50,400,000	50,400,000	50,400,000	50,400,000	50,400,000	50,400,000	50,400,000	50,400,000
Accountants	126,000,000	126,000,000	126,000,000	126,000,000	126,000,000	126,000,000	126,000,000	126,000,000	126,000,000
Sales and Marketing Manager	50,400,000	50,400,000	50,400,000	50,400,000	50,400,000	50,400,000	50,400,000	50,400,000	50,400,000
Sales and Marketing Staff	176,400,000	176,400,000	176,400,000	176,400,000	176,400,000	176,400,000	176,400,000	176,400,000	176,400,000
Human Resource Manager	50,400,000	50,400,000	50,400,000	50,400,000	50,400,000	50,400,000	50,400,000	50,400,000	50,400,000
Human Resource Officer	25,200,000	25,200,000	25,200,000	25,200,000	25,200,000	25,200,000	25,200,000	25,200,000	25,200,000
IT Manager	50,400,000	50,400,000	50,400,000	50,400,000	50,400,000	50,400,000	50,400,000	50,400,000	50,400,000
Internal Audit	100,800,000	100,800,000	100,800,000	100,800,000	100,800,000	100,800,000	100,800,000	100,800,000	100,800,000
Procurement and Disposal Manager	25,200,000	25,200,000	25,200,000	25,200,000	25,200,000	25,200,000	25,200,000	25,200,000	25,200,000
Procurement & Disposal Officer	25,200,000	25,200,000	25,200,000	25,200,000	25,200,000	25,200,000	25,200,000	25,200,000	25,200,000
Drivers	75,600,000	75,600,000	75,600,000	75,600,000	75,600,000	75,600,000	75,600,000	75,600,000	75,600,000
Administrative Support Staff	15,120,000	15,120,000	15,120,000	15,120,000	15,120,000	15,120,000	15,120,000	15,120,000	15,120,000
Total Indirect Salaries	**846,720,000**	**727,200,000**	**727,200,000**	**727,200,000**	**727,200,000**	**727,200,000**	**727,200,000**	**727,200,000**	**727,200,000**
Direct Employees									
Production Manager	120,000,000	120,000,000	120,000,000	120,000,000	120,000,000	120,000,000	120,000,000	120,000,000	120,000,000
Engineer	48,000,000	48,000,000	48,000,000	48,000,000	48,000,000	48,000,000	48,000,000	48,000,000	48,000,000
Quality Assurance Manager	48,000,000	48,000,000	48,000,000	48,000,000	48,000,000	48,000,000	48,000,000	48,000,000	48,000,000
Plant Operators	480,000,000	480,000,000	480,000,000	480,000,000	480,000,000	480,000,000	480,000,000	480,000,000	480,000,000
Packaging Officer	24,000,000	24,000,000	24,000,000	24,000,000	24,000,000	24,000,000	24,000,000	24,000,000	24,000,000
Packaging Assistants	42,000,000	42,000,000	42,000,000	42,000,000	42,000,000	42,000,000	42,000,000	42,000,000	42,000,000
Quality Officer	96,000,000	96,000,000	96,000,000	96,000,000	96,000,000	96,000,000	96,000,000	96,000,000	96,000,000
Lab Officer	48,000,000	48,000,000	48,000,000	48,000,000	48,000,000	48,000,000	48,000,000	48,000,000	48,000,000
Electrician	36,000,000	36,000,000	36,000,000	36,000,000	36,000,000	36,000,000	36,000,000	36,000,000	36,000,000
Boiler Engineer	24,000,000	24,000,000	24,000,000	24,000,000	24,000,000	24,000,000	24,000,000	24,000,000	24,000,000
Boiler Operator	36,000,000	36,000,000	36,000,000	36,000,000	36,000,000	36,000,000	36,000,000	36,000,000	36,000,000
Weigh Bridge operator	24,000,000	24,000,000	24,000,000	24,000,000	24,000,000	24,000,000	24,000,000	24,000,000	24,000,000
Wielder	16,800,000	16,800,000	16,800,000	16,800,000	16,800,000	16,800,000	16,800,000	16,800,000	16,800,000
Group Workers	60,000,000	60,000,000	60,000,000	60,000,000	60,000,000	60,000,000	60,000,000	60,000,000	60,000,000
Forklift Operators	24,000,000	24,000,000	24,000,000	24,000,000	24,000,000	24,000,000	24,000,000	24,000,000	24,000,000
Total Direct Salaries	**1,126,800,000**	**1,126,800,000**	**1,126,800,000**	**1,126,800,000**	**1,126,800,000**	**1,126,800,000**	**1,126,800,000**	**1,126,800,000**	**1,126,800,000**
TOTAL SALARIES AND WAGE	**1,973,520,000**	**1,854,000,000**	**1,854,000,000**	**1,854,000,000**	**1,854,000,000**	**1,854,000,000**	**1,854,000,000**	**1,854,000,000**	**1,854,000,000**

8.4 PRODUCT MIX

Starch and ethanol constitute a larger share of the total market compared to other products. Therefore, starch and ethanol production will run throughout the year at the proposed capacities while other products will be produced during the main harvest seasons. The total available machine capacity will be used for making different products. The product mix has been fixed in line with the current market demand for different products. The biggest share of production time has been allocated to starch, followed by ethanol, then carbon dioxide, Distillers Dry Grain (DDGS) and Technical Alcohol.

8.4.1 The distance to the raw materials location

Acholi is one of the sub-regions where the cassava productivity has increased significantly. In addition, its location directly bordered by other districts that can provide ease in accessing the resources of raw materials in some locations. The average distance from the location of industrial establishments towards the raw materials location is approximately 200km or the equivalent of approximately 6 hours road trip.

8.4.2 The distance to the market location

Kampala is the main marketing location for the resulting products. In addition to functioning as the capital city of Uganda, this location also has a function as a centre of trade and industry. The distance to be travelled from the factory to the market area that exists in Kampala is approximately 450 km or about 8-hour road trip.

8.4.3 Availability of workforce

Labour needs can be obtained from the community around the factory. Labour in Acholi can be obtained from the population aged 18 years and above. Statistically, those aged above 18 years are 38% of the total population, according to UBOS.

8.4.5 Prices

The study has been conducted with the assumption that the proposed products will be sold in both local and export markets. Product prices on the local market have been fixed based on the current market prices of similar products. Since the proposed factory will launch a new brand in the market, it will be important to set its prices lower than the prices of the existing brands to create a market pull. At the same time, it will also be important to give incentives to distributors and product users to make them push the new brand towards the market. This means offering higher margins to trade compared to the ones being offered on imports. In line with this, the sale prices of the products have been fixed with the following assumptions:

- The consumer retail prices will be 10% lower than the prices of similar products of the market leaders. For example, the retail price of starch by the market leader is UGX 2,500 per kg. In line with the assumption, the proposed price by the factory is estimated at UGX2,000. As a marketing 'pull' strategy, these lower prices will be an attractive incentive for the consumers to ensure the trial of the newly launched products.
- The second assumption is that the project will offer 11 - 12% margin to the distributors as added incentive to sell the proposed products. This margin is higher than the average margins offered by the industry.

Based on the above assumptions, the proposed prices for products are as follows:

Table 60: Product prices

Product	Existing Price	Proposed Distributor Price	Proposed Consumer Price
High quality cassava flour	2,500	1,800	1,980
Alcohol - RS (Rectified Spirit)	4,250	3,500	3,850
TA- (Technical Alcohol)	2,250	2,000	2,200
Carbon dioxide	1000	900	990
Distillers Dry Grain (DDGS)	600	500	550

8.4.6 Export-local sale distribution

The sales of different products have to be seen in terms of the available market. The prices of the starch and other products in the export market have been assumed to be the same as those in the local market. Product mix for the export market has been assumed to be the same as that for the local market.

8.4.7 Operating revenues

Based on the above production, and sale prices, the project will generate revenues of UGX2.224 billion during first year of operations, while operating at 55% capacity utilization. Summary of revenue calculations are presented in Table 61.

8.4.8 Sales price growth rate

Annual sale price growth rate of cassava starch has been considered as 5% in both local and export markets.

8.5 PROPOSED PROJECT FINANCIAL PERFORMANCE

While the building project lifespan is expected to be over 50 years and the production plant and equipment life is expected to top 20 years, this analysis considered a timeframe of 20 years to align with the country's Vision 2040 planning period. Financial statements were generated using performance benchmark and based on the assumptions highlighted in 8.2 above with the resultant indicative results below:

8.5.1 Projected profit and loss statements

Based on current projections, the project will generate positive results due to increased efficiency from better utilisation of resources.

Table 61: Projected income statements

Projected Income Statements						
Description	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**
Operating Revenues						
High quality cassava flour	9,900,000,000	11,700,000,000	14,400,000,000	16,200,000,000	18,000,000,000	18,000,000,000
Alcohol - RS (Rectified Spirit)	10,920,000,000	11,466,000,000	12,039,300,000	12,641,265,000	13,273,328,250	13,936,994,663
TA- (Technical Alcohol)	312,000,000	327,600,000	343,980,000	361,179,000	379,237,950	398,199,848
Carbon dioxide	702,000,000	737,100,000	773,955,000	812,652,750	853,285,388	895,949,657
Distillers Dry Grain (DDGS)	390,000,000	409,500,000	429,975,000	451,473,750	474,047,438	497,749,809
Total Revenue	**22,224,000,000**	**24,640,200,000**	**27,987,210,000**	**30,466,570,500**	**32,979,899,025**	**33,728,893,976**
Direct Costs						
Raw Cassava	400,000,000	400,000,000	400,000,000	400,000,000	400,000,000	400,000,000
Packaging	30,900,519	32,754,550	34,719,823	36,803,012	39,011,193	41,351,864
Chemicals & Lab	80,928,000	85,036,644	89,354,486	93,892,214	98,661,063	103,672,846
Electricity	45,600,000	49,248,000	53,187,840	57,442,867	62,038,297	67,001,360
Water	22,224,000	24,640,200	27,987,210	30,466,571	32,979,899	33,728,894
Maintenance	67,812,782	68,490,910	69,175,819	69,867,577	70,566,253	71,271,916
Direct Labour	1,126,800,000	1,126,800,000	1,126,800,000	1,126,800,000	1,126,800,000	1,126,800,000
Reagents	4,000,000	4,000,000	4,000,000	4,000,000	4,000,000	4,000,000
Total Direct Costs	**1,778,265,301**	**1,790,970,304**	**1,805,225,178**	**1,819,272,241**	**1,834,056,704**	**1,847,826,880**
Gross Operating Profit	**20,445,734,699**	**22,849,229,696**	**26,181,984,822**	**28,647,298,259**	**31,145,842,321**	**31,881,067,096**
Operating Costs						
Payroll Administration	846,720,000	727,200,000	727,200,000	727,200,000	727,200,000	727,200,000
Fixed Electricity	198,000,000	234,000,000	288,000,000	324,000,000	360,000,000	360,000,000
Marketing Expenses	297,000,000	351,000,000	432,000,000	486,000,000	540,000,000	540,000,000
Depreciation	550,872,495	550,872,495	550,872,495	550,872,495	550,872,495	550,872,495
Marketing Expenses	666,720,000	739,206,000	839,616,300	913,997,115	989,396,971	1,011,866,819
Office Maintenance	444,480,000	492,804,000	559,744,200	609,331,410	659,597,981	674,577,880
Licensing Fees	50,000,000					
Insurance	333,360,000					
Vehicle fuel & maintenance	222,240,000	246,402,000	279,872,100	304,665,705	329,798,990	337,288,940
Total Operating Costs	**3,609,392,495**	**3,341,484,495**	**3,677,305,095**	**3,916,066,725**	**4,156,866,437**	**4,201,806,134**
Earnings Before Interest and tax	**16,836,342,204**	**19,507,745,201**	**22,504,679,727**	**24,731,231,534**	**26,988,975,884**	**27,679,260,962**
Interest	-	-	-	-	-	1,008,947,202
Earnings before tax	**16,836,342,204**	**19,507,745,201**	**22,504,679,727**	**24,731,231,534**	**26,988,975,884**	**26,670,313,761**
Tax	5,050,902,661	5,852,323,560	6,751,403,918	7,419,369,460	8,096,692,765	8,001,094,128
Net Income	**11,785,439,543**	**13,655,421,641**	**15,753,275,809**	**17,311,862,074**	**18,892,283,119**	**18,669,219,633**
Balance brought forward		5,892,719,771	9,774,070,706	12,763,673,258	15,037,767,666	16,965,025,392
Total Profit available for appropriation	11,785,439,543	19,548,141,412	25,527,346,515	30,075,535,332	33,930,050,785	35,634,245,025
Dividend	5,892,719,771	9,774,070,706	12,763,673,258	15,037,767,666	16,965,025,392	17,817,122,513
Balance carried forward	**5,892,719,771**	**9,774,070,706**	**12,763,673,258**	**15,037,767,666**	**16,965,025,392**	**17,817,122,513**

The chart below shows an average growth in revenue of about 3% per annum which is higher than the growth in operational costs (2.6%). This assumption also means that the EBIDTA margin increases with time.

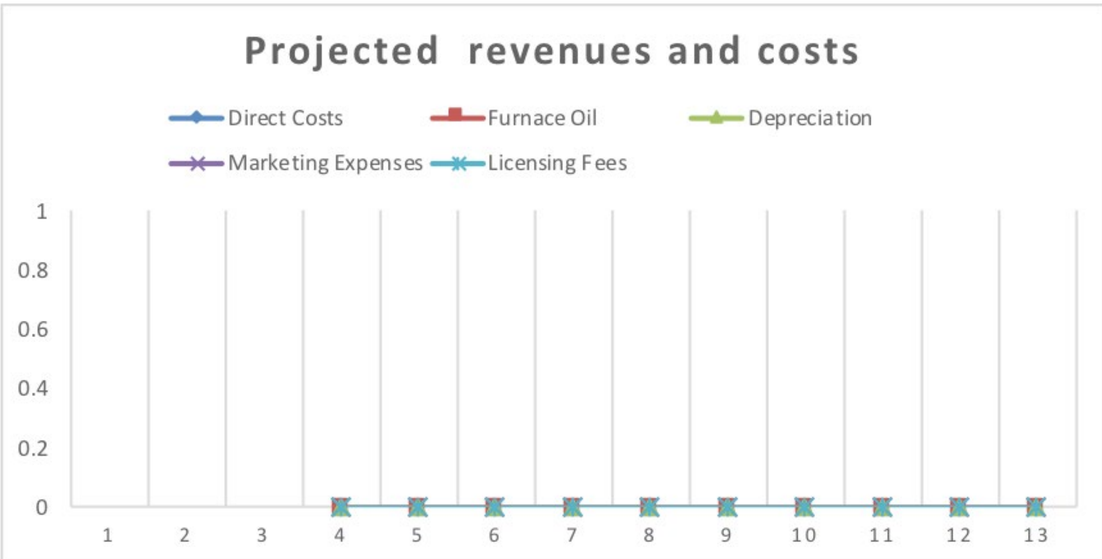


Figure 20:Abridged profit and loss statements

It is clear from the charts of revenues and costs above that revenues will continue to grow and exceed operating costs. Operational costs are made up for the greatest part by wages and salaries both direct and indirect and depreciation costs. Direct costs of revenue constitute c. 50% of the revenue (but their share is reducing). An average growth of revenues in the years 2022 – 2040 is 3.1%.

8.5.2 Proposed project abridged balance sheet

Table 62: Projected balance sheet

Projected Balance Sheet						
ASSETS						
	Year 0	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Current Assets						
Cash		15,556,800,000	20,581,740,000	23,287,077,000	25,524,680,850	31,567,462,913
Accounts Receivable		6,667,200,000	7,392,060,000	8,396,163,000	9,139,971,150	9,893,969,708
Spare Parts Inventory						
Total Current Assets	**-**	**22,224,000,000**	**27,973,800,000**	**31,683,240,000**	**34,664,652,000**	**41,461,432,620**
Fixed Assets						
Land	2,000,000,000	2,000,000,000	2,000,000,000	2,000,000,000	2,000,000,000	2,000,000,000
Building and Civil Works	10,392,475,327	10,184,625,821	9,976,776,314	9,768,926,808	9,561,077,301	9,353,227,795
Starch Plant	15,306,508,764	13,775,857,888	12,245,207,011	10,714,556,135	9,183,905,258	7,653,254,382
Ethanol Plant	14,866,856,064	13,380,170,458	11,893,484,851	10,406,799,245	8,920,113,638	7,433,428,032
Office Equipment and Furniture	262,004,500	209,603,600	157,202,700	104,801,800	1,150,842,486	262,004,500
Vehicles	1,900,000,000	1,710,000,000	1,520,000,000	1,330,000,000	1,140,000,000	950,000,000
Net Fixed Assets	**44,727,844,655**	**41,260,257,766**	**37,792,670,877**	**34,325,083,987**	**31,955,938,684**	**27,651,914,709**
Other Assets						
Contigencies						
Total Other Assets	**-**	**-**	**-**	**-**	**-**	**-**
TOTAL ASSETS	**44,727,844,655**	**63,484,257,766**	**65,766,470,877**	**66,008,323,987**	**66,620,590,684**	**69,113,347,329**
LIABILITIES						
	Year 0	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Liabilities						
Accounts Payable		5,000,400,000	5,544,045,000	6,297,122,250	6,854,978,363	7,420,477,281
Short term loan						
Other Current Liabilities		7,863,293,339	5,720,510,515	2,219,683,824		
Total Current Liabilities	**-**	**12,863,693,339**	**11,264,555,515**	**8,516,806,074**	**6,854,978,363**	**7,420,477,281**
Long Term Liabilities						
Long Term Debt	33,906,391,130	33,906,391,130	33,906,391,130	33,906,391,130	33,906,391,130	33,906,391,130
Long Term Liabilities	**33,906,391,130**	**33,906,391,130**	**33,906,391,130**	**33,906,391,130**	**33,906,391,130**	**33,906,391,130**
Equity						
Paid up Capital	10,821,453,525	10,821,453,525	10,821,453,525	10,821,453,525	10,821,453,525	10,821,453,525
Retained Earnings		5,892,719,771	9,774,070,706	12,763,673,258	15,037,767,666	16,965,025,392
Total Equity	**10,821,453,525**	**16,714,173,296**	**20,595,524,231**	**23,585,126,783**	**25,859,221,191**	**27,786,478,917**
TOTAL LIABILITIES AND EQUITY	**44,727,844,655**	**63,484,257,766**	**65,766,470,877**	**66,008,323,987**	**66,620,590,684**	**69,113,347,328**

8.5.3 Financial sustainability analysis

Financial sustainability is the analysis of the projected operating revenues and costs and the sources of finance. Accordingly, a project is financially sustainable when it does not incur the risk of running out of cash in the future given the timing of cash proceeds and payments. As seen from the table above, the project is financially sustainable. The Table 62 above indicates positive cash flows for the years of operation of the project implying that the expected cash inflows will meet the expected cash out flows.

8.5.6 Analysis of financial return on investment

As described in previous sections, the study used a financial model to process information on revenue, cost, and interest rate assumptions to produce a set of financial outputs. This output is important to understanding the relative financial feasibility of various funding options, and the overall financial reality of investment. The following sections outline the key results of this analysis for each funding option.

8.5.7 Payback period

The period taken for the project to recoup the UGX 37,742,459,509 initial investment given the estimated cashflows is 5 years 11 months. Using discounted net cashflows to utilise risk-adjusted information in the Payback period computation results in a period of 9 years 7 months. This project gives a good return period compared with similar investments in the manufacturing and agriculture sectors.

8.5.8 Net present value

The principal indicator applied is the financial net present value (FNPV). The FNPV is derived by subtracting the sum of the present value (PV) of a cash flow of costs from the sum of the PV of a cash flow of revenues. The difference between discounted revenues and discounted costs gives the FNPV. For a project to be considered financially viable, the FNPV must have a positive value as this indicates that the overall benefits outweigh the overall costs of the project over time. Additional viability indicator provided is the financial Internal Rate of Return (FIRR). The IRR is the discount rate at which present values of both benefits and costs are equal. Projects should have FIRR greater than the discount rate to be considered viable.

The NPV of cash outflows shows the projected cashflow surplus associated with a project. If this value is greater than zero, it indicates that the projected revenue stream in form of projected cashflows exceeds the amortized capital cost for the project, and that there is a present value net financial benefit to the public sector associated with its implementation.

The project NPV over the evaluation period is given as UGX3,701,425,379. This implies that the total cash inflows expected from the project adjusted using the rate of return of 11.4%, which is the expected interest rate on borrowing, exceed the initial investment outlay. The cash flows beyond the evaluation period will make the investment even a much better prospect as seen in table 63 below.

8.5.9 Internal rate of return

The internal rate of return (IRR) is the rate of return that equate projected cash inflows to cash outflows. The project IRR is compared to the required profitability to decide its viability. The IRR of the project is 12.3%.

Table 63: Abridged project financial sustainability statement for 10 years

FINANCIAL SUSTAINABILITY											
Description	YEAR										
	1	2	3	4	5	6	7	8	9	10	11
Total Financial Resources	44,298,866,458	-	-	-	-	-	-	-	-	-	-
Revenue	22,224,000,000	24,640,200,000	27,987,210,000	30,466,570,500	32,979,899,025	33,728,893,976	34,515,338,675	35,341,105,609	36,208,160,889	37,118,568,934	38,074,497,380
Residual Value											
Total In flows	66,522,866,458	24,640,200,000	27,987,210,000	30,466,570,500	32,979,899,025	33,728,893,976	34,515,338,675	35,341,105,609	36,208,160,889	37,118,568,934	38,074,497,380
Total Costs	11,726,614,826	11,209,298,531	11,995,525,535	12,591,514,148	13,197,563,975	13,414,601,311	13,642,780,603	13,882,686,001	14,134,745,199	14,399,773,821	13,576,708,639
Total Investment Costs	44,298,866,458	-	-	-	-	-	-	-	-	-	-
Interest	-	-	-	-	-	1,318,194,472	1,274,459,669	1,229,402,982	1,182,984,456	1,135,162,931	1,085,895,999
Loan Reimbusement	-	-	-	-	-	1,446,974,452	1,490,709,255	1,535,765,943	1,582,184,468	1,630,005,994	1,679,272,925
Taxes											
Total Outflows	56,025,481,284	11,209,298,531	11,995,525,535	12,591,514,148	13,197,563,975	16,179,770,236	16,407,949,527	16,647,854,926	16,899,914,123	17,164,942,745	16,341,877,563
Total Cashflow	10,497,385,174	13,430,901,469	15,991,684,465	17,875,056,352	19,782,335,050	17,549,123,741	18,107,389,148	18,693,250,683	19,308,246,766	19,953,626,188	21,732,619,818
Cumulated Total CashFlows	10,497,385,174	23,928,286,643	39,919,971,108	57,795,027,460	77,577,362,510	95,126,486,250	############	############	############	############	192,921,618,853
	CALCULATION OF FINANCIAL RATE OF RETURN										
	YEARS										
Description	0	1	2	3	4	5	6	7	8	9	10
Revenue	-	22,224,000,000	24,640,200,000	27,987,210,000	30,466,570,500	32,979,899,025	33,728,893,976	34,515,338,675	35,341,105,609	36,208,160,889	37,118,568,934
Total Operating Cost	11,726,614,826	11,209,298,531	11,995,525,535	12,591,514,148	13,197,563,975	13,414,601,311	13,642,780,603	13,882,686,001	14,134,745,199	14,399,773,821	13,576,708,639
Total Investment Cost	44,298,866,458	11,726,614,826	11,209,298,531	11,995,525,535	12,591,514,148	13,197,563,975	13,414,601,311	13,642,780,603	13,882,686,001	14,134,745,199	14,399,773,821
Total Expenditure	-	22,935,913,357	23,204,824,066	24,587,039,683	25,789,078,123	26,612,165,287	27,057,381,915	27,525,466,604	28,017,431,201	28,534,519,020	27,976,482,460
Net Cash Flow	-	(711,913,357)	1,435,375,934	3,400,170,317	4,677,492,377	6,367,733,738	6,671,512,062	6,989,872,071	7,323,674,408	7,673,641,869	9,142,086,474
Financial Net Present Value	3,701,425,379										
Financial Internal Rate of Return	15.40%										

09 Economic and Distribution Analysis

9.1 INTRODUCTION

This section provides a detailed overview of the main costs and benefits associated with each of the selected options. This analysis appraises the project contribution to the economic welfare of the country. Cost-benefit analysis (CBA) is used in determining the attractiveness of a proposed investment in terms of the welfare of society as a whole. By presenting social benefits and costs in a monetary format, CBA not only facilitates choices between alternative investment options but also gives an idea of the project worth. Economic analysis differs from financial appraisal which views an investment solely from the perspective of individual participants, focusing on private benefits and costs and using market prices. In contrast, economic analysis adopts a much broader approach, considering both monetary and non-monetary benefits and costs, and uses prices that more accurately reflect economic, environmental and social values because not all costs and benefits fall on the immediate group of individual participants; some may have wider impacts (externalities), not all costs and benefits have market prices, and not all market prices reflect the true costs and benefits to society.

In this study, economic analysis was based on analysing streams of costs and benefits over the project life, discounted at interest rate of 11.4 %. It is based on the economic indices of internal rate of return (IRR), net present value (NPV) and economic net present value. While the cost-benefit analysis is based on quantifiable economic benefits, the non-quantifiable benefits are significant, and an integral part of the overall economic case.

The economic analysis uses appropriate conversion factors for each of the inflow or outflow items as given by the MoFPED to incorporate benefits and social costs not considered by the financial analysis. It transforms market prices used in the financial analysis into accounting prices and considers externalities leading to benefits and social costs like environmental impacts or redistributive effects left out by financial analysis as they do not generate actual money expenditures or income. This becomes possible by attribution to each of the inflow or outflow items of an ad-hoc conversion factor to change market prices into accounting prices.

The figures used in this section are based on those used elsewhere in this study (e.g. for financial modelling) but have been adjusted for the purposes of the economic analysis. For example, the economic analysis focuses on impact on Acholi sub-region, and makes adjustments to the base figures to ensure consistency with other assumptions used in the study. Accordingly, there are differences between some figures used in this section and elsewhere in the feasibility study.

9.2 BASIS FOR ECONOMIC BENEFIT PROJECTION

While the cost-benefit analysis is based on quantifiable economic benefits, the non-quantifiable benefits are significant, and an integral part of the overall economic case. Following the arrays of costs and benefits calculated from the proposed investment, it is assumed that all products sold are paid for. Economic parity prices paid have been calculated. Both costs and benefits have been converted as appropriate to their corresponding economic values using appropriate national conversion factors. The economic internal rate of return (EIRR) was estimated over the project life. The outcomes are as follows:

a. **Micro level:** This investment project builds on Uganda's strengths and achievements in the agriculture industry. It further seeks to build on the success of cassava farming in Acholi. The project will be a major stimulus in the post-Covid era economic recovery whose reach is expected to be boosted by population demand and the potential for industrial use of the associated products and by-products. At the micro level, the investment will lead to an increase in cassava farming together with the associated increases in employment, income, food security, and well-being. The proposed project facilities will enable people living in the catchment to diversify income.

b. **Macro level:** Agriculture plays a leading role in Uganda. In a broader context, the ambitions of Uganda's agriculture sector are to increase farm output, boost farm gate prices, improve farmer incomes, increase value addition through agro-processing, tap export markets and increase foreign exchange. Macro level impacts will manifest themselves through export promotion and import substitution impacts on economic growth. In Uganda, agriculture growth serves as an "engine" of overall economic growth and changes will be key drivers behind improved earnings and foreign exchange in the economy.

9.3 ECONOMIC COSTS

The economic appraisal considers the following costs:

a. Capital costs associated with project construction.
b. Furniture, fixtures and equipment costs including IT and digital costs.
c. Raw material costs.
d. Operating costs for the factory.
e. Additional opportunity costs associated with the use of land for the proposed project.

1. **Capital costs:** Construction costs were estimated by the study engineering and technical team and have been based on prevailing economic conditions and extensive benchmarking. The key elements are:
    a. Project development costs
    b. Construction costs
    c. Statutory consents (planning permission approvals and building regulations)
    d. Fixtures, fittings, and equipment including digital and IT costs
    e. Professional fees
    f. Cost of project management
    g. Appropriate contingency allowance for construction and project management.

2. **Operating costs:** The appraisal considers the revenue costs associated with running the factory. These have been estimated using a detailed financial model developed during the study. The operating costs have been estimated for a steady state operating

year as well as the years pre- and post-commissioning. These costs are assumed to remain the same in real terms across the appraisal period thus no change in relative costs compared to the rest of the economy is assumed. Full details on the financial model are contained in the MS Excel model attached separately. It comprises the following elements:

a. Direct expenditure, including direct labour and indirect salaries.
b. Building-related expenditure which includes rates, insurance, clearing, security, utilities, repairs and maintenance, and minor works.
c. Technology and IT equipment.
d. Administration, marketing and overheads.

3. **Additional opportunity costs:** The economic appraisal also estimates any additional economic opportunity costs of the options which are not reflected in financial costs. These refer to potential value of the capital receipt and wider economic benefits foregone by UDC and the government as a result of using funds on the project. The main relevant opportunity cost here relates to the alternative use of the land on which the facility would sit. Where the site is owned by UDC, the same will in principle make a capital contribution to the project. In so doing, UDC will be effectively incurring a financial opportunity cost equal to the value of the land. The value of the land has been estimated in consultation with the stakeholders, using the property values and trends around the proposed site. The opportunity cost is based on the difference between the benefits economic that the economy would be able to achieve with the current economic use of the site compared to the most valuable alternative use.

9.4 BENEFITS ACCRUING TO KEY STAKEHOLDERS

When determining the desirability of an industry, there should be an evaluation of employment impacts, pressure on other industries, the impact on the households, environmental impacts, local government and other economic impacts. Employment impacts are how a new factory would influence local employment and the types of jobs it would generate. It is important to consider if the jobs generated by a new industry would be desirable to community members. Potentially negative pressure on other industries should be examined. There is a need to evaluate if a new industry would cause decline in industries already established. The impact on the household income is how a new industry might affect farmers, either causing the prices to increase or decrease, impact on their disposable incomes, health and standard of living. It is also important to evaluate if a new industry would cause negative environmental impacts in a community. The effect on government services and revenues is also an important consideration. A new industry could put pressure on locally provided public services. A growing population due to a new industry could force local governments to finance new infrastructure like roads and schools. Careful evaluation of all of the aspects of desirability is needed to determine if the positive results of a new industry outweigh any potential problems or issues it could cause. Considering these aspects will help determine if the industry would be an overall asset to the community.

The proposed cassava factory investment will provide opportunities in the cassava value chain. It will also provide important benefits to a range of stakeholder groups.

9.4.1 Cassava farmers and cooperatives

The project will offer market for cassava. The infusion of household incomes from the income and profits earned from the facility also were considered in the analysis. The number of households benefiting by selling cassava produce to the factory will grow by 3,833 in the first 10 years of operation. The acreage dedicated to cassava farming will grow to 15,180 acres.

Table 64: Project demographics

PROPOSED CASSAVA STARCH FACTORY PROJECT											
KEY PROJECT DEMOGRAPHIC OUTPUTS											
Indicator	Conversi	Years									
		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Demographics											
Facility Utilisation		55%	65%	80%	90%	100%	100%	100%	100%	100%	100%
Number of Families		3813	3817	3824	3829	3833	3833	3833	3833	3833	3833
Persons directly benefiting		20,971	20,996	21,033	21,058	21,083	21,083	21,083	21,083	21,083	21,083
Number of Acres Planted		15,099	15,117	15,144	15,162	15,180	15,180	15,180	15,180	15,180	15,180
Number of farm jobs		4,530	4,535	4,543	4,549	4,554	4,554	4,554	4,554	4,554	4,554

9.4.2 Employment

Between 100 and 200 jobs will be created at the factory plant including skilled positions and casual labourers. Total salaries will be in the region of UGX1.97 billion per year. Indirect workers will be required for farming estimated at 1 person per acre earning UGX60,000 during planting, UGX35,000 during weeding, and UGX35,000 during harvesting.

9.5 PROJECT BENEFITS AND ECONOMIC EVALUATION

9.5.1 Introduction

Economic analysis is carried out by calculating economic internal rate of return (EIRR) of the project based on the economic project costs and economic benefits.

9.5.2 Economic net present value

The ENPV of cash outflows shows the projected cashflow surplus associated with economic cashflows from a project. If this value is greater than zero, it indicates that the quantified economic benefits stream in form of projected economic cashflows exceeds the amortized economic cost for the project, and that there is a present value net benefit associated with implementation of the project.

The project ENPV over the evaluation period is given as UGX207,589,733,246. This implies that the total cash inflows expected from the project adjusted using the rate of return of 11.4%, which is the expected interest rate on borrowing, exceed the initial investment outlay. The cash flows beyond the evaluation period will make the investment even a much better prospect.

9.5.3 Economic internal rate of return

The economic rate of return (ERR) is the rate of return that equates projected benefits in form of economic cash inflows to economic costs. The project ERR is compared to the required profitability to decide its viability. The ERR of the project is 67.6%. Since the economic rate of return is higher than the cost of funds in form of the opportunity cost (11.4%), the project should pass the investment evaluation test.

Table 65: Abridged Economic Analysis Statement

PROPOSED CASSAVA STARCH FACTORY PROJECT											
KEY PROJECT DEMOGRAPHIC OUTPUTS											
Economic Revenue Item (UGX)		**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
Farm labour income	1.0000	543,564,000	544,212,000	545,184,000	545,832,000	546,480,000	546,480,000	546,480,000	546,480,000	546,480,000	546,480,000
High quality cassava flour	0.9073	8,982,270,000	10,615,410,000	13,065,120,000	14,698,260,000	16,331,400,000	16,331,400,000	16,331,400,000	16,331,400,000	16,331,400,000	16,331,400,000
Alcohol - RS (Rectified Spirit)	1.0730	11,717,160,000	12,303,018,000	12,918,168,900	13,564,077,345	14,242,281,212	14,954,395,273	15,702,115,037	16,487,220,788	17,311,581,828	18,177,160,919
TA- (Technical Alcohol)	1.0730	334,776,000	351,514,800	369,090,540	387,545,067	406,922,320	427,268,436	448,631,858	471,063,451	494,616,624	519,347,455
Carbon dioxide	0.9076	637,135,200	668,991,960	702,441,558	737,563,636	774,441,818	813,163,909	853,822,104	896,513,209	941,338,870	988,405,813
Distillers Dry Grain (DDGS)	1.0730	418,470,000	439,393,500	461,363,175	484,431,334	508,652,900	534,085,545	560,789,823	588,829,314	618,270,780	649,184,319
Total Economic revenue		**22,633,375,200**	**24,922,540,260**	**28,061,368,173**	**30,417,709,382**	**32,810,178,251**	**33,606,793,163**	**34,443,238,821**	**35,321,506,763**	**36,243,688,101**	**37,211,978,506**
Land	1.0000	1,000,000,000									
Cassava Starch 100tpd starch	0.9089	15,520,154,005									
36,000 LPD Extra New Alcohol Plant (ENA)	0.9089	13,332,319,004									
Office Furniture	0.9089	238,135,890									
Motor Vehicles	0.8995	1,709,050,000									
Lost Economic Activity	1.0000	1,509,900,000	1,511,700,000	1,514,400,000	1,516,200,000	1,518,000,000	1,518,000,000	1,518,000,000	1,518,000,000	1,518,000,000	1,518,000,000
External costs		33,309,558,898	1,511,700,000	1,514,400,000	1,516,200,000	1,518,000,000	1,518,000,000	1,518,000,000	1,518,000,000	1,518,000,000	1,518,000,000
Raw Cassava	0.9097	727,760,000	764,148,000	802,355,400	842,473,170	884,596,829	928,826,670	975,268,003	1,024,031,404	1,075,232,974	1,128,994,622
Packaging	0.9097	33,947,443	35,984,290	38,143,347	40,431,948	42,857,865	45,429,337	48,155,097	51,044,403	54,107,067	57,353,491
Chemicals & Lab	1.0000	80,928,000	85,036,644	89,354,486	93,892,214	98,661,063	103,672,846	108,939,981	114,475,525	120,199,301	126,209,266
Electricity	1.0725	48,906,000	52,818,480	57,043,958	61,607,475	66,536,073	71,858,959	77,607,676	83,816,290	90,521,593	97,763,320
Water	0.9076	60,511,507	22,363,446	25,401,192	27,651,459	29,932,556	30,612,344	31,326,121	32,075,587	32,862,527	33,688,813
Maintenance	0.9026	15,412,576,746	-	-	-	-	-	-	-	-	-
Direct Labour	0.9076	1,022,683,680	1,022,683,680	1,022,683,680	1,022,683,680	1,022,683,680	1,022,683,680	1,022,683,680	1,022,683,680	1,022,683,680	1,022,683,680
Reagents	0.9089	7,260,800	7,623,840	8,005,032	8,405,284	8,825,548	9,266,825	9,730,166	10,216,675	10,727,508	11,263,884
Payroll Administration	0.9076	768,483,072	660,006,720	660,006,720	660,006,720	660,006,720	660,006,720	660,006,720	660,006,720	660,006,720	660,006,720
Fixed Electricity	0.9089	179,962,200	212,682,600	261,763,200	294,483,600	327,204,000	327,204,000	327,204,000	327,204,000	327,204,000	327,204,000
Sales Expenses	0.9076	269,557,200	318,567,600	392,083,200	441,093,600	490,104,000	490,104,000	490,104,000	490,104,000	490,104,000	490,104,000
Depreciation	0.9026	497,217,514	497,217,514	497,217,514	497,217,514	497,217,514	497,217,514	497,217,514	497,217,514	497,217,514	497,217,514
Marketing Expenses	0.9076	605,115,072	670,903,366	762,035,754	829,543,782	897,976,691	918,370,325	939,783,641	962,267,624	985,875,805	1,010,664,395
Office Maintenance	0.9089	403,987,872	447,909,556	508,751,503	553,821,319	599,508,604	613,123,835	627,419,826	642,430,618	658,191,949	674,741,346
Licensing Fees	1.0000	50,000,000	-	-	-	-	-	-	-	-	-
Insurance	0.9076	302,557,536	-	-	-	-	-	-	-	-	-
Vehicle fuel & maintenance	0.9026	200,593,824	222,402,445	252,612,557	274,991,265	297,676,569	304,436,997	311,535,447	318,988,819	326,814,860	335,032,203
Interest	1.0000	-	-	-	-	-	1,008,947,202	975,472,545	940,986,117	905,457,337	868,854,700
Total Economic costs		17,387,313,377	1,983,034,539	2,034,982,064	2,088,739,946	2,145,268,066	2,203,083,836	2,263,980,559	2,328,126,889	2,395,607,142	2,466,693,193
Total Expenditure				3,549,382,064	3,604,939,946	3,663,268,066	3,721,083,836	3,781,980,559	3,846,126,889	3,913,607,142	3,984,693,193
Net Cash Flows		(33,309,558,898)	24,922,540,260	24,511,986,109	26,812,769,435	29,146,910,185	29,885,709,327	30,661,258,262	31,475,379,874	32,330,080,959	33,227,285,312
Economic Internal Rate of Return (ERR)				**81.00%**							
Economic Net Present Value (ENPV)				**217,053,314,071**							

10 Project Risk Analysis

10.1 MAJOR PROJECT RISKS

Project financial modelling incorporated risk analysis by identifying the “critical” variables and parameters of the model that have the greatest effect on the IRR or the NPV. The sensitivity analysis also considered the probability that the proposed project will achieve a satisfying performance (in terms of IRR or NPV), as well as the variability of the result compared to the best estimate previously made. An assessment of the key risks associated with the project has been undertaken. The key risks identified by the study appear in Table 66:

Table 66: Project key risk and mitigation

Risk	Likelihood	Proposed Mitigation
Loss of momentum: long-term project requiring on-going support and commitment of stakeholders	Low	Ensure full engagement of all project stakeholders with an appropriate stakeholder management strategy.
Public sector funding challenges	Low	Keeping project costs affordable and compliance with realistic fundraising and budgeting, reporting and accountability, and secure sufficient funding for all essential project elements.
Capital overrun	low	Proper capital projections have been made based on existing market conditions and benchmarking studies for similar facilities.
Higher operating deficit	Low	The financial model has been developed based on conservative estimates and has been tested against the cassava starch trade industry numbers.
Suitability of the proposed project site	Low	Closely monitor location factors and review other potential sites for appropriate contingencies during stakeholder engagement
Low entry revenue	Low	Prices were based on existing charges for similar products in the market.
Less than expected sales numbers	Low	Sales projection has been done using thorough day-to-day trade numbers in line with existing market and industry performance.
Inability to raise funding	Low	The base assumption of government funding is based on the assumption that government will access a loan facility to enable undertaking the project. Failure to access a one-off loan will be overcome by an anticipated development over a 5 year period using government funds.
Products do not adequately meet the needs of the market	Low	Ensure throughout market analysis and appropriate product development process and obtain appropriate professional and market advice at the earliest stage of project development.
Planning and legal framework delays in project delivery	Low	Ensure compliance with the requirements of all relevant authorities, obtain necessary permissions on time and maintain dialogue with key stakeholders
Inadequate stakeholder support	Low	Obtain support from relevant stakeholders without which development of the project may prove challenging.

10.2 BUSINESS MODEL RISKS

The business operation model is based on cautious assumptions, incomes and expenditures yielding the minimum anticipated project performance. For longer term projections, it is assumed that any inflationary increase of expenditure will be offset by increases in income and funding and therefore a neutral impact on the overall financial model. There are nonetheless specific areas of the business model which could result in greater volatility including:

a. **Staffing costs:** With the projected economic improvements, there is a likelihood of increased pressure on salaries due to the increasing living wage for staff and contractors.
b. **Utilities:** The cost of utilities is expected to grow due to inflation projections.

A prudent budgeting regime will be instituted to factor all relevant costs and provide for any adverse economic and business situations that may impact operational volatility. The proposed facility seeks to diversify income sources in form of the market both domestic and foreign.

10.3 TECHNICAL RISKS APPORTIONMENT AND MANAGEMENT

This section provides an assessment of how the associated risks might be apportioned between the project ("client") and third-parties ("others"). Please see the risk transfer matrix in Table 67 below.

Table 67: Project risk sharing

Risk Category	Risk Apportionment	
	Client	**Shared**
1. Design risk		✓
2. Construction and development risk		✓
3. Transition and implementation risk		✓
4. Availability and performance risk		✓
5. Operating risk	✓	
6. Variability of revenue risks	✓	
7. Termination risks	✓	
8. Technology and obsolescence risks		✓
9. Control risks	✓	
10. Residual value risks	✓	
11. Financing risks	✓	
12. Legislative risks	✓	
13. Planning risks	✓	
14. Other project risks	✓	

The key to technical risk management shall entail reliance on qualified and experienced teams with the required tools to reflect the ambitions of the project with an aim of achieving a successful manufacturing concern.

A core part of project design shall entail a procurement strategy and implementation timescales that ensure services required as part of project implementation are managed to the detail and on time with all the necessary contractual and insurance safeguards to optimise risk-sharing advantages and afford management the opportunity to focus on project core activities.
Risks will be managed through the project delivery structure which is the project management board/ committee. One of the core competencies of the project manager will be the ability to set up and monitor a robust risk management process.

10.4 SENSITIVITY ANALYSIS

The sensitivity analysis was undertaken on the project operating costs and inflows. Particular consideration was placed on sales numbers, prices, revenues, operating costs and construction costs. Sensitivity of the project's viability in terms of NPV and IRR was analysed with respect to changes in different revenue and cost components. In addition, the project's capacity to absorb debt cost was also analysed. While studying the effect of one variable, all other variables were assumed to be constant.

10.4.1 Project's sensitivity to sales revenue

The project's financial calculations have already been based on product sale price lower than the prices of the comparable products already present in the market. However, management may still intend to further penetrate the market by fixing the prices even lower than that. Therefore, a sensitivity analysis was carried out to know the impact of a possible low-revenue strategy on the project's feasibility. The analysis assumes an equal percent decrease in the prices and revenue of all the products in both local and export markets. Corresponding decrease in NPV and IRR is shown in the table 68 below.

Table 68: Estimated project revenue NPV and IRR

Impact on Project	**Revenue Percentage Decrease**	
	5%	**10%**
NPV	UGX 2,199,182,569	UGX -10,374,149,657
IRR	12%	8.2%

A 5% reduction in revenue leaves the project viable with a positive NPV of UGX 2,199,182,569 and IRR of 12% which is higher than the 11.4% cost of capital. A reduction of 10% makes the project unacceptable using NPV criteria as it yields a negative NPV of UGX (10,374,149,657) and IRR of 8.2% which is lower than the required 11.4%.

10.4.2 Project's sensitivity to construction and equipment cost

The project uses commercial rate of land in the selected location in Acholi sub-region. Average increase in construction costs has been used to determine the resultant project variability. There is the possibility that UDC may have to spend more on construction depending upon the availability and costs of materials and labour and the specific project location. In that context, the impact of land cost on the project's viability was analysed. The table below shows the results (***Table 69: Estimated Project construction cost NPV and IRR***).

Table 69: Estimated project construction cost NPV and IRR

Impact on project	Construction Cost Percentage Increase			
	10%	**20%**	**30%**	**40%**
NPV	UGX11,381,875,682	UGX 7,991,236,569	UGX 4,600,597,456	UGX 1,209,958,343
IRR	14.5%	13.4%	12.5%	11.5%

The project is seen to be fairly safe with increase in construction costs. NPV remains positive even if the construction cost is incurred at 40% of the estimated project construction and equipment costs that has been used in project's calculations. At an increased construction and equipping cost of 10%, the NPV is UGX11,381,875,682 and the IRR is 14.5%. At a cost increase of 40%, the resultant NPV is UGX1,209,958,343 and the IRR is 11.5%. The project remains robust faced with increased construction and plant costs.

10.4.3 Project's sensitivity to operating costs

The project's financial calculations are based on proportionately high operating costs. Faced with tough economic conditions, management may be faced with higher operating costs than initially projected. Therefore, a sensitivity analysis was carried out to know the impact of increased operating costs on the project's feasibility. The analysis assumes an equal percent increase in of all project costs. Corresponding decrease in NPV and IRR is shown in Table 70.

Table 70: Estimated project operational cost NPV and IRR

Impact on project	Operating Cost Percentage Increase	
	5%	**10%**
NPV	UGX 4,633,127,865	UGX -5,506,259,064
IRR	12.8%	9.8%

As seen in the table above, with a 5% increase in operating cost, the project remains viable with a positive NPV of UGX4,633,127,865and IRR of 12.8% which is higher than the 11.4% cost of capital. An increase of operating costs to 10%, however, makes the project unacceptable using NPV criteria as it yields a negative NPV of UGX (5,506,259,064) and IRR of 9.8% which is lower than the required 11.4%.

10.5 SWOT ANALYSIS

SWOT analysis was used in the study to systematically identify the various factors the UDC will use as a basis to formulate strategy upon which the proposed factory will base. Analysis was based on a logic that the UDC and indeed the proposed factory can seek to maximise the strengths (strengths) and resolve weaknesses using internal factors within their control while at the same time taking advantage of opportunities and avoiding threats that are outside their direct control but will still impact on their operations. The SWOT analysis led to the delineation of patterns from internal and external, and supportive or risky that form a dynamic frame within which the proposed factory will operate and a proposal on how to build on the positive value factors and mitigate the negative value factors.

Table 71: Proposed project SWOT analysis

Impact / Source	Internal source / within management control	External source / outside management control
Beneficial to operations	**Strengths** • Proposed project aligned with national development goals • Proposed project already prioritised by UDC in its strategic plan • Cassava among the leading crops in Uganda • Proposed location close to the source of raw materials will minimise operational costs • The project promoter has experience in start-up of similar undertakings with adequately qualified staff • The proposed structure based on past experience and similar undertakings will optimise the potential for success • Availability of labour	**Opportunities** • National strategy to promote exports and replace imports including Buy Uganda Build Uganda strategy • Favourable conditions for cassava production in the Acholi sub-region • Acholi producing about 34% of national cassava output • Cassava output sufficient for operations • Current market prices for raw cassava within the proposed operating cost structure for profitability • Ongoing programmes aimed at strengthening the cassava value chain including research and production promotion • Existing value chain intermediaries like Gulu Archdiocese and farmers associations • Existing high output cassava varieties • Cassava farming experience in the region • Inadequate technology in cassava farming
Risky to operations	**Weaknesses** • Low trust between value chain actors due to past experiences • Low demand triggered by potential clients using alternative products • The long procedure for accessing the investment funds yet the need for the project is urgent	**Threats** • Declining volume of output due to allocation of land to other high value products • High competition from imported cassava and other starch and ethanol products • High production of low yield cassava • The possibility of cassava diseases • The seasonality of cassava and fluctuation in production will impact operations

10 Conclusions and Recommendations

11.2.1 IMPLEMENTATION OF THE PROPOSED PROJECT

The study concluded that the implementation of the project is feasible and government support and external financial support are essential. The UDC should take the first action to realise the project, which is to take a decision of implementation of the project and establish a steering committee to oversee the structuring and formation of an entity that will operate the investment.

Because the project capital expenditure needs are sizeable, every effort should be made to find money from sources that minimise the impact on the national debt outlook. A project board should be established and empowered to oversee operations, and the management team engaged should have experience in running similar projects with a drive to realise objectives and operate a sustainable venture. Ensure value for money by closely supervising contractors through the planning, designing and construction phases.

The support and technical advice of other government departments, particularly NEMA, MOW and local governments to UDC will be essential to ensure compliance with standards, completion of the construction on schedule, and eventual project success.

11.1 CROP AND AGRONOMIC RECOMMENDATIONS

It is recommended that the government, through its support agencies like NAADS and OWC, should focus on the popularisation and provision of improved high yielding and short maturity cassava varieties that also produce high quality starch. The highest yielding varieties that are recommended are TME-14, NASE-19, and NASE-14 NAROCASS 1 and need to be heavily promoted and distributed.

It's also recommended that a 500-acre supply nuclear farm should be planned for in the medium term to serve as an alternative supply to the facility, but also serve as a model farm for the region.

11.2 LOCATION RECOMMENDATION

Pader has one of the largest and most organised casava farmer groups in the region under the Gulu Catholic Archdiocese. This farmer group identified 25 acres of land at Acholibur (3°09'03.7"N 32°54'54.6"E 3.151040, 32.915161) to host the facility and it is fully recommended by the consultants. The location has access to three-phase power and is close to the main Gulu to Kitgum highway. Besides, Pader was the second highest district allocating land for cassava cultivation and with the second lowest price per kilogramme of tuber. This makes Acholibur the best location to set up the processing facility (Figure 11).

11.2 PRODUCTS AND CAPACITIES RECOMMENDATIONS

It's recommended that the cassava facility should produce:

I. Cassava starch as a core product

II. Ethanol as the key subsidiary product.

The two products have the most potential to not only consume substantial amount of the cassava thus offering opportunities to farmers, but also have the biggest local and export market. This will also have an impact on import substitution. The local, regional and global figures detailed in this feasibility provide the justification.

The two products also provide the widest scope for other downstream industries. The multiple uses of both starch and ethanol can spur additional industries as already elaborated.

11.2.1 Recommendation

It is thus recommended that the proposed cassava starch factory starts with two lines:

I. A 400-ton per day fresh cassava processing line capable of producing 100Tons per day of starch.

II. A 100-ton per day cassava chips processing line capable of producing 36,000 litres per day of ethanol (rectified spirit-RS), 1600L of TA- (technical alcohol), 8.1Tons of carbon dioxide and 6.25 tons of Distillers Dry Grain (DDGS) 6.25ton (animal feeds).

The combination of these two lines offers the best sustainable start to the cassava industrialisation programme in the country and the Acholi region — offering an expanded chance for local value addition in the production of cassava chips at farm level.

The facility however can only consume less than 5% of regional production thus expansion will be needed in the medium term. The key recommended expansion ideas for the facility are:

1. Addition of a high fructose cassava syrup (HFCS) production line to further add value to the starch and expand the product offering while positively impacting on import substitution of these syrups for medicinal beverage and confectionery production.

2. Production and packaging of final retail products like high quality cassava floor (HQCF), sanitiser, surgical spirits, among others.

3. It is also recommended that a 500-acre supply nuclear farm should be planned for in the medium term to serve as an alternative supply to the facility but also serve as a model farm for the region.

11.3 MANAGEMENT AND OPERATIONAL RECOMMENDATION

It is recommended that a project management team (PMT) consisting of all key stakeholders for the facility as detailed in the study be formed to oversee the implementation of the project by the government through UDC.

11.4 FINANCIAL RECOMMENDATIONS

The project is anticipated to cost UGX33,906,391,130 and it is assumed that the government will contribute most of this money. Other stakeholders like farmers through Gulu Catholic Archdiocese may also contribute land but also pay for their share through the supplies of raw materials over time to help recoup project investment.

11.2.2 OTHER RECOMMENDATIONS

Because of the size of the proposed project, it is recommended that implementation be handled in a manner that enables procurement of local materials to optimise the national and local gains.

Specifically, actions should be undertaken in line with ESIA to ensure protection and improvement of the environment of the area.

The execution of this project should incorporate management techniques most current and suitable to local circumstances. The study concluded that the project is feasible. The success of the project requires the implementation of a range of actions, including:

- Enforcement of quality controls over materials and workmanship.
- Strengthening of the project management team to take responsibility for the management, implementation, and operation of the project.
- Construction of support infrastructure required for project success.
- Training of personnel in project management, financial management, operation and maintenance of facilities.

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Appendix 1: ESTIMATED CASSAVA PRODUCTION IN NORTHERN UGANDA *Estimated Annual sales (MT)*

				2020	2020	2021	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
District	Number of households	HHs growing cassava	Annual acreage (ha)	Annual production (MT)	Annual sales (MT)	Annual production (MT)	Annual sales (MT)	1.50%	1.50%	1.50%	1.50%	2.00%	2.00%	2.00%	2.00%	2.00%	2.50%
Gulu	65,600	39,708	35,945	57,008	38,589	80,496	93,076	94,473	96,362	98,289	100,255	102,260	104,305	106,391	108,519	110,690	113,457
Nwoya	46,500	23,250	17,549	381,791	197,997	519,720	467,524	474,537	484,028	493,709	503,583	513,654	523,927	534,406	545,094	555,996	569,896
Amuru	45,000	23,571	13,129	79,814	73,332	285,439	335,589	340,623	347,436	354,384	361,472	368,702	376,076	383,597	391,269	399,094	409,072
Kitgum	45,400	22,700	33,589	33,526	25,851	39,719	56,477	57,324	58,470	59,640	60,832	62,049	63,290	64,556	65,847	67,164	68,843
Pader	39,800	19,900	35,597	46,325	37,368	80,913	102,635	104,175	106,258	108,384	110,551	112,762	115,018	117,318	119,664	122,058	125,109
Omoro	40,300	27,825	28,308	69,538	58,817	91,227	135,980	138,020	140,780	143,596	146,468	149,397	152,385	155,433	158,541	161,712	165,755
Lira	104,300	57,115	4,816	174,160	145,563	1,152,051	1,108,447	1,125,074	1,147,576	1,170,527	1,193,938	1,217,816	1,242,173	1,267,016	1,292,356	1,318,204	1,351,159
Nebbi	56,700	42,525	33,598	82,711	57,010	331,576	285,554	289,838	295,634	301,547	307,578	313,730	320,004	326,404	332,932	339,591	348,081
Adjumani	43,200	32,400	25,599	63,018	43,436	252,629	217,565	220,829	225,245	229,750	234,345	239,032	243,813	248,689	253,663	258,736	265,204
Agago	47,900	23,950	42,841	55,753	44,973	97,380	123,524	125,376	127,884	130,442	133,050	135,711	138,426	141,194	144,018	146,898	150,571
Lamwo	30,800	15,400	22,787	22,745	17,538	26,946	38,314	38,889	39,667	40,460	41,270	42,095	42,937	43,796	44,671	45,565	46,704
Oyam	90,700	49,667	4,188	151,451	126,583	1,001,831	963,913	978,372	997,940	1,017,898	1,038,256	1,059,022	1,080,202	1,101,806	1,123,842	1,146,319	1,174,977
Kole	58,000	31,761	2,678	96,848	80,946	640,642	616,395	625,640	638,153	650,916	663,935	677,213	690,758	704,573	718,664	733,037	751,363
Otuke	28,200	15,442	1,302	47,088	39,356	311,485	299,695	304,191	310,275	316,480	322,810	329,266	335,851	342,568	349,419	356,408	365,318
Pakwach	37,500	28,125	22,221	54,703	37,705	219,296	188,859	191,692	195,525	199,436	203,425	207,493	211,643	215,876	220,193	224,597	230,212
Masindi	313,800	181,016	165,706	800,302	507,810	1,564,901	1,500,776	1,523,287	1,553,753	1,584,828	1,616,525	1,648,855	1,681,832	1,715,469	1,749,778	1,784,774	1,829,393
Kiryandongo	340,500	196,417	179,805	868,397	551,018	1,698,052	1,628,471	1,652,898	1,685,956	1,719,675	1,754,068	1,789,150	1,824,933	1,861,431	1,898,660	1,936,633	1,985,049
Apac	44,700	24,478	2,064	74,640	62,384	493,736	475,049	482,175	491,818	501,654	511,688	521,921	532,360	543,007	553,867	564,944	579,068
Overall	1,478,900	855,250	671,721	3,159,818	2,146,275	8,888,038	8,637,845	8,767,413	8,942,761	9,121,616	9,304,048	9,490,129	9,679,932	9,873,531	10,071,001	10,272,421	10,529,232
Volume bought by offtakers					40,000		40,000	40,600	41,412	42,240	43,085	43,947	44,826	45,722	46,637	47,569	48,759
Volume bought by industrial processors					842,500		842,500	855,138	872,240	889,685	907,479	925,628	944,141	963,024	982,284	1,001,930	1,026,978
	Bukona				22,000		22,000	22,330	22,777	23,232	23,697	24,171	24,654	25,147	25,650	26,163	26,817
	Britania				10,000		10,000	10,150	10,353	10,560	10,771	10,987	11,206	11,431	11,659	11,892	12,190
	Riham				10,000		10,000	10,150	10,353	10,560	10,771	10,987	11,206	11,431	11,659	11,892	12,190
	Breweries				150,000		150,000	152,250	155,295	158,401	161,569	164,800	168,096	171,458	174,887	178,385	182,845
		CHIPS			337,000		337,000	342,055	348,896	355,874	362,992	370,251	377,656	385,209	392,914	400,772	410,791
		Fresh tuber equivalent			842,500		842,500	855,138	872,240	889,685	907,479	925,628	944,141	963,024	982,284	1,001,930	1,026,978
	Year					2,020	2,021	2,022	2,023	2,024	2,025	2,026	2,027	2,028	2,029	2,030	2,031
	Surplus for Starch factory				1,263,775	1,263,775	7,755,345	7,871,675	8,029,109	8,189,691	8,353,485	8,520,554	8,690,965	8,864,785	9,042,080	9,222,922	9,453,495
	Fresh cassava for starch half of which can male ethanol						110,000	110,000	110,000	110,000	110,000	112,200	114,444	116,733	119,068	121,449	123,878
	Proportion of excess cassava converted						14	14	14	13	13	13	13	13	13	13	13

Appendix 2: Shortlisted Option Scoring

ID	Category	Weighting factor	Score Option 1	Weighted Score Option 1	Score Option 2	Weighted Score Option 2	Motivation for scores
A	**Current Market and Scope**			**48**		**124**	
A1	Ability to utilise the existing raw materials	8	1	8	4	32	**Option 1:** Continues current state of inadequate production capacity. **Option 2**: Capacity improvement and an investment message to the farmer and market
A2	Provide range of products for domestic and regiona markets	8	2	16	5	40	**Option 1:** Continues current state of limited capabilities and product range. **Option 2**: A new range of products including high quality starch and ethanol in addition to by-products
A3	Provide for the comprehensive macro-market potential and local market	8	2	16	5	40	**Option 1:** Continues current state of limited market coverage with limited exports. **Option 2**: Production capacity will target regional markets and domestic industrial users
A4	Offer a sustainable, fit-for-purpose manufacturing options	4	2	8	3	12	**Option 1:** Continues current state of limited market coverage with limited exports. **Option 2**: Project will offer opportunities for cassava value chain improvement
B	**Accountability, governance and participation**			**32**		**56**	
B1	Minimise risk for public sector finances	8	3	24	2	16	**Option 1:** Investment requires PPP option together with associated efficiency benefits but delayed contracts. **Option 2**: Required formation of legal entity to operate as a private enterprise easy to operate and form
B2	Align with UDC national objectives	8	1	8	5	40	**Option 1:** Not among the priority investment options. **Option 2**: Project is key in the NDPIII and UDC priorities
C	**Financial assessment**			**8**		**20**	
C1	Cover capital and operational costs from revenue stream	4	1	4	3	12	**Option 1:** Requires investment in new equipment and existing firms making losses. **Option 2**: New project configuration will optimise operations leading to efficiency
C2	Operate at a high level of functional and organisational efficiency	4	1	4	2	8	**Option 1:** Requires investment in new equipment and existing firms making losses. **Option 2**: New project configuration will optimise operations leading to efficiency
D	**Quality of products**			**28**		**56**	
D1	Provide quality products meeting standards	8	2	16	4	32	**Option 1:** Existing product have reasonable quality but limited product range. **Option 2**: New project will offer state-of-the-art technology with improved quality and product range
D2	Meet standards and benchmark for product safety and operational safety	4	1	4	4	16	**Option 1:** Existing factory setup, equipment and facilities are old and require revamp. **Option 2**: New factory will offer latest technology with better safety and operations programming
D3	Achieve product user satisfaction	4	2	8	2	8	**Option 1:** Current products considered good quality. **Option 2**: New factory will offer additional products and by-products

ID	Category	Weighting factor	Score Option 1	Weighted Score Option 1	Score Option 2	Weighted Score Option 2	Motivation for scores
E	**Regional economy and community**			**24**		**66**	
E1	Provide a basic scale of potential commercial activities	8	2	4	3	24	**Option 1:** Expanding existing entities will not realise growth to tap the potential. **Option 2**: Proposed project will offer new value chain opportunities across the region
E2	Provide employment opportunities for skilled and semi-skilled staff	2	2	4	5	10	**Option 1:** Expanding existing entities will offer a few additional jobs. **Option 2**: Proposed project will offer over 100 new job opportunities
E3	Provide employment opportunities through agricultural marketing value chains	8	2	16	4	32	**Option 1:** Expanding existing entities will offer a few additional jobs. **Option 2**: Proposed project will offer opportunities in farming, transport, trade and manufacturing
F	**Quality of employment**			**8**		**40**	
F1	Offer quality terms and conditions for work	4	1	4	2	8	**Option 1:** Expanding existing entities will operate under PPP with efficiency the main driving force. **Option 2**: Proposed project will offer improved terms
F2	Offer an attractive working environment to staff	4	1	4	4	32	**Option 1:** Expanding existing entities will not fundamentally alter existing facilities for the better. **Option 2**: Proposed project designs and layout will optimise resources and ensure quality space
G	**Address inequalities in income**			**24**		**32**	
G1	Satisfy constraints on market proximity and competitive prices	8	3	24	4	32	**Option 1:** Expanding existing entities will not fundamentally alter existing access for the region. **Option 2**: Proposed project will broaden access and coverage
H	**Adaptability to change**			**4**		**16**	
H1	Provide flexibility to cope with qualitative and quantitative changes in demand	4	1	4	4	16	**Option 1:** Expanding existing entities will offer limited capacities. **Option 2**: Proposed project will offer multiple production capacities and thus flexibility
I	**Added value**			**24**		**28**	
I1	Serve as a centre of transformation for the region	8	2	16	2	16	**Option 1:** Expanding existing entities will offer limited transformation opportunities. **Option 2**: Proposed project has potential to transform cassava farming and trade
I2	Offer opportunities for commercial cassava processing and research	4	2	8	3	12	**Option 1:** Expanding existing entities will offer limited research in form of PPP. **Option 2**: Proposed project has potential to build research capabilities to improve the materials and products as required by the market
	Total Scores			**196**		**438**	

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