



Banana

Value Chain Analysis Report

Proposed Interventions for NAROSec to Catalyze Agro-Industrialisation






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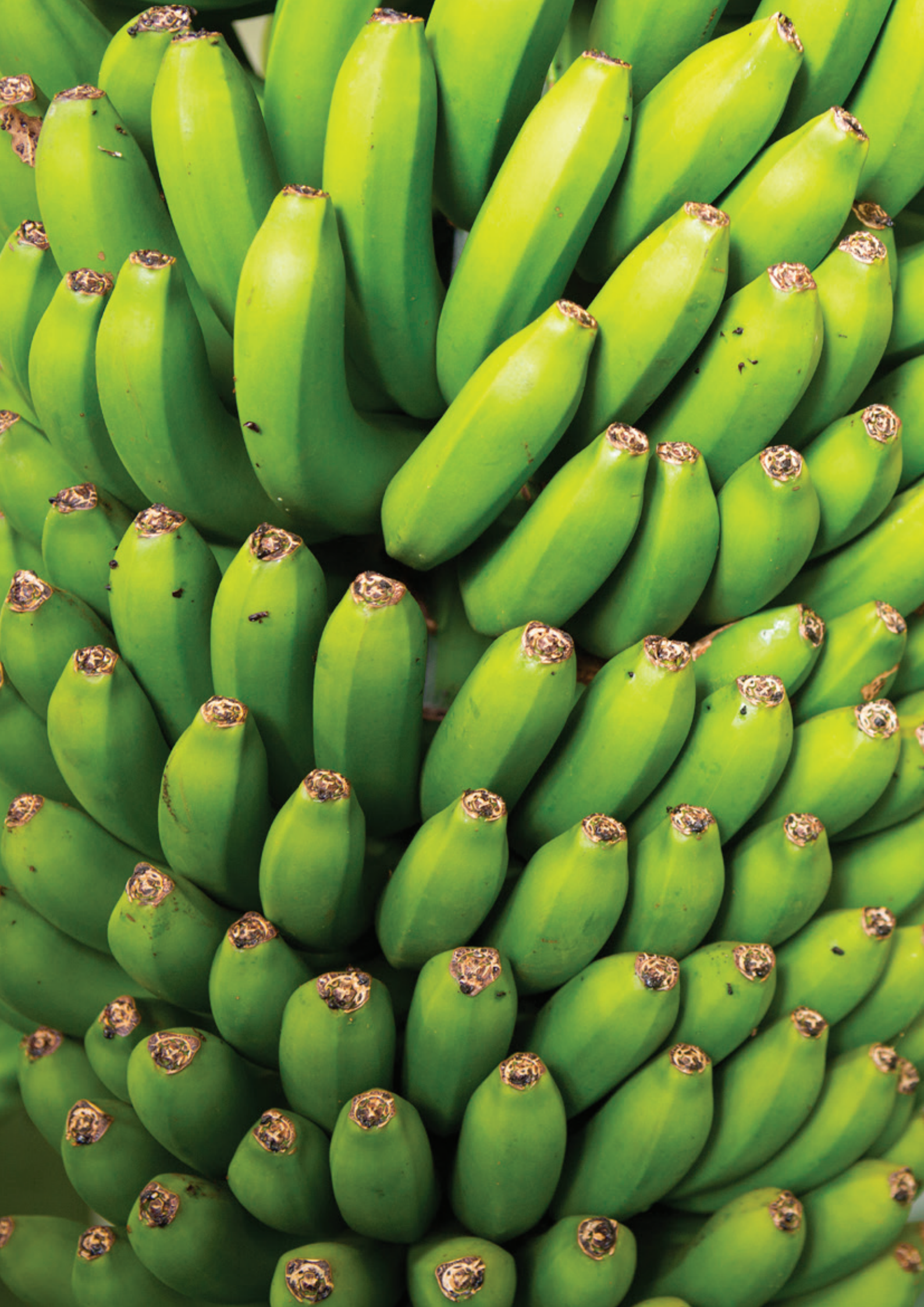


Extended
Executive Summary

1.1 Background

Although agricultural sector is the biggest employer (with 63.4% of labour force) in Uganda, its contribution to gross domestic product (GDP) stands at only 24% (4), and for the past 5 years the sector has only grown at an average of 3.9% per annum against set target of 6% per annum from 2015/16 to 2019/20.

The sector has a huge untapped potential to contribute to country's GDP and reduce poverty through employment creation, a reason for sector prioritization under agro-industrialisation, export promotion and private sector development strategies of the National Development Plan 2020/21 – 2024/25 (NDP III). NDP III also highlighted the top 10 strategic commodities for fostering development of agricultural sector and specifically agro-industralisation strategy, of which bananas is among. However, banana sub-sector growth is still challenged by: (i) underdeveloped banana processing sector characterized with poor technologies and practices, (ii) low on farm productivity, mainly due to disease and pests burden, (iii) high post harvest losses due to poor marketing infrastructure and technologies, (iv) unstructured value chain that is dominated by middlemen, and many other factors. Potential across the value chain is underutilized which call for deeper understanding of the underlying issues and also explore how research and development can play a more significant role in addressing these challenges.

USAID FtF Uganda Agriculture Research Activity is a 5 year, US$10 million flagship research and development project, funded by USAID and implemented by CGIAR centers and NARO which seeks to promote use and commercialization of improved crop and livestock technologies with yield and nutrition enhancing characteristics. The activity focuses on: (i) continued improvement of crop genetics, bio-fortification, and integrated pest and disease management for both crops and livestock, in response to market-demand, and (ii) strengthening NARO's institutional sustainability in the marketplace. Specific activities that the project focuses on include: (i) facilitate the release and commercialization of varieties developed under previous and ongoing research efforts, (ii) develop improved crop and animal production and management technologies in response to emerging threats and market demands, and (iii) consolidate previous gains in institutional and human capacity development to align research with market needs, and mobilize domestic resources that will displace current development partner funding. For USAID FtF Uganda Agriculture Research Activity to execute its mandate, (i) there is need for a clear understanding of the current and future trends in the target value chains, (ii) identify the most profitable nodes of the banana value chains and (iii) identify interventions for NAROsec and others to catalyze agro-industrialisation at profitable nodes of banana value chain. Based on the above, Knowledge Wells Ltd was contacted by NAROsec to undertake a detailed desk research on banana value chain Uganda to guide activity priorities.

1.2 Key Findings

- In 2019, global banana production reached 128.78 million Tonnes. Dessert banana varieties (Cavendish, Gros Michel and others) accounted for 59%, while cooking banana varieties for 17%. Since 2015, production has been on a decreasing trend, registering a 75% decrease. This is mainly attributed to biotic and abiotic stress in the major production zones. The main production zones are located in Asia, representing 49% of global production, followed by Americas (23%), Africa (17%) and the rest account for the remaining proportion. By country, India is the leading banana producer globally (13.46 million MT), followed by China (11.6 million MT) and Indonesia (7.28 million MT). In Africa alone, bananas are a source of income and jobs for more than 70 million people.

- Bananas are largely consumed domestically in producing countries, where they provide a substantial source of nutrition and food security for more than 400 million people. Globally, dessert bananas have become an important part of the diet. Countries with highest banana per capita consumption include: Rwanda (166 kg/capita/year), Tanzania (43 kg/capita/year) and Angola (41 kg/capita/year). On the other hand, countries with the highest levels of plantain/cooking banana per capita consumption in 2018 were Cameroon (197 kg/capita/year), Ghana (141 kg/capita/year) and Uganda (68 kg/capita/year).

- In terms of quantity, bananas remain the number one fruit traded globally ahead of apples or citrus groups. However global trade represents only 21.8% of world banana production. This could be attributed to its high perishability which makes transportation over long distances expensive. Therefore local consumption or domestic markets are the main outlets for production (i.e. 78.2%). Dessert bananas are the most exported (mainly cavendish variety, probably because its more resistant to physical shocks during transportation), with estimates as of 2020 reaching 26.3 million MT (94.9% of total global exports). This is in comparison with only 3.4 million MT (5.08% of total global exports) of cooking bananas and 4,783 MT (0.02% of total global exports) of other plantain. Most of the bananas are traded as fresh form. Ecuador dominates global dessert banana exports, followed by Philippines, Costa Rica, Colombia and Guatemala. The biggest import markets for dessert bananas in 2020 were USA (37.5% of total global imports), Belgium (16.6% of total global imports), Russia (16.4% of total global imports), Germany (14.9% of total global imports) and Japan (14.5% of total global imports). The biggest import markets for plantain are USA (30.1% of total global imports), Saudi Arabia (14% of total global imports), and Netherlands (5.6% of total global imports). Its also important to note that the main importing countries are not necessarily the main consuming countries, since some act as a hub for the banana trade. For example, Belgium, the world no. 3 importer, which imported 1.2 million MT of bananas in 2020 via Antwerp, re-exported the bulk of it to neighbouring European countries. It is also the case with Germany (port of Hamburg) and the Netherlands (port of Rotterdam).

- Generally global banana prices have remained stable over the years, registering only 4% increment. Fluctuations in prices are however observed during the year, largely due to seasonality of demand and production related challenges such as cooler temperatures or weather related events such as El Niño phenomenon and drought that affect production in some major exporting countries. Since 2010, import prices on European Market have oscillated between 756 euros and 854 euros per metric ton. Europe has seasonal banana consumption which is dependent on temperatures, competition from other fruits and school calendar. Consumption peaks in autumn and early spring (April-May and October) when temperatures are favourable for banana consumption and low competition from local fruits. General trends shaping banana markets globally include: (i) increasing demand in producing countries, (ii) growing health conscious population, (iii) increasing demand for fair trade bananas, (iv) weather related events, (v) pests and diseases and (vi) acceptance of Genetically Modified Organisms (GMOs).

- EAC region produces 51% of Africa's banana output, with Uganda as the biggest producer (8.3 million MT). All banana production in east Africa is done by smallholder farmers, who mainly market the raw produce through informal channels (control over 90% of banana market). In the region only 0.14% (12,306 MT against 8.7 million MT produced) of bananas production was traded beyond the region. This means that almost all the bananas produced, are consumed within the region. Formally, 2,982MT of bananas valued at US$ 610,000 was traded in 2020 across borders in EAC region. This trade has been increasing for the last 5 years at a rate of 18%. The low level of intra-regional trade in bananas compared to total production, shows a big potential for growth if more investments are made to unlock opportunities in banana value chain.

- In Uganda, bananas are consumed in different forms depending on type. The most consumed type is the cooking banana (Matooke) which accounts for over 90%. Its harvested at green stage (fruit mature), peeled, steamed and mashed (wrapped in banana leaves) or boiled in water, then typically eaten with or without a sauce. At times banana fingers are cooked/steamed without peeling (empogola) and served as light meal, though in rare occasions. Roasting bananas (mostly gonja) is harvested at green mature stage, ripened, peeled and roasted/grilled on a wire mesh using charcoal stoves. The main market segment for this type are long distance travelers who purchase it from bus stops and consume it as a light meal. Dessert bananas (mainly Gros Michel (Cavendish) and apple bananas/sukali ndizi) are consumed as a fruit or pulp mixed with cassava flour to make a cake that is deep fried, locally known as Kabalagala sold in schools and road sides. Dessert bananas are sold in open markets and exported. Beer bananas are mainly used to make non alcoholic and alcoholic beverages.

- Other products produced from bananas though at very low scale include banana flour (raw or instant) and crafts mainly targeting the export market with no or limited domestic market penetration. Potential products that can be exploited include: (i) thickening, colouring and flavour agents, (ii) textiles, (iii) macro and micro-nutrients, (iv) nutracecuticals, (v) animal feed, (vi) natural fibre to make ropes (vii) charcoal briquettes, and (viii) bio-fertilisers

- Domestically, prices of matooke vary across the year and follow supply seasons. Peak season is normally observed in the months of June, July and August, and this coincides with low lowest prices observed within the year. Highest prices are observed in April and December, mainly because of the festive seasons when demand is the highest. Retailers earn the highest market share for the different banana types. Unit prices are determined by visual inspection, as reported by all producers, brokers, bicycle traders and wholesalers, which is subjective and arbitrary, and therefore presents risks for unfair marketing transactions. Price determination along the marketing chain is largely done by bargaining

- The banana market system in Uganda is complex, given the different types of bananas grown in the country. The main value chain actors comprise of producers (either individuals or marketing in groups), collectors (brokers and bicycle traders), transporters, a few processors, wholesalers, exporters, retailers and consumers. Banana value chain in Uganda is largely informal/unstructured and mainly domestic, with a small percentage of products exported. The cooking banana type is the most dominant, accounting for 93% of all bananas produced, followed by beer bananas which account for 6% and lastly sweet bananas which account for 1%.

- The main banana marketing system (cooking bananas) involves farmers selling their produce from farmgate to rural traders (mostly use bicycles, although a few use small trucks), who move from farm to farm. Rural traders sell to brokers at weekly assembly markets within production areas. Brokers sell aggregated produce to truck traders or wholesalers, who transport produce to major towns, mainly Kampala markets.

- A small proportion of bananas are sold through supermarkets or exported (formally and informally). However the roasting, dessert and brewing banana value chains are rather short compared to the cooking banana type value chain.

- Consumers purchase bananas as bunches (47%), unpeeled banana fingers in bags (17%), heaps of unpeeled banana (15%), clusters (11%), and peeled bananas (10%). The main distribution outlet for cooked bananas are open markets. 60% of the banana sold in the open markets in the urban centers goes to individual households consumers, while the rest goes to other customers such as hotels and restaurants. With families becoming smaller, need for consumer convenience and poor waste management in urban areas, peeled banana market share is expected to grow. This can also facilitate labelling to meet the needs of a growing consumer population that is looking for specific varieties of bananas to purchase for consumption.

- Within Uganda, cooking bananas flow from the major producing areas in the western region toward key markets in Kampala, Jinja, and Gulu. Bananas from the Mt. Elgon region flow to Lira, Iganga, Jinja, Moroto, Kotido, and Kampala. Some of these markets further connect the bananas to markets in neighboring countries (Juba in South Sudan, Busia in Kenya).

- Bananas are an important staple crop in Uganda. Out of the 7.4 million agricultural households in the country, 3.48 million households (representing 47%) grow bananas on about 668,000 hectares. Uganda's total production was estimated at 8.3 million MT by 2019, with average yield of 12.3 MT/Ha. Generally, productivity remains way below potential of 60–70MT/Ha. Smallholder farmers (working individually or in groups – although those in organized groups are few) owning <0.5 ha on average dominate production, although medium sized farms are more prominent in Southern Uganda.

- On average, In Western Uganda (Isingiro district), a farmer sells approximately 400 bunches and 23 bags of unpeeled fingers per month during surplus (June-August and December-February), while in scarcity season (September-November and March-May) each sells approximately 280 bunches and 14 sacks per month.

- Most demanded banana varieties in the market are Kibuzi, Nakitembe Mbwazirume and Musakala. However, access to clean planting materials for these varieties remains a big challenge. Productivity and general production is mainly constrained by: (i) Limited use of and access to quality to clean planting materials. Most farmers still get suckers from neighbours, (ii) disease and pest outbreaks such as banana Xanthomonas wilt (BXW), black sigatoka, fusarium wilt, weevils and nematodes (iii) diminishing land size due to fragmentation, (iv) declining soil fertility due to limited access and use of inputs such as fertilisers and manure, (v) limited knowledge and skills on improved farm management practices, (vi), drought/ water stress resulting in decreased bunch size, (viii) high post harvest losses partly attributed to improper harvesting techniques, and (ix) limited access to markets or low prices especially during peak season i.e. June and July. In addition, perishability of bananas, coupled with inadequate storage facilities for extended shelf life, forces retailers to sell bananas in the shortest time possible to minimize losses which limit their bargaining power.

- Although Uganda is among the lead producer of bananas globally, value addition into diversified processed products (such as fresh peeled vacuum packaged matooke, juice, wine, vinegar crisps, flour, biscuits, sweets, crisps, cake, jam, sauce, yoghurt etc) has been exploited to a small extent. Furthermore, there is massive underutilization of by products such as peels, leaves, pseudostem, stalk and inflorescence. Although growth of banana processing industry is at infancy, of recent, there are several cottage and small banana processors cropping up.

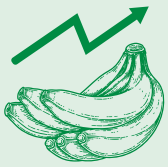
- Just like for most agricultural value chains, few studies (if they exist) have been done to assess current labour markets and employment potential that can be tapped in. However, UBOS reported that there approximately 3.48 million households (representing 47% of total agricultural households) that grow bananas. Production provides employment for both family workers and hired labourers. Although statistics are not readily available, we know that several people are directly employed as bicycle traders, brokers, lorry traders/ wholesalers, workers in processing entities, retailers, loaders/off loaders. Banana sub-sector

also has a multiplier effect on support sectors were several people are employed in as: (i) input suppliers, (ii) lorry drivers providing transport service, (iii) providers of different tools and equipment, (iv) financial service providers, (v) extension officers and many others.

Profitability analysis along coffee value chain shows that:



- Profitability at farmer level increases from **UGX 151,700** per acre (under traditional system) to **UGX 2,113,700** per acre (under low input system) to UGX **4,069,247** per acre (under high input and modern farming system). Under traditional system, the main cost drivers are weeding (accounts for **23.4%**), ploughing (**23.2%**), digging holes (**13.9%**) and support poles (**13.9%**). Under low input system, the main cost drivers are poles and staking (**16.5%**), trapping weevils (**12.8%**), ploughing (**12.7%**) and suckers (**12.0%**). Lastly under high input system, the main cost drivers are mulch & mulching (**23.2%**), manure & its application (**17.3%**), fertilizer & its application (**10.0%**) and poles & staking (**9.1%**). Profitability data for other nodes of the value chains is not available in literature.



- Key support systems to the banana sub-sector in Uganda are categorized into: (i) input suppliers such as Agro Genetic Technologies, (ii) equipment suppliers for production, post harvest handling, and processing, (iii) financial institutions, (iv) information providers and (v) research and development



- Existing agricultural sector enabling environment in Uganda is generally supportive of banana subsector development evidenced by several existing supportive frameworks and policies. Specifically at banana sub-sector level, there is National Agricultural Research Laboratories- NARL (a semi autonomous entity under NARO), mandated to generate and promote improved banana varieties and practices that enhance banana productivity and utilization. Under NARL, there is a special program (i.e. National banana program), has bred seven improved banana (matooke) hybrids since 1990 which yield almost four times compared to the local varieties grown under similar growth conditions and their taste is comparable to the local varieties. Most of these are resistant to tolerant to black Sigatoka, tolerant to nematodes and weevils, and short maturity period. These include KABANA 6H (Kiwangaazi, M9), KABANA 7H (M2), NAROBan 1, NAROBan 2, NAROBan 3, NAROBan 4, and NAROBan 5. Apart from varietal development, NARL has been at the forefront of developing and popularizing improved cultural practices for management of banana bacterial wilt. This has been done through collaboration with development partners such as IITA, CABI and BMGF.



- SWOT analysis that summaries the strengths, weaknesses, opportunities and threats within the banana sub-sector is presented in figure below. Proposed strategies to take advantage of such opportunities are also included

Banana value chain SWOT analysis

		Strengths (S)	Weakness (S)
	Internal factors / *External Factors*	▪ Uganda is among the top producers of bananas globally ▪ New banana cultivars developed by NARL ▪ Bananas are grown in most agro-ecologies ▪ Huge domestic and regional banana market	▪ Underdeveloped banana processing sector characterized with poor technologies and practices. ▪ Low on farm productivity ▪ High post harvest losses that affect 14.9% of the volume of cooking bananas produced, translating into a loss of 1.1 million tons per year ▪ Weak regulation of the sub-sector and dominance of brokers (informality) ▪ Weak market development for diversified banana products ▪ Weak input system and unorganized or weak farmer institutions ▪ In ability to meet phytosanitary and sanitary measures to penetrate export markets ▪ Bananas are almost 80% water which makes dried products price uncompetitive compared to substitutes ▪ Limited information of banana substitute markets to competitively position banana subsector
		SO Strategies	**WO strategies**
Opportunities (O)	▪ Banana plantlet business presents an opportunity for rural entrepreneurs especially youths ▪ Emerging banana markets especially in the Middle East ▪ Productivity is still below potential which present opportunities in varietal improvement, and development of management protocols ▪ Growing export markets ▪ Existence of harmonized standards within EAC to ease trade ▪ Existence of niche market for organic certified bananas in markets like USA	▪ Establish appropriate supportive frameworks and policies for banana sub-sector ▪ Investment in market research to guide further investments in innovations ▪ Strengthen partnerships within regional trading blocs or bilateral agreements to increase market penetration ▪ Develop new products based on different banana varieties because organoleptic properties, nutrient content and texture vary widely across varieties	▪ Strengthening value chain coordination/alliances for industry self regulation, advocacy and improved information sharing with the value chain ▪ Train farmers on improved farming practices especially innovative pests and disease management ▪ Investment in micropropagation facilities closer within production areas ▪ Invest in adequate infrastructure for pre-packaging, transportation, cold storage, packaging and distribution, ▪ Promote appropriate financing mechanisms/schemes for investment in processing and enabling timely access to quality agro-inputs by farmers ▪ Enhance the shelf life of bananas, which is likely to reduce losses due to ripening and bruising through promotion of varieties with intrinsic longer shelf-life (such as Kibuzi) or loss reduction technologies ▪ Promote weight-based pricing system
		ST Strategies	**WT strategies**
Threats (T)	▪ High perishability of bananas ▪ Population boom leading to land fragmentation ▪ Unpredictable weather patterns (drought and hailstorms) ▪ Competition from banana substitutes leading to price volatility ▪ Pests and disease outbreaks especially banana wilt. ▪ Price fluctuations due to seasonality of supply	▪ Adopting genetic engineering to supplement conventional breeding to control pests/diseases and promote desired sensory attributes	▪ Institute policies on land consolidation ▪ Investment in breeding for climate-resilient banana cultivars, and other biotic and abiotic stress especially banana Xanthomonas wilt (BXW), Fusarium wilt ▪ Promotion of sucker staggering for continuous supply across the year

1.2 Key Findings

Much as good progress has been made to develop new cultivars and protocols, popularization of the same among farming community remains limited. Furthermore, research in extended shelf life and value added products with high commercialization potential needs to be enhanced. Through the Presidential Initiative on Banana Industrial Development (PIBID), government has invested substantial resources for research and commercialization of banana value added products, however, mixed assessments have been made because of the failure to reach industrial production and penetrate markets.

Possible reasons for low adoption of developed research products are: (i) weak linkages between research and private sector (especially nursery operators) who play a critical role in commercialization of such technologies; (ii) real needs of users are sometimes not met due to limited involvement of relevant stakeholders during technology development process which is critical for buy-in; (iii) developed technologies are costly in terms of acquisition, operation and maintenance,; (iv) information asymmetry, partly attribution to weak research – extension – end user linkages to facilitate timely and effective dissemination of research products for enhanced awareness and adoption; (v) focus has been more on knowledge transfer or dissemination of research results (through publications, trainings, workshops, seminars, grants, and fellowships) rather than technology commercialization; (vi) mass production (producing the product at a commercial scale) is often the most expensive aspect of the development process as it usually requires investment in a facility, equipment, and workers; (vii) breeding focus has been more inclined towards improved resistance and agronomic characteristics, with less emphasis on consumer tastes and preferences; (viii) limited funding directed to research; and (ix) limited access to demonstration trails by end users i.e. often times, trails are done at research stations which are distant from end users

For research commercialization to be effective, the following needs to be considered: (i) have private sector playing a leading role in commercialisation i.e. involve private sector in early stages of research; (ii) strengthen linkages between research institutions, companies, and broader agricultural development programs with complementary interests; (iii) support the development and use of intermediaries (such as Technology Transfer Office, (TTOs), accelerators, incubators, business and science parks, NGOs etc) to bridge the gap between researchers and businesses; (iv) ensure that public funding allows for co-creation and co-development with private sector; (v) develop systematized structures and procedures to engage with the private sector on research early and at a strategic level as part of the R&D process; (vi) establishing quality control during mass production.

For greater impact, banana research should be driven by the current and future coffee market dynamics. Such dynamics include the following: (i) urbanization which might call for convenience favoring the peeled banana market and shelf life extended banana products, (ii) calls for proper waste management within upcoming towns could drive the peeled cooking banana trade, (iii) incomes and population growth expected to positively influence banana consumption, (iv) youth population and changing lifestyles and culture could lead to decrease in banana consumption per capita due to recent shift to cereal based foods such as rice and maize. Therefore, prices of other carbohydrate substitutes will have a big influence of banana sub-sector performance, (v) new markets such as middle East will drive exports especially for apple bananas and bogoya, (vi) research on pest, diseases and climate tolerance will have a big bearing on production of bananas, and (vii) reducing landholding as a result of population pressure could lead to reduced production.

Key recommendations to increasing commercialisation of banana research are presented in matrix below

Table 2: Specific recommendations for the activity

Theme	Activity	Recommendations
Continued improvement of crop genetics, bio-fortification, and integrated pest and disease management for both crops and livestock, in response to market-demand	Facilitate the release and commercialization of varieties developed under previous and ongoing research efforts	• Organize periodic networking events to bring together researchers with value chain players and enablers i.e. strengthen seed systems, biotechnology and prototyping platforms to enhance service delivery • Strengthen linkages with extension agencies and development partners to leverage networks for catalysing technology commercialization • Advocate for conducive investment climate to incentivize private sector (especially nursery operators) to commercialize innovations such as public procurement, taxation policy, and subsidy scheme for new products to lower product price for market demand generation while covering development costs • Facilitate access to capital for product development • Establish trails on farmer plots for easy buy in.
	Develop improved crop and animal production and management technologies in response to emerging threats and market demands	• Undertake market research in niche or premium and emerging markets to guide NaCORI research • Develop high yielding, drought and disease resistant coffee varieties targeting Screen 18 and above grades. In addition to research in certified and specialty coffees • Adopt interactive development of knowledge and technologies with intended end users rather than development of technologies for potential users • Intensify research on coffee nutrition, management, mechanisation and post-harvest techniques/methods (to create different aromas and unique flavours).
Strengthening NARO's institutional sustainability in the marketplace	Consolidate previous gains in institutional and human capacity development to align research with market needs, and mobilize domestic resources that will displace current development partner funding	• Develop and implement policies, legal frameworks and guidelines for management of IP, technology transfer/ commercialization and partnership with industry • Establish Technology Transfer Offices to support researchers through the formal and administrative aspects of technology commercialization • Build capacity of staff/researchers in modern technology transfer and commercialization process, • Strengthen linkages with business incubators to sharpen entrepreneurship • Equip NARS with adequate equipment and funding of research daily operation expenses (consumables) • Establish innovation fund/vouchers to support spin-offs/start-ups or SMEs commercialize developed products

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Acryomns

AGT: Agro Genetic Technologies Laboratories
ASSP: Agriculture Sector Strategic Plan
BBW: Banana Bacterial Wilt disease
BMGF: Bill & Melinda Gates Foundation
CGIAR: Consultative Group on International Agricultural Research
DRC: Democratic Republic of Congo
EAC East African Community
EU European Union
FAO: Food and Agricultural Organisation
FHIA: Fundacion Hondureade De Investigacion' Agricola
FtF: Feed the Future
GAPs: Good Agricultural Practices
ICT: Information Communication Technology
IITA: International Institute of Tropical Agriculture (IITA)
Kg: Kilogram
MAAIF: Ministry of Agriculture, Animal Industry and Fisheries
MT: Metric Tonnes
NAADS: National Agricultural Advisory Services
NaRL: National Agricultural Research Laboratories
NARO: National Agricultural Research Organisation
NAROsec: National Agricultural Research Orgnisation Secretariat
NBC: National Biosafety Committee
NBRP: National Banana Research Programme
NDP III: Third National Development Plan
NGO: Non Government Organisations
PIBID: Presidential Initiative on Banana Industrial Development
PVP: Plant Variety Protection
R&D: Research and Development
ROI: Return on Investment
TTO: Technology Transfer Office
UAE: United Arab Emirates
UBOS: Uganda Bureau of Statistics
UGX Uganda Shillings
UIRI: Uganda Industrial Research Organisation
UK: United Kingdom
UNBS: Uganda National Bureau of Standards
US$ United States Dollars
USA United States of America
USAID: United States Agency for International Development
ZARDI: Zonal Agricultural Research and Development Institute
ZoI: Zone of Influence

Acknowledgement

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Lastly, to all organizations, private companies and individuals whose data data and information has been used to develop this report.



1. Introduction

Its estimated that the agricultural sector in Uganda employs about over 63.4% of the labour force is employed in the sector[1], contributes to more than 50% of country's export earnings, and approximately 60% of manufacturing output[2], making it an important sector for economic growth.

According World Bank, agriculture sector is two to four times more effective in reducing poverty compared to other sectors [3]. However sector's contribution to gross domestic product (GDP) stands at only 24%[4], and for the past 5 years the sector has only grown at an average of 3.9% per annum against set target of 6% per annum from 2015/16 to 2019/20[4 & 5].

General slow sector growth is attributed to: (i) low agricultural production and productivity; (ii) poor storage infrastructure and post harvest management; (iii) low value addition; (iv) poor market access and low competitiveness of agro based products in domestic, regional, continental and international markets; (v) limited access to agricultural financial services and critical inputs; and (vi) poor coordination and inefficient institutions for planning and implementation of agro industrialization[6].

Amidst the above challenges, the sector has a huge untapped potential to contribute to country's GDP and reduce poverty through employment creation, a reason for sector prioritization under agro-industrialisation, export promotion and private sector development strategies of the National Development Plan 2020/21 – 2024/25 (NDP III).

Bananas were identified among the 10 priority commodities in the National Development Plan (NDP III) for fostering development of agricultural sector and specifically agro-

1 Uganda Bureau of Statistics (UBOS), 2018. Uganda National Household Survey 2016/2017, UBOS, Kampala, Uganda.
2 Ministry of Agriculture Animal Industry and Fisheries (MAAIF), 2020. Situation Analysis of Agricultural Sector in Uganda, MAAIF, Kampala, Uganda.
3 World Bank, 2021. Agriculture and Food, World Bank, Washington DC, USA. Available on https://www.worldbank.org/en/topic/agriculture/overview#1
4 Uganda Bureau of Statistics (UBOS), 2020. Statistical Abstract 2020. UBOS, Kampala Uganda.
5 Ministry of Finance, Planning and Economic Development (MoFPED), 2020. Agricultural Sector Annual Budget Monitoring Report. Financial Year 2019/20, MoFPED, Kampala, Uganda.
6 National Planning Authority (NPA), 2020. NDP III Agroindustrialisation Programme Implementation Action Plan, NPA, Kampala, Uganda.

industralisation strategy. Furthermore, bananas are a major staple, thus contribute significantly to population's food and nutrition security. However, banana sub-sector growth is still challenges by: (i) underdeveloped banana processing sector characterized with poor technologies and practices, (ii) low on farm productivity, mainly due to disease and pests burden, (iii) high post harvest losses due to poor marketing infrastructure and technologies, (iv) unstructured value chain that is dominated by middlemen, and many other factors. Potential across the value chain is underutilized which call for deeper understanding of the underlying issues and also explore how research and development can play a more significant role in addressing these challenges.

1.2: About USAID FtF Uganda Agriculture Research Activity

USAID FtF Uganda Agriculture Research Activity is a 5 year, US$10 million flagship research and development project, funded by USAID and implemented by CGIAR centers and NARO which seeks to promote use and commercialization of improved crop and livestock technologies with yield and nutrition enhancing characteristics. Since 2004, USAID has invested over US$17.8 million to support research efforts (for both crops and livestock) in Uganda, in addition establishing NARO as a premiere research organization on the continent through infrastructure and human capacity development. Although NARO continues to develop new technologies to respond to development challenges, commercialization of such technologies remains the biggest impediment for the institution. Although this activity will continue to support development of new technologies, more focus will be put on positioning NARO as a leader in commercializing transgenic and conventional crop and animal technologies through (i) establishing partnerships/market linkages with private sector to take up developed technologies, (ii) partnering with other USAID Uganda activities to leverage public and private sector resources and sell its products

The activity focuses on: (i) continued improvement of crop genetics, bio-fortification, and integrated pest and disease management for both crops and livestock, in response to market-demand, and (ii) strengthening NARO's institutional sustainability in the marketplace. Specific activities that the project focuses on include: (i) facilitate the release and commercialization of varieties developed under previous and ongoing research efforts, (ii) develop improved crop and animal production and management technologies in response to emerging threats and market demands, and (iii) consolidate previous gains in institutional and human capacity development to align research with market needs, and mobilize domestic resources that will displace current development partner funding.

The activity is implemented through different Consultative Group on International Agricultural Research (CGIAR) centers, collaborating with specific NARO research institutions based on the targeted value chains. CGIAR centers and NARO also leverage expertise from USAID/ Washington staff, Feed the Future Innovation Labs and other centrally-funded research programs. Lastly, the activity leverages on-going USAID projects in Uganda (such as Inclusive Agricultural Markets activity, USAID Uganda's Biosafety activity, and Institutional and Systems Strengthening activity) to facilitate private sector engagement and assess demand for new products that need to be developed and commercialized.



1.3: Specific objectives and outputs of the study

Table 1: Specific objectives and outputs of the study

Specific objective	Deliverable
Conduct livestock (banana) value chain analysis	Value chain assessment report highlighting current and future trends in Uganda's coffee value chain
Identify the most profitable nodes for each of the focus value chains based on return on investment (ROI)	Most profitable nodes identified based on return on investment analysis
Suggest best interventions to catalyze agro-industrialization at profitable nodes	Compendium of proposed interventions for NAROsec and others to catalyze agro-industrialisation at profitable nodes of coffee value chain



2. Methodology

Data and information contained in this report was obtained principally from existing literature through desk research. The data was analyzed and triangulated to come up with different analytical products and also to inform recommendations. The approach used is presented on schematic diagram in Figure 1.

Approach

Description of Phase	Phase I	Output
Comprehensive review of literature, data mining and analysis was undertaken to produce secondary based report	Phase I: Secondary data review	Secondary data based report

Sources: *UCDA website and reports, online publications, ICO reports, online databases such as ITC website*

Figure 1: *Schematic for the Methodology and Approach*

Limitations to the study

The study mainly relied on secondary data sources some of which were not upto date especially information on trade, gross margins etc.
Information on ongoing development initiatives, value chain support function and banana research process was scanty



3. Key Findings

3.1: Banana Market Review

3.1.1: Global banana Industry

In 2019, global banana production reached 116 million tonnes [7]. World production of bananas to grow at 1.4% p.a., to reach 138 Mt in 2030 [8]. Dessert banana varieties (Cavendish, Gros Michel and others) accounted for 59%, while cooking banana varieties for 17% (Figure 2). Since 2015, production has been on a decreasing trend, registering a 75% decrease [9]. This is mainly attributed to biotic and abiotic stress in the major production zones.

The main production zones are located in Asia, representing 49 - 53% of global production, followed by Americas (23%%), Africa (17%) and the rest account for the remaining proportion. By country, India is the leading banana producer globally (13.46 million MT), followed by China (11.6 million MT) and Indonesia (7.28 million MT) as shown in Figure 3 [9].

Globally, dessert bananas have become an important part of the diet. Bananas are largely consumed domestically in producing countries, where they provide a substantial source of nutrition and food security for more than 400 million people [9]. They are the staple food for millions of people and are considered the world's preferred fruit, given that they provide an affordable source of energy, vitamins, and potassium (10). In Africa alone, bananas are a source of income and jobs for more than 70 million people [10].

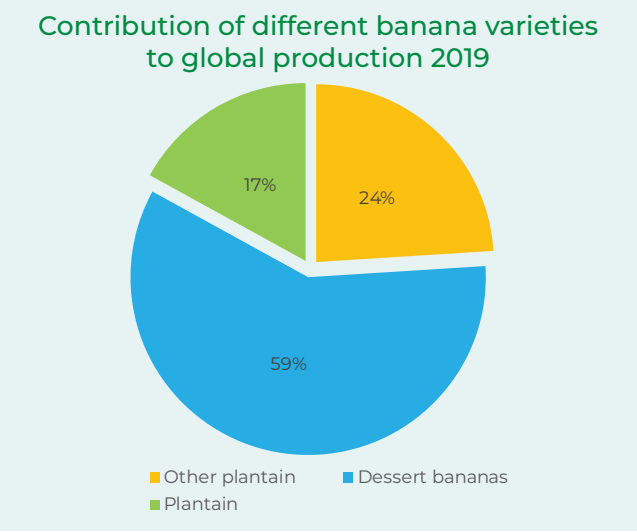

Figure 2: Banana production by varieties

Asia-Pacific leads the banana market with a 61.0% share of the global consumption [7]. In terms of dessert bananas, Papua New Guinea ranked the highest in banana consumption per capita with 135 kg followed by Laos (115ks) and Rwanda (67kg) [11].

On the other hand, countries with the highest levels of plantain/cooking banana per capita consumption in 2018 were Cameroon (197 kg/capita/year), Ghana (141 kg/capita/year) and Uganda (68 kg/capita/year). The most notable rate of growth in terms of plantain per capita consumption was attained by Democratic Republic of the Congo [12].

However, with respect to importing markets, England (16 kg/capita/year), followed by Israel (15 kg/capita/year), Germany (12 kg/capita/year) have the highest per capita consumption for bananas (mainly dessert). Figure 4 shows capita consumption of different regions of the world.

Consumption markets are still on the rise, and more particularly in the emerging markets and with COVID 19 pandemic many consumers are expected to increase their consumption in a bid to boost immune system .

7 – Mordor Intelligence, 2021. Banana Market – Growth, Trends, COVID-19 Impact and Forecasts (2022 - 2027). Accessed on Banana Market | 2022 - 27 | Industry Share, Size, Growth - Mordor Intelligence
8 – OECD and FAO (2021). OECD-FAO Agricultural Outlook 2021-2030. Accessed on https://www.oecd-ilibrary.org/sites/e1ed44a3-en/index.html?itemId=/content/component/e1ed44a3-en
9- United Nations Conference on Trade and Development (UNCTAD), 2016. Banana. An INFOCOMM Commodity Profile. UNCTAD Trust Fund on Market Information on Agricultural Commodities, UNCTAD, Geneva, Switzerland.
9 International Coffee Organisation (ICO), 2021. Coffee Market Report, August 2021, ICO, London United Kingdom.
10 International Trade Centre (ITC), 2021. ITC statistics, ITC, Geneva, Switzerland.
11 Caldarelli C. E., Gilio L., Zilberman D., (2019) "The Coffee Market in Brazil: challenges and policy guidelines", São Paulo, Brazil.

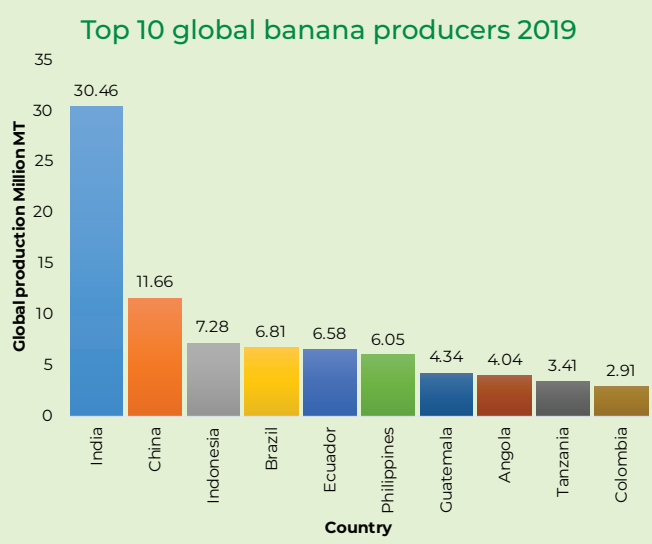

Figure 3: Top 10 Banana producers

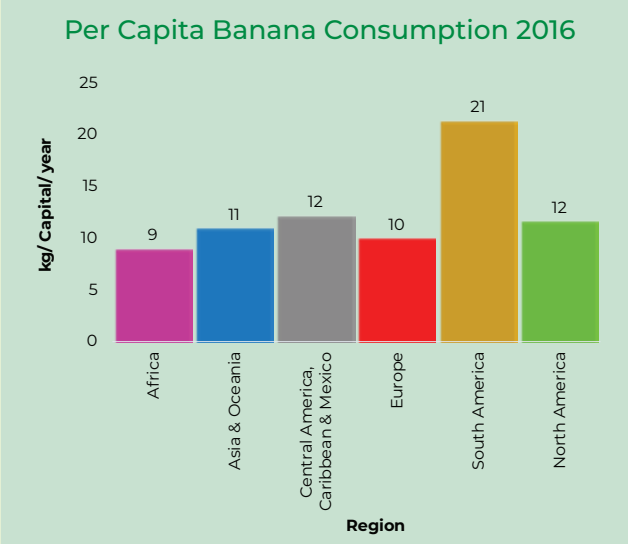

Figure 4: Per capita dessert banana consumption for different regions

3.1.2: Global Trade in Banana Products – Exports

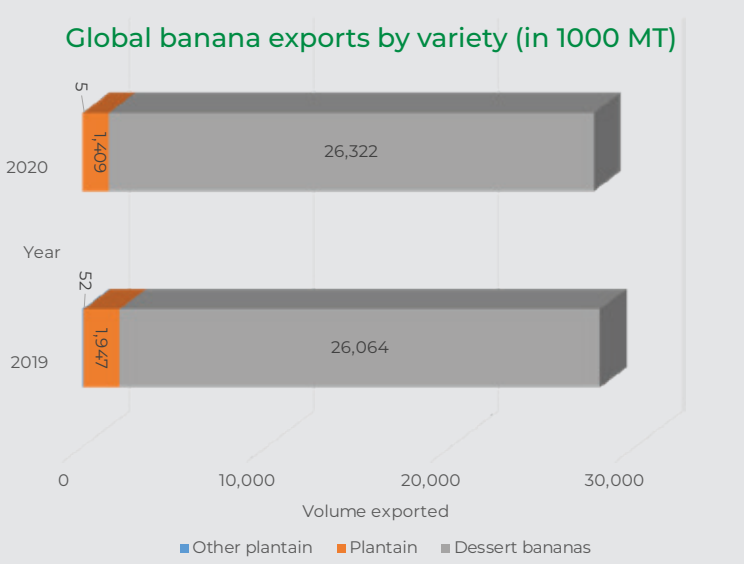

Figure 5: Global banana exports by variety

In terms of quantity, bananas remain the number one fruit traded globally ahead of apples or citrus groups [10]. However global trade represents only 21.8% of world banana production. This could be attributed to its high perishability which makes transportation over long distances expensive. Therefore local consumption or domestic markets are the main outlets for production (i.e. 78.2%). Dessert bananas are the most exported (mainly cavendish variety, probably because its more resistant to physical shocks during transportation), with estimates as 2020 reaching 26.3 million MT (94.9% of total global exports) (Figure 5) [13]. This is in comparison with only 3.4 million MT (5.08% of total global exports) of cooking bananas and 4,783 MT (0.02% of total global exports) of other plantain [10].

Most of the bananas are traded as fresh form: Available statistics report an aggregate of fresh or dried bananas (excluding plantains) and fresh or dried plantains, while no data is provided for processed banana products [13].

Ecuador dominates global dessert banana exports, followed by Philippines, Costa Rica, Colombia and Guatemala (Figure 6). Myanmar dominates global Plantain exports, followed by Guatemala, Ecuador, Dominican Republic, and Colombia (Figure 7) [13].

10- Voora V., Larrea C., Bermudez S., (2020). "Global Market Report: Bananas. Integrated Seed Sector Development (ISSD) report: Sustainable commodities marketplace series 2019." ISSD, Kampala, Uganda.
11- Helgi Library, 2021. Banana Consumption Per Capita. Accessed on https://www.helgilibrary.com/indicators/banana-consumption-per-capita/
12- IndexBox, 2019. Africa's Plantain Market to Reach Over 30M Tonnes by 2025. Published report in Global trade magazine : 'Africa – Plantains – Market Analysis, Forecast, Size, Trends and Insights'. https://www.globaltrademag.com/africas-plantain-market-to-reach-over-30m-tonnes-by-2025/. accessed 13/Dec/21

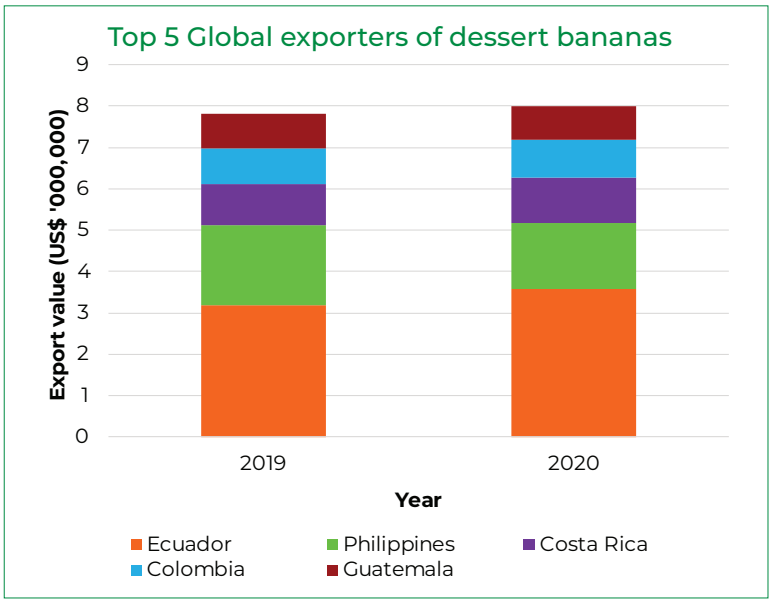

Figure 6: Top exporters of dessert bananas

In Africa Ivory coast is the leading exporter mainly to European union followed by Cameroon, Mozambique, and Ghana. Its also worth noting that unlike leading producers where domestic consumption is the main market outlet, Ecuador is primarily focused on exports (100% of volumes produced). Ecuador supplies all the world markets, with nearly 61.8% of its supply aimed at the three main ones, the Russia, USA, and EU, as well as UK [14].

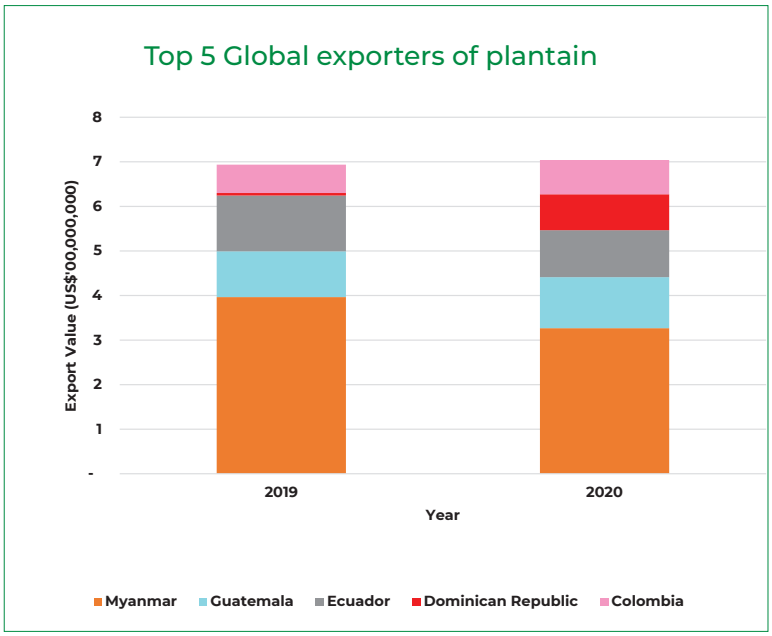

Figure 7: Top exporters of plantain

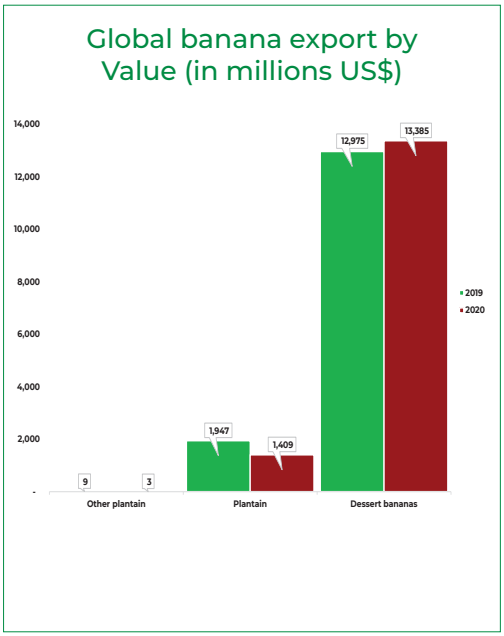

Figure 8: Global banana exports by value

9 International Coffee Organisation (ICO), 2021. Coffee Market Report, August 2021, ICO, London United Kingdom.
10 International Trade Centre (ITC), 2021. ITC statistics, ITC, Geneva, Switzerland.
11 Caldarelli C. E., Gilio L., Zilberman D., (2019) "The Coffee Market in Brazil: challenges and policy guidelines", São Paulo, Brazil.

3.1.3: Global Trade in Banana Products - Imports

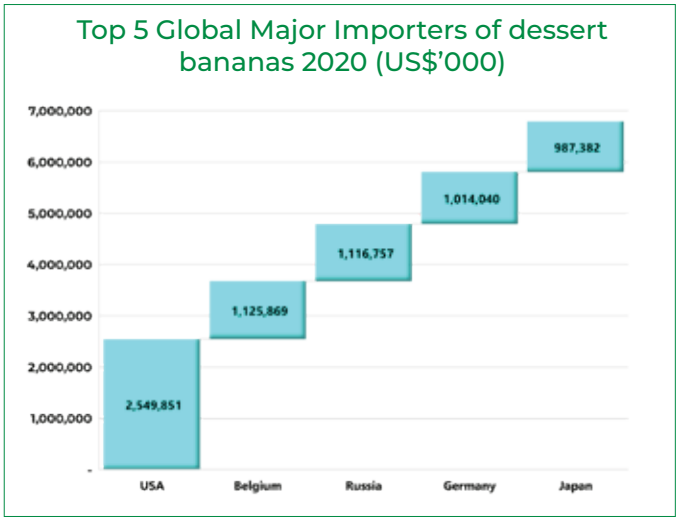

Figure 9: Top importers of dessert bananas

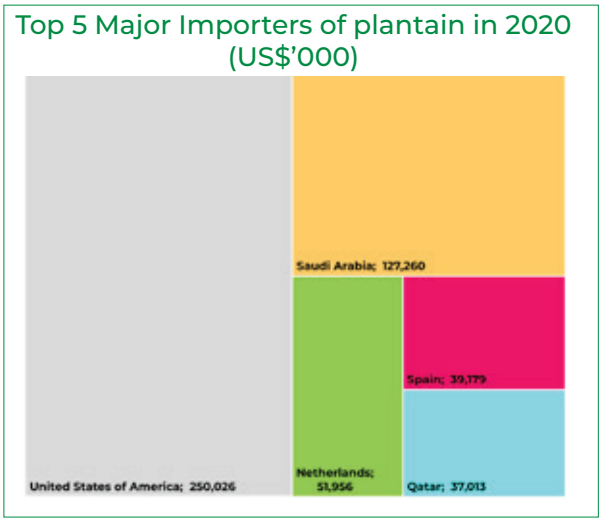

Figure 10: Top importers of cooking bananas/plantain

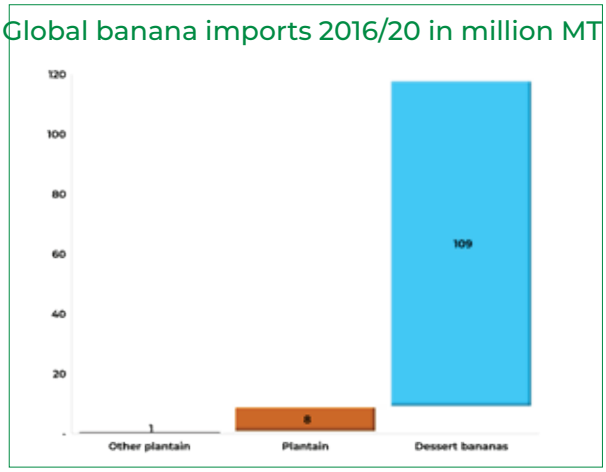

Figure 11: Global banana imports by varieties in volumes

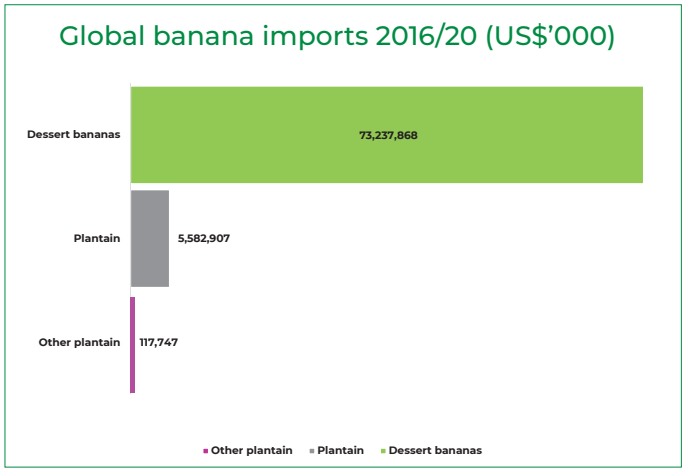

Figure 12: Global banana imports by varieties in value

The biggest import markets for dessert bananas in 2020 were USA (37.5% of total global imports), Belgium (16.6% of total global imports), Russia (16.4% of total global imports), Germany (14.9% of total global imports) and Japan (14.5% of total global imports) as shown Figure 9 [3]. Apart from the traditional markets, there are emerging markets especially in the middle east and Eastern Europe where imports for dessert bananas have increased by 34.4% over the last 10 years [14].

The biggest import markets for plantain are USA (30.1% of total global imports), Saudi Arabia (14% of total global imports), and Netherlands (5.6% of total global imports) as shown Figure 10 [13].

Its also important to note that the main importing countries are not necessarily the main consumer countries, since some act as a hub for the banana trade. For example, Belgium, the world no. 3 importer, which imported 1.2 million MT of bananas in 2020 via Antwerp, but which re-exported the bulk of it to neighbouring European countries. It is also the case with Germany (port of Hamburg) and the Netherlands (port of Rotterdam). France also acts as a hub for produce from Africa and the French West Indies, with which it has maintained close historical ties, and re-exports one-third of incoming volumes [9].

9- United Nations Conference on Trade and Development (UNCTAD), 2016. Banana. An INFOCOMM Commodity Profile. UNCTAD Trust Fund on Market Information on Agricultural Commodities, UNCTAD, Geneva, Switzerland.
13- International Trade Center (ITC), 2021. Trade map: Trade statistics for international business development, ITC, Geneva, Switzerland. https://www.trademap.org/Product_SelProduct_TS.aspx?
14- Food and Agriculture Organization (FAO), 2020. Banana Statistical Compendium 2020. FAO, Rome, Italy

So what? Given that Dessert (cavendish) banana account for 94.5% of global trade, Uganda should re-focus its efforts to tap into this market.

3.1.4: Global Banana Price Review

Since 2010, import prices on European Market have oscillated between 756 euros and 854 euros, reaching its maximum in 2012 (Figure 13) [14]. Generally prices have remained stable over the years, registering only 4% increment. Fluctuations in prices are however observed during the year (Figure 14)) largely due to seasonality of demand and production related challenges such as cooler temperatures or weather related events such as El Niño phenomenon and drought that affect some production in some major exporting countries [9].

Europe has seasonal banana consumption which is dependent on temperatures, competition from other fruits and school calendar. Consumption peaks in autumn and early spring (April-May and October) when temperatures are favourable for banana consumption and low competition from local fruits [9]. Demand decreases during summer and end of year holidays when school canteens are closed, temperatures push consumers towards other products. And demand turn to other local seasonal fruits [9].

Spread of the recently emerged Tropical Race 4 strain of the fungal disease Fusarium wilt in banana plantations in major exporting countries might have an impact on production, ultimately impacting prices [10]

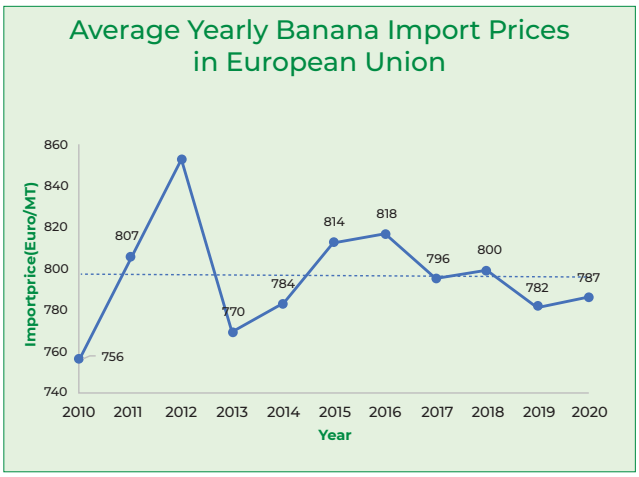

Figure 13: Global Prices of different dairy products

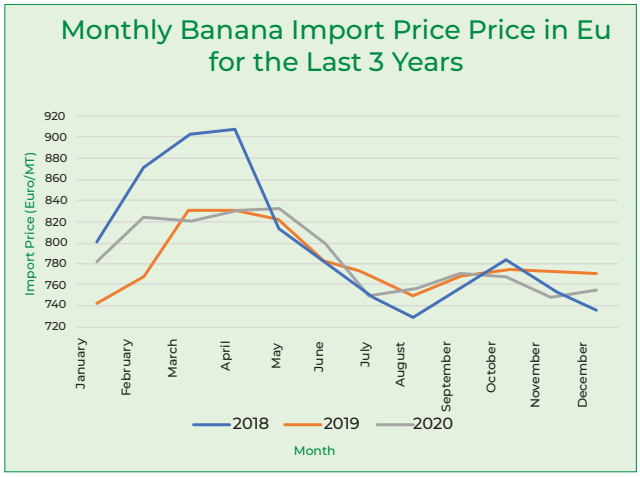

Figure 14: Monthly banana import prices in EU

9- United Nations Conference on Trade and Development (UNCTAD), 2016. Banana. An INFOCOMM Commodity Profile. UNCTAD Trust Fund on Market Information on Agricultural Commodities, UNCTAD, Geneva, Switzerland.
10- Voora V., Larrea C., Bermudez S., (2020). "Global Market Report: Bananas. Integrated Seed Sector Development (ISSD) report: Sustainable commodities marketplace series 2019." ISSD, Kampala, Uganda.
14- Food and Agriculture Organization (FAO), 2020. Banana Statistical Compendium 2020. FAO, Rome, Italy

3.1.5: Global trends shaping current and future Banana markets

Trends expected to shape current and future banana markets include (9 & 10):

- Project growth in banana demand will primarily be driven by increasing demand in producing countries (with Asia – Pacific region account for 61% of global production) as a result of population growth, improvements in per capita incomes, and associated shifts in diets related to health benefits and awareness
- Growing health conscious population. Bananas are also becoming increasingly popular in Europe and North America, with consumers increasingly looking for healthier options, such as bananas and other tropical fruits, to replace products containing refined sugar. Covid 19 pandemic has amplified this need as consumers aim to increase their intake of fresh fruits and vegetables
- Increasing demand for Fairtrade and organic bananas on global markets. Organic banana market poised to grow by US$252 million between 2021 and 2025, with forecasted annual growth rate of 9% [15]. United States will remain the major global market for organic bananas. Major global organic banana market vendors that include Agrofruit Holding Corp., Chiquita Brands International Sarl, Coliman Grupo SA de CV, Compagnie Fruitiere, Dole Food Co. Inc., Fresh Del Monte Produce Inc., Grupo Iren Fruits SL, Melissas World Variety Produce Inc., Sumitomo Corp., and The Grupo Daabon.
- There is also a trend toward dual certification. In France, supermarkets such as Carrefour have opted to convert their organic bananas to organic-Fairtrade.
- Production and supply on the world markets will continue to be affected by weather related events such as severe floods/heavy rains, cooler temperatures, winds and mudslides. These affect banana plant cycle and consequently lead to yield losses. Not only do these affect production but also rural infrastructure such as roads. On the other hand drought also lead to yield loss.
- Diseases which affect production especially fungal diseases such as Black Sigatoka (or black leaf streak disease), banana wilt, and Fusarium wilt (it wiped out the Gros Michel variety in the 1960s and is now threatening the Cavendish with its new Tropical Race 4 strain).
- Acceptance of genetically modified crops which are more resistant to some of the biotic stresses

9- United Nations Conference on Trade and Development (UNCTAD), 2016. Banana. An INFOCOMM Commodity Profile. UNCTAD Trust Fund on Market Information on Agricultural Commodities, UNCTAD, Geneva, Switzerland.
10- Voora V., Larrea C., Bermudez S., (2020). "Global Market Report: Bananas. Integrated Seed Sector Development (ISSD) report: Sustainable commodities marketplace series 2019." ISSD, Kampala, Uganda.
15 – Research and Markets, 2021. Global Organic Banana Market 2021-2025. Accessed on https://www.researchandmarkets.com/reports/5311034/global-organic-banana-market-2021-2025

3.1.6: EAC Market and inter- regional trade

According to FAOSTAT (2016), annual banana production in the East African region was 16 million tonnes, with Uganda and Tanzania contributing more than 50% of total production [16]. All banana production in east Africa is done by smallholder farmers, who mainly market the raw produce through informal channels (control over 90% of banana market).

Demand for bananas is expected to increase in the region due to increasing urbanization, population growth and the increase in the deposable income of middle class.

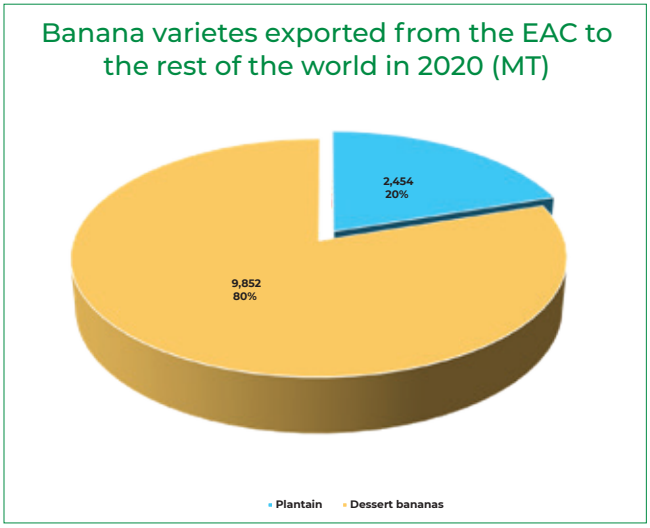

Figure 15: Exports by variety from EAC region to rest of the World

In the region only 0.14% (12,306 MT against 8.7 million MT produced) of bananas production was traded beyond the region [13]. This means that almost all the bananas produced are consumed within the region. In 2020, the region exported 2,454 MT of plantain (worth US$ 2 million) and 9,852 MT of dessert bananas (worth US$ 2.6 million), up from 1,258 MT of plantain (valued at US$ 928,000) and 9,453 MT of dessert bananas (worth US$ 434, 000) that was exported in 2019 [13]. EAC region exports are very low. The low EAC export trade to other regions could be attributed to strong competition from more advanced banana producers from south America and failure to meet the quality requirements in the importing countries [13].

Exports were mainly destined to South Sudan USA, UK, Canada, Somalia, Malawi, Australia, Botswana, Zambia, UAE, Sweden, Belgium, Italy and Germany. The largest exporter was Tanzania, exporting more of dessert bananas (to Zambia and Malawi), and small quantities of plantain (to Malawi, Australia and Botswana). The second leading exporter from the region was Uganda, exporting more of plantain (to South Sudan and USA), and negligible quantities of dessert bananas (to DRC). Rwanda comes in third, exporting more of dessert bananas to Belgium, and Kenya comes in fourth with exporting dessert bananas to Norway [13].

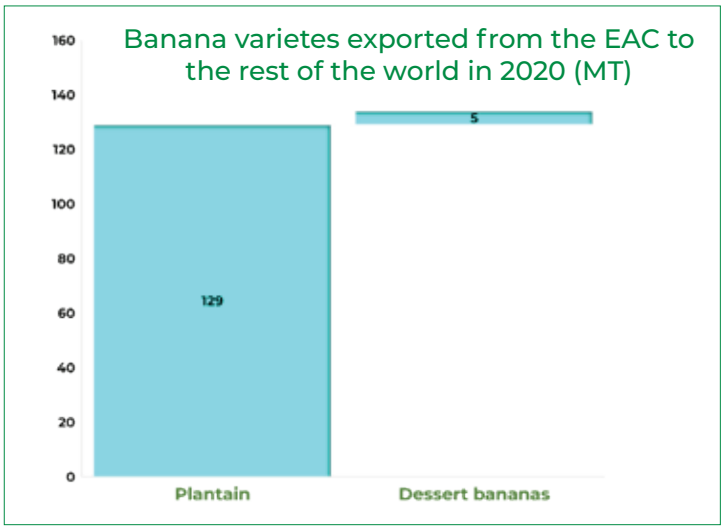

Figure 16: Banana imports (MT) into EAC region by variety

The demand gap for the different types of bananas is shown by the amount imported from outside EAC. In 2020, the region imported 129 MT of plantain (worth US$ 22,000), and 5 MT of dessert bananas (worth US$ 7,000), up from 299 MT of plantain (valued at US$ 20,000) and 7 MT of dessert bananas (worth US$ 2,000) that was imported in 2019 (13). The decrease could be due to COVID impacts on trade. Kenya was the main destination for dessert bananas

followed by Uganda and Tanzania in the period 2016 to 2020. Uganda and Tanzania were the only destination for plantain in the same period (13).

The major suppliers of dessert bananas to Kenya are South Africa, UK and Ecuador. The major supplier of dessert bananas to Uganda is DRC (17). The major suppliers of dessert bananas to Tanzania are Germany, South Africa and UAE. The major supplier of plantain to Tanzania are South Africa and UK. The major supplier of plantain to Uganda is DRC (17). This is mainly through informal channels.

3.1.7: Intra Regional Trade in Banana Products

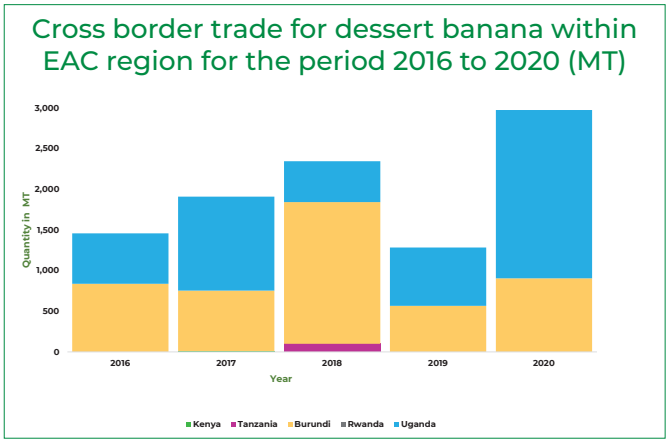

Figure 17: Cross border trade for dessert bananas within EAC region

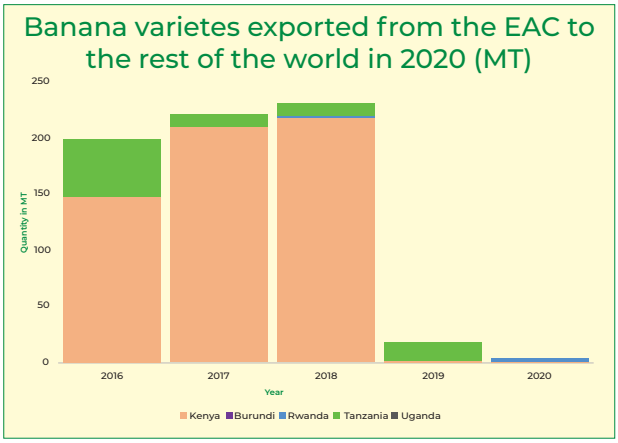

Figure 18:Cross border trade for plantain within EAC region

- Formally, 2,982MT of bananas valued at US$ 610,000 was traded among EAC countries in 2020. This trade has been increasing for the last 5 years at a rate of 18% as shown in figure 16 [13].
- The main exporters of dessert bananas to EAC counterparts are Uganda, and Burundi (Figure 17). Kenya is the main destination for dessert bananas from EAC countries. Kenya is followed by Rwanda, Burundi and Tanzania. On average within the region 2,977 MT, valued at US$ 608, 000 of dessert bananas was traded for the period in 2020. While plantains was 5MT valued at US$2,000. Rwanda is the main destination for plantain from EAC countries followed by Uganda [13]. Export of plantains from Uganda are mainly to Kenya as shown in Figure 18 [13].
- Level of intra-regional trade in different varieties of bananas compared to total production, shows a big potential for growth if more investments are made to unlock opportunities in banana value chain. There is potential for large producers like Uganda and Tanzania to supply EAC countries that are importing from outside the region. Regional demand for bananas is mainly driven by urbanization, growing middle class with more disposable income, and population growth.

3.1.8: Domestic Banana Market in Uganda

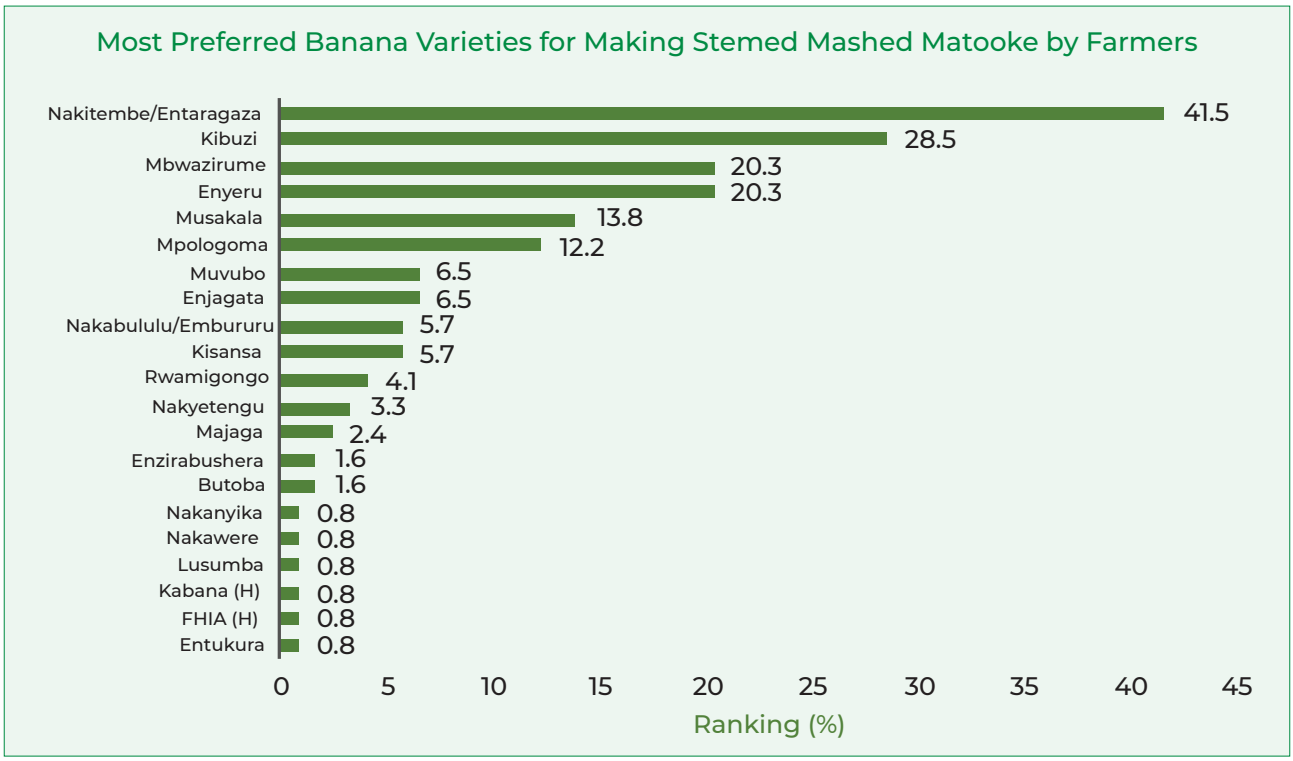

Figure 19: Most preferred banana varieties

- Bananas are an important dietary staple to over 13 million people in Uganda [16 & 18]. 17% of total daily per capita caloric food intake in Uganda is contributed by bananas [18]. Cooking banana per capita consumption stands at 68Kg/capita per year [12].
- Bananas are consumed in different forms based on the type. The most consumed type is the cooking banana (Matooke) which accounts for over 90%. Its harvested at green stage (fruit mature), peeled, steamed and mashed (wrapped in banana leaves) or boiled in water, then typically eaten with or without a sauce [19 & 20]. At times banana fingers are cooked/ steamed without peeling (empogola) and served as light meal, though in rare occasions. When cooked, Matooke is characterized by a unique flat taste and aroma, golden yellow colour and a soft texture. Cooking bananas when ripe are also used for juice production.
- Preferred traits that influence consumers purchase decision in order of importance are: (i) big fingers, (ii) big bunches, although most families are becoming smaller in size which might positively influence sale of fingers or well peeled and packaged bananas in smaller weights, (iii) yellowish/cream pulp in colour, (iv) soft when touched and cooked, (v) tasty and good aroma, (vi) shinny light green fingers, (vii) disease free or spot less fingers, (viii) long fingers, (ix) low sap content, although fingers with much sap give better steamed matooke, (x) easy to peel i.e. soft or thin peel and (xi) shelf life [19]. Its also important to note that price heavily influence purchase decisions. Most of the above traits are influenced by variety. From Figure 19, its clear that the most demanded banana varieties for steamed matooke are local; improved varieties such as FHIA and Kabana are ranked the least [19].
- Consumers purchase bananas as bunches (47%), unpeeled banana fingers in bags (17%), heaps of unpeeled banana (15%), clusters (11%), and peeled bananas (10%) [21]. The main

distribution outlet for cooked bananas are open markets. 60% of the banana sold in the open markets in the urban centers goes to individual households consumers, while the rest goes to other customers such as hotels and restaurants. With families becoming smaller, need for consumer convenience and poor waste management in urban areas, peeled banana market share is expected to grow. This can also facilitate labelling to meet the needs of a growing consumer population that is looking for specific varieties of bananas to purchase for consumption.

- Roasting bananas (mostly gonja) is harvested at green mature stage, ripened, peeled and roasted/grilled on a wire mesh using charcoal stoves. The main market segment for this type are long distance travelers that purchase it from bus stops and consume it as a light meal. However, a few cottage processors are using it to produce deep fried crisps sold through supermarkets. At household level, its also cooked/steamed and consumed as breakfast snack [22].
- Dessert bananas (mainly Gros Michel (Cavendish) and apple bananas/sukali ndizi) are consumed as a fruit or pulp mixed with cassava flour to make a cake that is deep fried, locally known as Kabalagala sold in schools and road sides. Dessert bananas are sold in open markets and exported [22].
- Beer bananas are mainly used to make non alcoholic and alcoholic beverages. There are mainly four major products from beer bananas i.e. juice, wine, beer and waragi/brandy or gin. These are mainly produced from Kayinja, Kisubi and Mbidde cultivars. However, of recent, most processors are adopting cooking bananas for beverage production due to low production of beer bananas, attributed to banana Xanthomonas wilt significant impact on beer banana production [23].

3.1.8: Domestic Banana Market in Uganda

- Originally, the juice was made for home consumption, however of recent, there are few cottage and small processors who have presented branded products on the market. Alcoholic beverages such as home-brewed waragi and banana beer are more popular in rural areas (rural bars) than in Kampala because of the high competition from established alcoholic companies. Waragi is the most consumed because it's the cheapest way of getting drunk. However, slight increase in incomes, makes consumers to switch to bottled beer [23].
- With establishment of modern banana wineries such as Silgad Investments Ltd, Afri banana Ltd, there are several cottage industries that process and brand banana wine sold through retail shops/dukas and a few supermarkets. The same is true for banana beer/ tonto that is bottled and sold through the same network by companies such as KDB Kyarenga Wines. These mainly target the low income market segment. With product and process upgrading, the potential of banana beverage industry is huge.
- Other products produced from bananas though at very low scale include banana flour (raw or instant) and crafts mainly targeting the export market with no or limited domestic market penetration.
- Potential products that can be exploited include: (i) thickening, colouring and flavour agents, (ii) textiles, (iii) macro and micro-nutrients, (iv) nutraceuticals, (v) animal feed, (vi) natural fibre to make ropes (vii) charcoal briquettes, and (viii) bio-fertilisers [24].

- Apart from the attributes presented above that influence purchase decision decisions of cooking bananas, general factors that influence or likely to influence future banana industry in Uganda include: (i) Urbanization which might call for convenience favoring the peeled banana market, (ii) Beverage sector (both soft and alcoholic) which directly compete with banana beverage sector, (iii) price of other carbohydrate substitutes, (iv) culture – bananas are a staple, (v) population growth in Uganda and (vi) growing export markets.

3.1.9: Uganda's Banana Products Imports and Exports

- Uganda imports from other countries, although volumes are low. For instance, Uganda imported banana products worth US$25,000 (135 MT) in 2020 [13] compared to US$10,000 million imported in 2018, mainly in form plantain (representing 99.3% of total import volumes). Plantain specifically 'gonja' is a growing market segment, mainly targeting the urban population Kampala metropolitan. Value addition on plantain (gonja) presents a unique opportunity that can be tapped into by local processors, however, it requires substantial investment in quality assurance along the value chain.
- Uganda's plantain imports mainly come from DRC (129 MT representing 96.3%), and Tanzania (5 MT representing 3.7%) [13]. Plantain is imported in fresh form. Only 1MT of dessert bananas was imported into the country in 2020.
- Plantain (specifically 'matooke') is an important staple in Uganda, which could explain its prioritization by government. As such, Uganda is a major exporter of plantain within and the EAC region. Uganda is also a major exporter of dessert bananas within and the EAC region [13].
- According to ITC (2021), in 2020, Uganda exported 6,162 MT of bananas, valued at approximately US$ 3.445 million up from 5,079 MT (valued at US$ 2.7 million) in 2019 [13]. This was attributed to increased in the quantity of dessert bananas exported which grew at a rate of 175 in the two years.
- In 2020, exports were mainly in form plantain (3,995 MT valued at US$ 2.825 million) and dessert bananas (2,167 MT valued at US$ 620,000). Plantain exports were mainly exported to Kenya, South Sudan, United States of America, Canada, Rwanda, Sudan. Dessert bananas were exported to Kenya, Canada, Democratic Republic of Congo, United States of America, Sudan [13].
- According to ITC (2021), Uganda's untapped export potential for bananas stands is US$ 5 million. In the terms of products, the highest potential is in dessert bananas followed closely by plantain [13].
- To tap into this potential, Uganda needs to capitalize on its low banana producer price, invest in the cold chain for along the value chain with emphasis on transportation of fresh produce, processing of organic dessert banana products, and ensure export of the highest quality fresh bananas especially in the region.

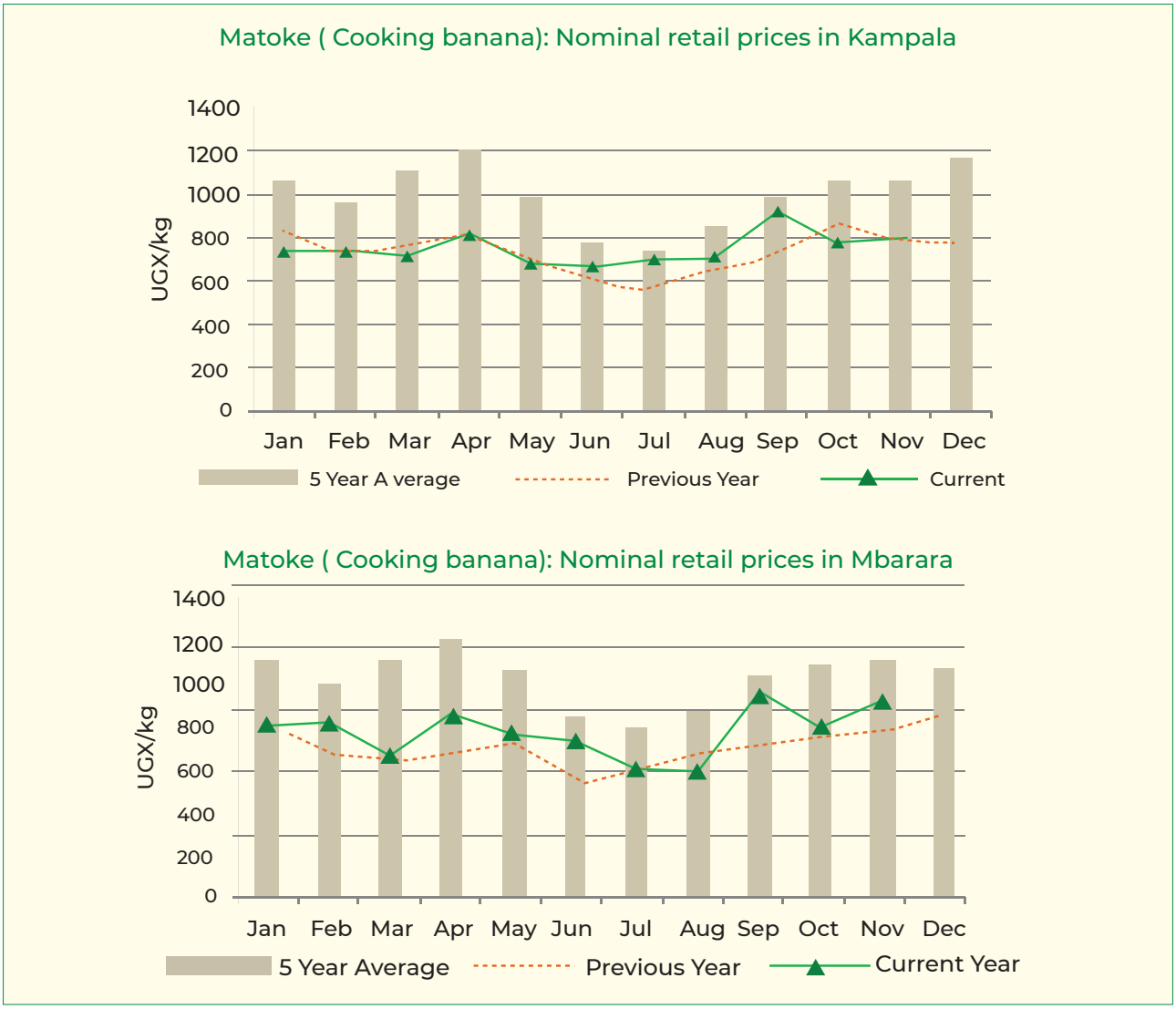

Figure 18:Cross border trade for plantain within EAC region

- Prices of matooke vary across the year and follow supply seasons (Figure 20) [25]. Peak season is normally observed in the months of June, July and August, and this coincides with low lowest prices observed within the year [26]. On the other hand, low supply season is between September and May, which coincides with the higher prices. Highest prices are observed in April and December, mainly because of the festive seasons when demand is the highest. In Kampala (which is the main market), retail prices can go as high as UGX 30,000 and 25,000/ bunch (of 23 -25kg), implying UGX1,200 per kilogram, While the lowest prices can be as low as UGX 14,500 per bunch (implying UGX 580 per Kilogram) during peak season

- Unlike other years, 2020 and 2021, saw matooke prices going below the 5 year average mainly attributed to COVID-19.

  However its important to note that matooke prices are determined by bargaining since no proper weighting system is used in the main distribution channel.

3.2: Banana Market System Development mapping

The banana market system in Uganda is complex, given the different types of bananas grown in the country

The main value chain actors comprise of producers (either individuals or marketing in groups), collectors (brokers and bicycle traders), transporters, a few processors wholesalers, exporters, retailers and consumers.

Apart from the main actors above, there several support players and enablers providing different services and products to improve value chain performance.

Figure 21 shows the key players in Uganda's banana value chain, catering for cooking, roasting, dessert and beer banana types.

Note that the thick arrows represent the most significant channel

The banana map is unpacked in the section 3.2.4.

an affordable source of energy, vitamins, and potassium (10). In Africa alone, bananas are a source of income and jobs for more than 70 million people [10].

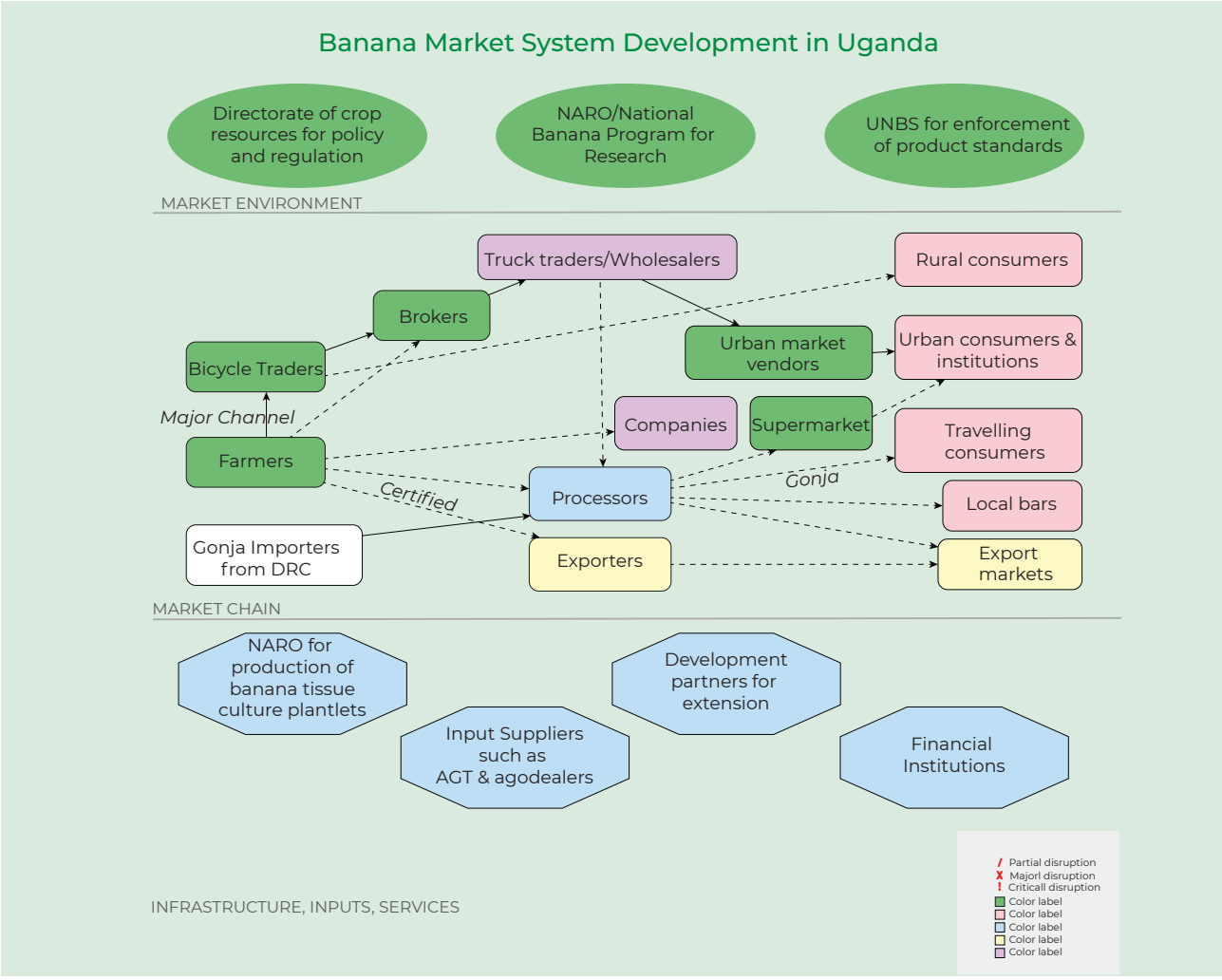

Figure 21: Banana Market System Development Map in Uganda

3.2.2: Banana Products Channels and Trade Flow

Banana value chain in Uganda is largely informal/unstructured and mainly domestic, with a small percentage of products exported. The cooking banana type is the most dominant, accounting for 93% of all bananas produced, followed by beer bananas which account for 6% and lastly sweet bananas which account for 1% [21].

The main banana marketing system (cooking bananas) involves farmers selling their produce from farmgate to rural traders (mostly use bicycles, although a few use small trucks), who move from farm to farm. About 36.5% and 63.5% of produced bananas are marketed at household level during scarce and surplus season [29]. Rural traders sell to brokers at weekly assembly markets within production areas. Brokers sell aggregated produce to truck traders or wholesalers, who transport produce to major towns, mainly Kampala markets such as Kasubi, Kisaasi, Bugolobi, Kalerwe, Kawempe, Kibuye, Nakawa, Kansanga, Nakasero, St Balikuddembe, Wandegeya, Nankulabye and Kasubi [21, 29] . The truck traders in turn sell bananas (mainly in bunches) to urban retailers/ market vendors who retail to final consumer. Urban retailers sell their product alongside roads and major highways and within markets [27]. A small proportion of bananas are sold through supermarkets or exported (formally and informally). However the roasting, dessert and brewing banana value chains are rather short compared to the cooking banana type value chain.

For roasting banana type (Gonja), its mainly sourced from DRC and at times Tanzania [17]. Small cross border traders procure the bananas from border markets such as Mpondwe. The produce is delivered by passenger buses to consumption towns (mainly highway towns) such as Mubende. Traders in turn sell to roasters who retail roasted gonja to travellers. A few processors make banana crisps from gonja which is packed and distributed through supermarkets.

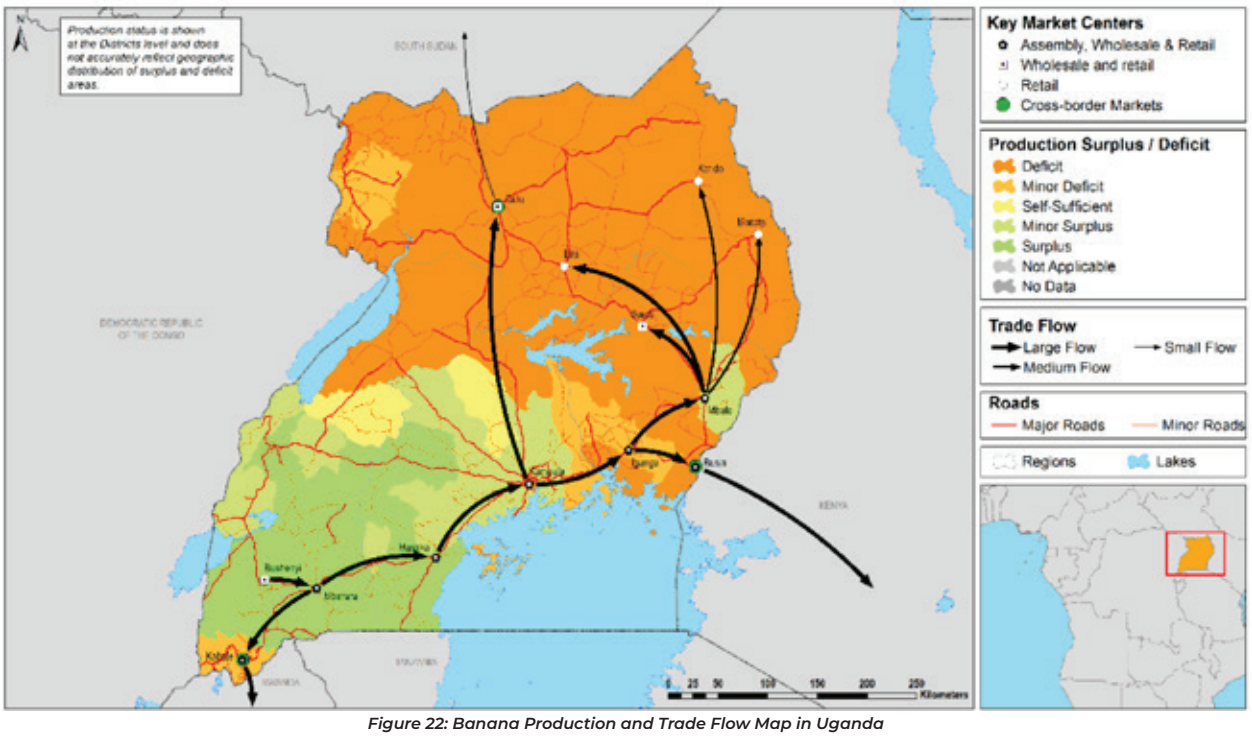

Figure 22: Banana Production and Trade Flow Map in Uganda

3.2.3 Value Share Across Cooking Banana Value Chain

Retailers earn the highest market share (30%) for the cooking banana types [26]. The broker earns the least share of the price paid by the consumer (4%).

Unit prices are determined by visual inspection, as reported by all producers, brokers, bicycle traders and wholesalers, which is subjective and arbitrary and therefore presents risks for unfair marketing transactions. Price determination along the marketing chain is largely done by bargaining

	Farmer	Bicycle Trader	Brokers	Truck Traders	Urban vendors
Price received (UGX/bunch)	5,100	6,000	6,667	10,000	15,000
Market share (%)	20%	10%	4%	6%	30%

Figure 23: value share along cooking banana value chain – for small bunch during surplus season.

	Farmer	Bicycle Trader	Brokers	Truck Traders	Urban vendors
Price received (UGX/bunch)	7,650	10,000	13,000	16,600	23,500
Market share (%)	20%	10%	4%	6%	30%

Figure 24: value share along cooking banana value chain – for large bunch during surplus season.

3.2.4 Function mapping

Key functions performed at different nodes of the value chain are presented in Figure 25.

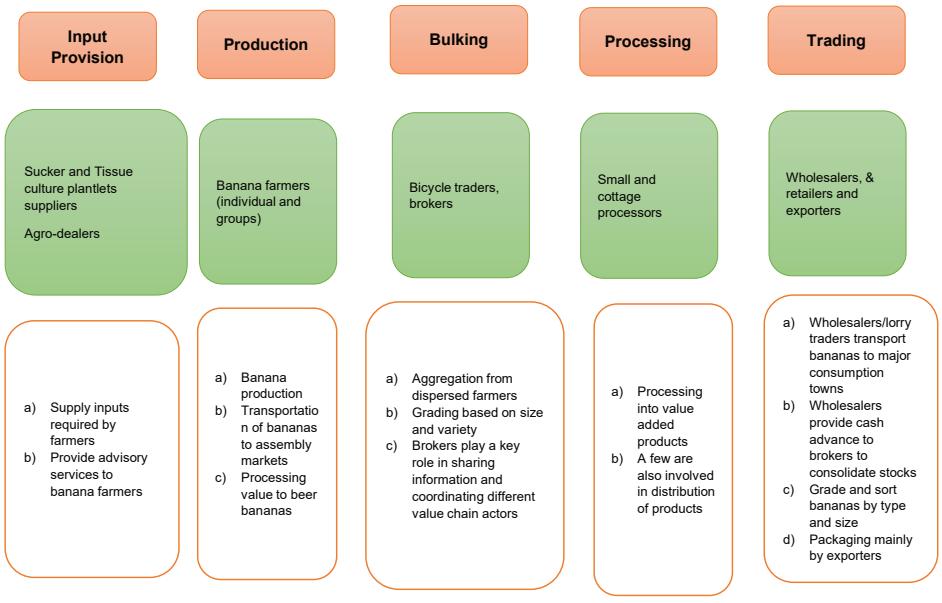

Figure 25: Functions performed on each node

3.2.4 Function mapping

Bananas are an important staple crop in Uganda. Out of the 7.4 million agricultural households in the country, 3.48 million households (representing 47%) grow bananas on about 668,000 hectares [1, 2]. Uganda's total production was estimated at 8.3 million MT by 2019 (Figure 26) [4], with average yield of 12.3 MT/Ha [1]. Most of the production was attributed to the second season (4.0 million MT) as compared to the first season (2.5 million MT). Its also worth noting that area under banana production was almost stagnant from 2015 to 2017 and thereafter drastically decreased. This is mainly attributed to the negative effect of banana Xanthomonas wilt (BXW) which has devastated most banana plantations.

Banana production is mainly concentrated around Lake Victoria Crescent, Western, and parts of Eastern Uganda (Elgon region), with Mbarara ZARDI (with 2.6 million MT), Mukono ZARDI (1.4 million MT) and Rwebitaba ZARDI (1 million MT) being the lead producing zones. Yield analysis at regional level indicate that the highest yields are registered in Ankole and Tooro (16 and 14.1 MT/Ha respectively) followed by North and South Buganda with 10 and 9MT/Ha respectively. while the lowest yields were in Bukedi and Teso (6 MT/Ha) [4]. Generally, productivity remains way below potential of 60–70MT/Ha [30].

Smallholder farmers (working individually or in groups – although those in organized groups are few) owning <0.5 ha on average dominate production, although medium sized farms are more prominent in Southern Uganda. These produce bananas both for household food security and marketing. For instance, a study carried out by Nalunga et al. 2015 in Rakai and Isingiro districts highlighted that 93% of farmers grew bananas both for food and market, 6% of farmers for only home consumption and at least 1% were commercial farmers [21]. On average 30% of the produced bananas is marketed [21].

On average, a farmer sells approximately 400 bunches and 23 bags of unpeeled fingers per month during surplus (June-August and December-February), while in scarcity season (September-November and March-May) each sells approximately 280 bunches and 14 sacks per month [21].

In Uganda, the most widely grown cultivars are the cooking type belonging to the East African highland banana (EAHB) subgroup. They are mainly classified according to their use i.e. (i) Cooking bananas (matooke, or green bananas/plantains), which are used for food and constitute about 93% of total production; (ii) Beer bananas, which represent about 6%; and (iii) Sweet bananas, which represent about 1% [31]. Because of the high susceptibility to pests and diseases, dessert, beer and roasting bananas are grown mainly for home consumption with surplus sold in the local market ([34]). Most farmers grow a mixture of cultivars, upto 10 cultivars in one farm ([33]).

Table 2 provides details of widely grown banana types and cultivars [32, 33].

Most demanded banana varieties in the market are Kibuzi, Nakitembe Mbwazirume and Musakala. However, access to clean planting materials for these varieties remains a big challenge ([19]).

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4 – Uganda Bureau of Statistics (UBOS), 2020. Statistical Abstract 2020. UBOS, Kampala Uganda.
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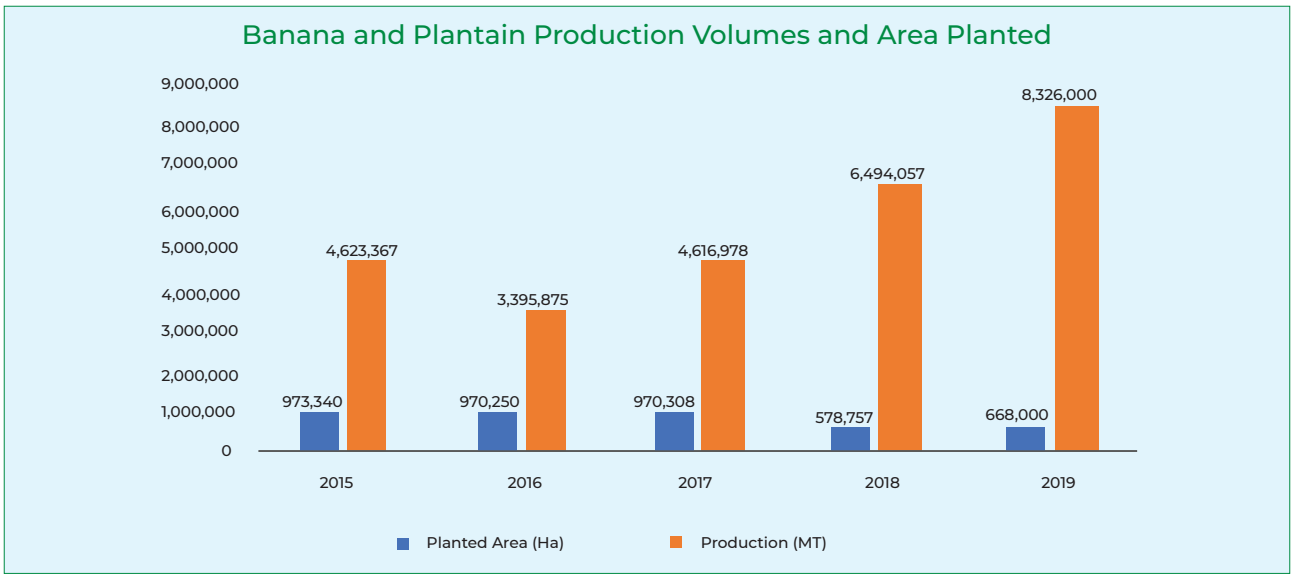

Figure 26: Banana Production trends and area planted

Bananas are grown as monocrop (37.5%), or intercropped (62.5%) with either coffee, beans, maize, cassava, sweet potatoes, fruit and wood trees for income diversification, reduce pest and disease prevalence, improve soil fertility, and increase resilience to adverse weather conditions such as drought. However intercropping is reported to be time consuming and labour intensive, thereby adding to costs of operations such as weeding.

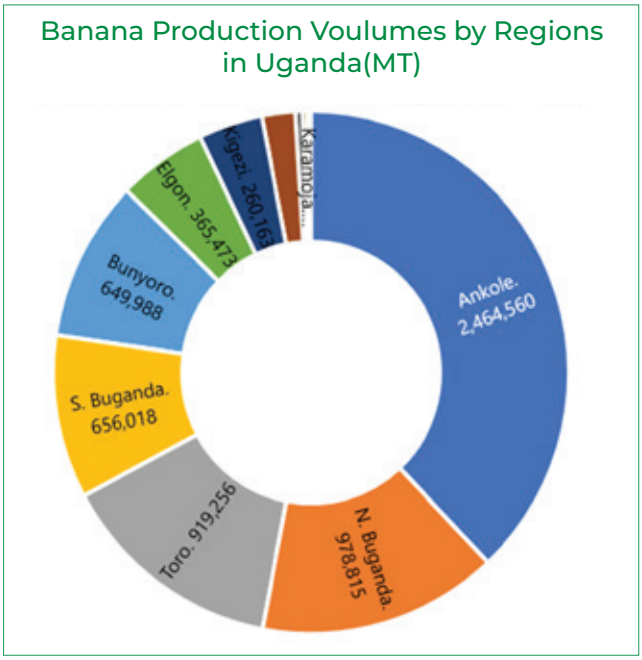

Figure 27: Contribution of different regions to national banana production

Productivity and general production is mainly constrained by: (i) Limited use of and access to quality to clean planting materials. Most farmers still get suckers from neighbours, (ii) disease and pest outbreaks such as banana Xanthomonas wilt (BXW), black sigatoka, fusarium wilt, weevils and nematodes (iii) diminishing land size due to fragmentation, (iv) declining soil fertility due to limited access and use of inputs such as fertilisers, (v) limited knowledge and skills on improved farm management practices, (vi), drought/ water stress resulting in decreased bunch size, (viii) high post harvest losses partly attributed to improper harvesting techniques, limited access to markets or low prices especially during peak season i.e. June and July.

During low production , on-farm post-harvest losses account for 3.3% of the produced volume (physical losses) and 5.4% of the generated value (economic losses), increasing during the peak period to 9.6% and 8.1%, respectively [21].

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Table 2: Widely grown banana types and cultivars in Uganda

Functional Group	Genome	Clone Set	Cultivar	Characterization
Cooking(Matooke)	East African Highland bananas (AAA-AE)	Musakala	Musakala, Kisansa & Mpologoma	• Most frequently grown; Quick maturing; soft-textured & tasty food • Mpologoma has big bunches and high marked value/ demand. However, farmers do not consume it due to bad taste; its also very sensitive to climatic changes and has a relative short lifespan.
		Nakabululu	Nakabululu	• Good taste; Quick-maturing; gives tasty bunches and withstands weather conditions. • Weakness: Prone to pests and because of the small bunch not a lot of farmers grow the variety.
		Nakitembe	Nakitembe	• Quick maturing; Produce soft-textured and tasty food; withstands most climate conditions; & average bunch size. • Weakness: Susceptible to pests and toppling
			Kibuzi	• Most preferred banana type: give food with excellent texture and flavor. However its most affected by drought, followed by Nakitembe
			Mbwazirume, muvubo	• Muvubo gives big fingers and has a good bunch size • Mbwazirume' is the most grown local cultivar because of its desirable consumer attributes, including good taste, soft food, and good flavour . A reason why its often used as a reference cultivar in the banana breeding programme at NARO-Uganda
	AAAA		FHIA series	• FHIA is known to give very big bunches but the taste is not appreciated by most farmers. It can be invasive to other varieties. Most farmers have a few mats for food security. It is less affected by BXW. The variety is part of a line of hybrids which are all called FHIA.
Beer	Exotic AB	Ney Poovan	Kisubi	
	Exotic ABB	Pisang awak	Kayinjaa	• Grown in single cultivar stands-large and seperated from the home garden, Used forbrewing such as banana wine and waragi
		Mbidde	Mbidde	
Dessert	Exotic (AAA)	Gros Michel (Cavendish)	Bogoya	

N.B: production of roasting banana diminished due to pest and disease attack. Currently, most of the Gonja is imported from DRC

Apart from the widely grown banana cultivars, National Banana Research Programme (NBRP), has bred improved seven banana (matooke) hybrids since 1990 which yield almost four times compared to the local varieties grown under similar growth conditions and their taste is comparable to the local varieties. Most of these are resistant to resistant to black Sigatoka, tolerant to nematodes and weevils, and short maturity period. These include KABANA 6H (Kiwangaazi, M9), KABANA 7H (M2), NAROBan 1, NAROBan 2, NAROBan 3, NAROBan 4, and NAROBan 5 [35]. However, adoption of improved varieties remains low [19].

3.2.4.2 Aggregation

Bicycle traders play an important role of aggregating bananas from smallholder farmers who are widely dispersed in villages. Traders have a strong relationship with producers because they are well known individuals in the communities which enables them aggregate good volumes. On average, a bicycle trader deals/sells 80 bunches per week during peak season and 60 bunches during low production season.

Aggregated volumes are transported to assembly markets/collection centers to be sold to brokers. Not all aggregated volumes are sold to brokers, 20% of the sales go to local consumers, market vendors and lorry traders [21].

Farmers with large farms who can fill a whole truck, sell directly to lorry traders. In rare cases, some large scale farmers own trucks that transport bananas from farm straight to urban retailers.

Key constraints faced by bicycle traders include: (i) price fluctuations especially prices hiking during lean season due to low supply, (ii) high costs of aggregating dispersed small volumes especially during lean season, (iii) high post harvest losses (as high as xx%) during transportation. Losses are mainly caused by bruising, breakages and scotching (browning of the fingers when exposed to the sun for long hours), (iv) lack of storage facilities which also contribute to losses, (v) limited supply of market demanded varieties (Kibuzi, Musakala, Nakitembe and Mbwazirume).

Apart from bicycle traders, brokers or commission agents who operate from assembly markets in production areas aggregate small volumes from bicycle traders to fill up trucks which is sold to wholesalers or lorry traders. 70% of their supply to brokers come through bicycle traders, while the rest is delivered by individual farmers. Brokers on average sell 1,900 bunches and 1,128 sacks per month [21].

Just like bicycle traders, brokers are challenged by: (i) access to market demanded varieties, (ii) high post harvest losses (characterized with ripening of bananas) due to bruising during transportation which increases ethylene production, respiration rate and senescence, (iii) supply of immature bananas especially during lean seasons, (iv) Mixing of varieties for fingers packed in polythene bags, making it difficult to sell to export markets, (v) limited access to working capital.

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3.2.4.3 Transport and Trading

From the assembly markets, wholesalers purchase produce and transport it to urban centres such as Kampala –Uganda's capital city which is the biggest market for that produce. Wholesalers have established with brokers as evidenced by provision of advances to facilitate aggregation from bicycle traders [21].However in most cases procurement is done on cash basis with a few incidences of procurement on credit. Only less than 30% of the wholesalers have own trucks, implying that majority hire truck to deliver produce to urban retailers which is the biggest cost driver for this node. Its estimated that over 200 wholesalers operate around Kampala alone, spread in city markets including Nakasero, St Balikuddembe, Nakawa, Wandegeya, Kalerwe, Nankulabye and Kasubi. On average wholesalers handle 1,292 bunches and 148 sacks per month [21].

Apart from high cost of hiring transport means, wholesalers are constrained by: (i) scattered nature of farmers and the poor road infrastructure in the villages discourage lorry traders to transact directly with the farmers, (ii) high post harvest losses due to ripening given the short shelf life of bananas and poor handling, (iii) inability to meet demand during lean season due to low supply. This in most cases leads to farmers harvesting immature bananas to take advantage of high prices.

70% of urban retailers/vendors are women and 90% are self employed working from market stalls [21], although a few sell bananas alongside roads and major highways to final consumers [27]. Retailers mainly sell to household consumers, hotels, restaurant and schools. Retailers sell 47% of bananas in form of bunches, 17% bags of unpeeled bananas, 11% clusters, 15% heaps of unpeeled banana and 10% peeled bananas. However there is a growing demand for peeled bananas. On average a retailer sells between 122 and 210 bunches, 10 bags of unpeeled fingers, 520 clusters, and 530 (small) packs of peeled fingers per month [21].

However, perishability of bananas, coupled with inadequate storage facilities for extended shelf life, forces retailers to sell bananas in the shortest time possible to minimize losses which limit their bargaining power. For instance, At retail level, for instance, physical losses during periods of scarcity are estimated at about 6.2%, while economic losses affect approximately 6.5% of traded banana, reducing its price by about 52%. During surplus periods, physical losses increase to 9.8% and volumes affected by economic losses almost double to 11.9%, resulting in a 60% discounted selling price per damaged bunch [36]. Physical losses are attributed mainly to ripening and bruising, and while the economic ones are caused by ripening, bruising, and finger plucking in scarcity seasons.

Other challenges include: limited access to working capital, packaging and transportation that are not compatible with the changing consumer needs

A small proportion of bananas go through supermarkets (mainly targeting middle class). Under this channel, quality control is given due attention. Bananas are mainly sold in form of clusters . Supermarkets prefer varieties with longer shelf life and large finger size, however are constrained by inconsistent supply.

A small proportion of marketed bananas is exported. Exporters sell in form of bunches (for regional market – Kenya and South Sudan) and/or clusters packed in boxes weighing 18.5kgs (for European Market). Bananas for export to International markets are graded by size, variety and quality. To control ripening, bananas are shipped in refrigerated containers or transported by air. Ripening is done artificially with ethylene before being transported to retailers and wholesalers. Some of the exporting companies include Amfri Farms Ltd, KK Fresh Producer Exporters, SM Impex (U) Ltd, Tropical Dynasty Agencies Limited, 49 Miles Farm Business SMC Ltd, Marse Veges Uganda Limited, Roki Fruits & Vegetables Limited, Asasira Traders Ltd, Y.T.B.M Afro Fruits, United Pearl Exporters Limited, BioFresh Limited and many others. These export apple bananas.

Key challenges faced by most exporting companies include: (i) adherence to phytosanitary and sanitary measures especially quarantine pests, and (ii) limited production of demanded varieties

21 -Nalunga A., Kikulwe E., Nowakunda K., Ajambo S., Naziri D., (2015). "Technical report: Structure of the Cooking Banana Value Chain in Uganda and Opportunities for Value Addition and Postharvest Losses Reduction."
27 – Ssennoga F., Mugurusi G., Oluka P. N., (2019). "Food insecurity as a supply chain problem. Evidence and lessons from the production and supply of bananas in Uganda." Scientific African 3 (2019) e0 0 076. https://doi.org/10.1016/j.sciaf.2019.e0 0 076
36 - Kikulwe E. M., Okurut S., Ajambo S., Nowakunda K., Stoian D., Naziri D., (2018). "Postharvest Losses and their Determinants: A Challenge to Creating a Sustainable Cooking Banana Value Chain in Uganda." Sustainability 2018, 10, 2381; doi:10.3390/su10072381. https://www.researchgate.net/publication/326271310



3.4.3 Processing

Although Uganda is among the lead producer of bananas globally, value addition into diversified processed products (such as fresh peeled vacuum packaged matooke, juice, wine, vinegar crisps, flour, biscuits, sweets, crisps, cake, jam, sauce, yoghurt etc) has been exploited to a small extent. Furthermore, there is massive underutilization of by products such as peels, leaves, pseudostem, stalk and inflorescence. However these can be processed into thickening, colouring and flavour agents, textiles, and as alternative sources of macro and micro-nutrients, nutracecuticals, animal feed, natural fibre charcoal briquettes, crafts and bio-fertilisers [24].

Most common forms of banana value addition range from juice, beer/tonto, waragi and wine production from beer bananas; fresh or dried fruit from dessert bananas; roasted gonja or deep fried crisps from roasting bananas; banana flour and vacuum sealed matooke from cooking bananas; and crafts from by products mainly done on a small scale [37]. A few modern banana value addition players do exist such as Excel Hort Consult Ltd, Presidential Initiative on Banana Industrial Development (PIBID). Afri Banana Products Ltd and Bibilical wines and Centre for Textile Innovations (TEXFAD). These produce banana juice, banana flour. fresh vacuum sealed matoke, wine and banana textile making: respectively [37].

Although growth of banana processing industry is at infancy, of recent, there are several cottage and small banana processors cropping up. Some have already certified their products with UNBS.

Table 2: Widely grown banana types and cultivars in Uganda

Product	Processors
Still table wine	Forest Fruits Foods Ltd; Bugarama Super Banana Wine Producers Limited; Native Beverages Limited; Greendoor Supplies Uganda Limited; Amo Best Promise Co. Ltd; Leah Trading Company Limited; Kyama Entreprises (Km Wines); Silgad Investments Limited; Native Beverages Limited; Sulumans Investments Limited; Mambor Wine Limited; Superior WorldWide Breweries Ltd
Tonto	Kdb Kyarenga Wines - Smc Ltd; Basket International Limited; Tukundine Enterprises Limited; Tutarame Super Wine (U) Limited; Safari Distillers (U) Ltd; Nutricom Food and Beverages; Gutu Tonto Beverages Ltd; Akanovera Wine Limited; Omunugura Natural Drink; Twingane Brothers Solution Ltd; Mian Wines Smc Limited
Banana Juice	Seven Seasons Foods; Newman Foods Limited; Bana Beverages Uganda Limited; Excel Hort Consult Ltd
Brandy/waragi/gin	Native Beverages Limited
Non-alcoholic fermented beverage	Century Bottling Company Limited;
Dried plantain banana crisps	Negonja Organics Limited
Biscuits	Meta Plus (U) Limited
Banana flour (raw and instant)	Presidential Initiative on Banana Industrial Development (PIBID)
Jam	Communnauts Ltd
Banana Flat plastic bags	Pacha Investments Limited
Banana fibre textiles and handicrafts	TEXFAD
Peeled vacuum sealed matooke	Afri Banana Products Ltd

Key challenges affecting development of banana value added products industry include: inability to adhere to food safety measures and standards, lack of infrastructure (cold chain) and technologies to store bananas, poor processing technology used, low price competitiveness of banana products (flour) in comparison to substitutes

24 – Tinzaara W., Ocimati W., Kikulwe E. and Otieno G., (2018). 'Challenges and opportunities for smallholders in banana value chains." Research gate DOI: 10.19103/AS.2017.0020.10. https://www.researchgate.net/publication/328105469

37 - Alex A., Makindara J., Tumwesigye G., Sikira A., (2015). Opportunities for Upgrading the Banana Value Chain in Uganda. Journal of Continuing Education and Extension (JCEE), Volume 6, Issue 1, 2015.

38 – Uganda National Bureau of standards (UNBS), 2021. List of certified products under UNBS product certification scheme, UNBS, Kampala, Uganda. https://cims.unbs.go.ug/api/website/

3.2.5: Banana VC supporting Functions

Key support systems to the banana sub-sector in Uganda are categorized into: (i) input suppliers, (ii) equipment suppliers for production, post harvest handling, and processing, (iii) financial institutions, and (iv) information providers

Banana input suppliers can be categorized into suppliers of agro-chemicals and farm tools; suppliers of planting materials and providers of manure. Generally, rural based agro-dealers/ stockists are the main suppliers of farm equipment and implements such as hoes, pangas, pruning sickles, wheelbarrows and general agrochemicals such as herbicides. These procure their stocks from wholesalers/distributors, mainly based in Kampala.

Although, there few emerging private suppliers of clean planting materials (Tissue culture plantlets) such as Agro Genetic Technologies Ltd (AGT) and nursery operators, majority of farmers still get planting materials (suckers) from fellow farmers. AGT has a network of nursery operators to increase availability of clean planting materials. Each nursery operator sells over 2,000 plantlets every six months. 1,700 plantlets are sold directly to individual farmers while others are sold to NGOs and institutions. Nalunga et al reported that only 20% of farmers planted tissue culture plantlets [21]. The low adoption of clean planting materials is attributed to limited last mile distribution network by existing players and high cost of acquisition.

Apart from implements, agro-chemicals and planting materials, other critical input to banana production is manure. The major manure suppliers are livestock farmers, who sell each 4MT truck at approximately UGX 150,000. To reduce on cost, some banana farmers especially in Western Uganda also keep livestock to compliment banana production.

Case of Agro Genetic Technologies (AGT) laboratories

AGT is a private company that uses biotechnology to produce banana tissue culture plantlets that are disease and pest free. The company has a capacity to produce 10 million plantlets per year. Other crops targeted include pineapples, coffee, tea, cassava, sweet and Irish potatoes, ornamentals, and forest trees. To increase uptake, the company has set up several nurseries (sales points) and demonstration gardens in local farming communities, where farmers can access the plantlets and are trained about the technology, respectively. Occasionally, AGT has received support from government and development partners.

3.5.2: Technology suppliers (for production, post-harvest handling and processing)

At production level, mechanization is mainly form of use of tractors, irrigation pumps/ rainwater harvesting. However, mechanization of the sector at production remains limited due to few players providing mechanization services.

The biggest challenge with Uganda's banana sub-sector is the post harvest losses due to the high perishability of the crop (which makes it vulnerable to post harvest deterioration) Losses are mainly in form of bruising, sun burns and ripening. Technologies and practices employed during harvesting, transportation, aggregation, storage and processing to reduce losses and add value are still rudimentary which either increases damage to the crop or doesn't provide maximum preservation for extended shelf life.

Harvesting is done using pangas which at times led to bruising due to big falls. Transportation is done using bicycles and open trucks which increases sun burns and piling of bananas on top of each other increases production of ethylene (a gas responsible for fast ripening). This is coupled with overloading of trucks which increase bruising. Rarely do you find actors with proper storage for banana. In most cases bananas are piled or stored in open spaces, at times covered with tarpaulins at night. Tropical temperatures fasten ripening. A few exporters have cold chain system (in form of refrigerated trucks) which lower ethylene production in transit.

At processing most processors use rudimentary and non food grade processing equipment like aluminum sauce pans. A few small and medium scale processors have invested in imported stainless steel equipment such as boilers, solar drying facilities or complete lines (e.g. Silgard Winery). The equipment are mainly imported by Snow man Group. However, a few upcoming local fabricators are manufacturing banana processing equipment. However, most of the equipment locally manufactured are not food grade attributed to high cost of stainless plates (raw material).

3.2.5.3: Extension service providers/skilling and Training

Just like other value chains, extension outreach remains a key bottleneck to increasing farm productivity. Although new technologies and improved practices are available, their awareness among farmers remain low due to limited number of extension workers and lack of funds to facilitate the work of extension agents at the local government level. Extension service provision in banana sub-sector is mainly done by a few existing development partners through projects; public extension workers and NAADS. However the ratio of extension workers to farmers remain very high. Public extension providers focus on agronomy and banana value addition.

Few private extension service providers do exist, whose outreach is equally limited. Private extension services are mainly provided by exporters such as Amfri Farms Ltd or input suppliers such as AGT. Due to unresponsiveness of public extension and budget constraints, there is greater shift to private sector extension provision using models such as farmer to farmer approach and village agent model.

Generally, extension outreach remain low and often farmers and processors lack guidance on improved farming practices, and quality standards

21 -Nalunga A., Kikulwe E., Nowakunda K., Ajambo S., Naziri D., (2015). "Technical report: Structure of the Cooking Banana Value Chain in Uganda and Opportunities for Value Addition and Postharvest Losses Reduction."

3.2.5.4: Information

Information source and flow within the value chain is mainly from the actors themselves. Brokers play an important role in coordinating and consolidating information from different players and on-ward sharing since they are often in contact with farmers, bicycle traders, truck drivers, lorry traders/wholesalers. This gives brokers significant control to control the value chain. Key information shared is mainly on prices, available or desired volumes, availability of trucks and associated prices. Information is shared and transactions are often carried out on mobile phones. Although information service providers such as Farmgain, Infotrade and many others exist, these collect information on prices from major markets. However, dissemination to value chain actors is limited since they are mainly dependent on availability of development funding.

Other sources of information include radios, however they focus on extension (good agronomic practices such as wilt control) and not consistent since such campaigns are dependent on development funding.

However, there is a need to leverage ICT to improve access to extension through digital tools such as mobile apps [39].

3.2.5.5: Finance

Financing access is a key ingredient to value chain development. However, access to finance by different actors for increased investment into banana value chain has remained low. Although there no specific study on financial access by different banana value chain actors, generally key constraints affecting financial access which are also applicable to banana value chain include: (i) limited commercialization and informality of the value chain, (ii) in appropriate financial products, (ii) poor business management and many others.

Sources of financing include: (i) personal savings, (ii) village savings and loan associations, (iii) micro-finance institutions and (iv) commercial banks.

3.2.5.6: Research and Development

Banana research in Uganda is spread headed by National Agricultural Research Organisation (NARO) through its affiliated National Agricultural Research Laboratories (NARL), located at Kawanda. Under NARL, there is a special program (i.e. National banana program), has bred seven improved banana (matooke) hybrids since 1990 which yield almost four times compared to the local varieties grown under similar growth conditions and their taste is comparable to the local varieties. Most of these are resistant to resistant to black Sigatoka, tolerant to nematodes and weevils, and short maturity period. These include KABANA 6H (Kiwangaazi, M9), KABANA 7H (M2), NAROBan 1, NAROBan 2, NAROBan 3, NAROBan 4, and NAROBan 5 [35].

Apart from varietal development, NARL has been at the forefront of developing and popularizing improved cultural practices for management of banana bacterial wilt. This has been done through collaboration with development partners such as IITA, CABI and BMGF. Much as good progress has been made to develop new cultivars and protocols, popularization of the same among farming community remains limited. Furthermore, research in extended shelf life and value added products with high commercialization potential needs to be

39- CABI, 2021. Banana farmers in Uganda and Tanzania reap a 64% increase in yields worth an extra USD $8.15m a year, CABI, Wallingford UK. https://www.cabi.org/news-article/banana-farmers-in-uganda-and-tanzania-reap-a-64-increase-in-yields-worth-an-extra-usd-8-15m-a-year/

enhanced. Through the Presidential Initiative On Banana Industrial Development (PIBID), government has investment substantial funds for research and commercialization of banana value added products, however, mixed assessments have been made because of the failure to reach industrial production and limited market penetration.

To increase banana research impact, NARL needs to explore cost effective ways of dissemination of research products to value chain actors, more research on shelf life extension and differentiated products that respond to demand.

3.2.5.7: Rural Infrastructure

Poor road network, limited mobile and internet connectivity, unsuitable transport means (no clod chain), inadequate infrastructure for storing and marketing bananas in rural, peri-urban and urban market places, limited access to technologies for processing and other forms for increasing shelf life are some of the critical rural infrastructure challenges affecting general performance and efficiency of banana value chain in Uganda [24].

3.2.5.8 Value chain relationships /VC Governance

Apart from a few existing farmer organizations at local level, coordination or alliance among banana value chain actors horizontally or vertically is weak or non existent. At national level there is no platform that bring together banana value chain actors to advocate for the issues affecting the value chain. Absence of such strong networks among value chain actors complicates the general development of the value chain.

At national level, Its only exporters of fruits and vegetables (banana included) who associate under the Horticultural Exporters Association of Uganda to address challenges they face to penetrate export markets. However this alliance is not specific to bananas, thus banana sub-sector issues might not be prioritized

Apart from cooperatives, at sub-county level, banana farm organizations do exist, although they are few and majority are weak. The absence of strong value chain institutions could explain why the value chain has largely remained informal which has given brokers an opportunity to dominate and thrive. Informality of relationships along the value chain could partly explain the cash based transactions. Value chain relationships between actors are mainly based on prior working relationship.

To a small extent, a few exporters (such as AMfri Farms Ltd) have contracted outgrowers to grow specific varieties for targeted markets. Apart from just off-taking, such exporters also provide trainings (on proper agronomy, quality etc), and pre-financing of inputs

35 – National Agricultural Research Organization (NARO), 2021. NARO banana hybrids, NARO, Kampala, Uganda. https://www.banana.go.ug/products/banana-hybrids

24 - Tinzaara W., Ocimati W., Kikulwe E., Otieno G., (2018). “Challenges and opportunities for smallholders in banana value chains.” Research gate DOI: 10.19103/AS.2017.0020.10. https://www.researchgate.net/publication/328105469

3.2.6: Ongoing and pipeline Initiatives

3.2.6.1 Development Partners

Most of the previous and ongoing development projects have been geared towards banana research, with a few focus on value chain development or go beyond production. Probably this could partly explain the current strength of the banana value chain. Key development organizations that have had a significant contribution to banana sub-sector development include BMGF, IITA and CABI, mainly focusing on banana research and agronomy. Recently concluded and on-going development projects that new initiatives can build on are presented in Table 4.

Table 4: Past and on-going initiatives by development partners

Development Partner & size of project	Geographical area	Ongoing Interventions
Bill and Melinda Gates foundation (BMGF)- "Improving scalable banana agronomy for small scale farmers in East Africa project." In collaboration with NARO, IITA, TARI, CABI, Makerere University, Bioversity International	Western & central regions	• Building extension delivery and improved farming practices among banana farmers
United Nations Industrial Development Organization, Global Environment Facility in partnership with MAAIF Banana Livelihood Diversification Project	Western Uganda - Mbarara, Isingiro, Bushenyi, Mitooma, Ntungamo, Sheema, Rubirizi, and Buhweju district	• Develop and implement a favorable policy and institutional framework that will facilitate a coordinated development of the banana industry • Banana and by products value addition • Access to clean seed
USAID Feed the Future Uganda Agriculture Research Activity	Not specific	• Facilitate the release and commercialization of varieties developed under previous and ongoing research efforts, • Develop improved crop and animal production and management technologies in response to emerging threats and market demands, • Consolidate previous gains in institutional and human capacity development to align research with market needs, and mobilize domestic resources that will displace current development partner funding.

3.2.6.2 Government projects (on-going and pipeline – NDPIII)

Government support to the banana subsector has mainly been through annual budget support to NARO and Presidential Initiative on Banana Industrial Development (PIBID) project. Within the NDP III, the only project idea listed under the innovation, technology development and transfer programme is the establishment of banana industrial technology park



3.2.6.2 Government projects (on-going and pipeline – NDPIII)

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3.2.7.1: Institutional, policy, legal and business environment

Existing enabling environment in Uganda is supportive of banana subsector development evidenced by several existing supportive frameworks and policies.

The national Development Plan (NDP III) that runs from 2020/21 – 2024/25, a tool for delivering Vision 2040 (of transformation of the agriculture sector from subsistence farming to commercial farming), prioritizes bananas among the 10 strategic commodities not only for agro-industralisation, but also food and nutrition security.

Agricultural sector is also guided by National Agricultural Policy of 2013 (NAP) which provides sector direction and guides all agriculture and agriculture related sub-sector plans, policy. NAP's vision is a competitive, profitable and sustainable commercial and agriculture Sector through enhanced sustainable productivity and value addition; provide employment opportunities, and promote agribusinesses, investments and trade.

Government has formulated several policies at sector and sub-sector level that cover commodities like bananas. Agriculture Sector Strategic Plan (ASSP) of 2020/21 – 2024/25 provides an strategic direction for agricultural sector. ASSP targets to increase banana production volumes to 13 million MT by 2020 through control of pests and diseases especially the Banana Bacterial Wilt (BBW) disease; generation and distribution of clean planting materials to farmers for example tissue culture; promoting the use of organic and inorganic fertilizers and soil moisture conservation techniques; strengthening extension services and training in good agricultural practices (GAPs); and support to value addition through PPPs [40].

Other policies that directly or indirectly affect the banana subsector include: (i) National Agricultural Extension Policy and Strategy which provides strategic direction for extension service delivery through pluralistic delivery and value chain approach. Under the policy, MAAIF focus on policy direction, technical backstopping and quality assurance while actual delivery is carried out by staff at local government. However, due to budget constraints to recruit more staff and catering for field operational expenses, extension outreach remains limited i.e. the ratio of extension worker to farming households is still high at 1:1800 compared to the FAO standard of 1:500, (ii) National Seed Policy of 2018 to ensure availability of and access to safe and high quality seed under a pluralistic seed system [41], (iii) National Fertilizer Policy (2016) – provides for use of both organic and inorganic fertilizers to increase soil fertility with the aim of increasing production of agricultural products to sustain the domestic and international market demands, (iv) Food and Nutrition policy (2003) – emphasizes promotion of organic farming to produce safe and healthy food for local consumers as well as for export to other markets as a panacea for a productive population, and (v) National Organic Agriculture Policy that guides investments in organic agriculture value chains focusing on organic research and technology, value addition and processing of organic products, certification and accreditation of organic products.

At banana sub-sector level, there is National Banana Research Program (NBRP) under National Agricultural Research Laboratories- NARL (a semi autonomous entity under NARO),

mandated to generate and promote improved banana varieties and practices that enhance banana productivity and utilization.

Other critical support agencies to the banana sector include:

UNBS – formulate, promote and enforce use of banana products standards

UIRI – for new banana products development and commercialization

3.2.7.2: Banana rules, regulations and standards

There are no legislations governing the banana sub-sector in Uganda. However, operations are regulated through other generic bills and acts. These include: (i) The Plant Variety Protection (PVP) Act 2014 that guides for the promotion of development of new plant varieties and their protection as means of enhancing breeders' innovations and rewards through granting of plant breeders rights and other related matters, and (ii) Seed and Plant Act (2006) that provides for the promotion, regulation and control of variety release, multiplication, conditioning, marketing, importing and quality assurance of seeds and planting materials.
To enhance food safety and increase market penetration, UNBS has developed several banana products standards that have to be adhered to by value chai actors. These include: (i) US EAS 138:2019 for still table wine, (ii) US 2143:2019 for tonto, (iii) US 1923: 2020 for cake, (iv) US EAS 948:2019 for fruit juice, (v) US 872: 2020 for non alcoholic fermented beverage, (vi) US 877: 2011 for dried fruits, (v) US EAS 781:2012 for biscuits, (vi) US 983:2015 for matooke flour, (vii) US 31:1999 for banana jam, (viii) US 773:2007 for banana plastic bags, and (ix) US EAS 143:2014 for banana brandy (42). Although, standards have been developed there adoption among processors remains a major concern.

40 - Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), 2021. Agriculture Sector Strategic Plan (ASSP), MAAIF, Kampala, Uganda. https://www.agriculture.go.ug/agriculture-sector-strategic-plan-assp/
41 – Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), 2018. National Seed Policy, MAAIF, Kampala, Uganda.
42- Uganda national Bureau of standards (UNBS), 2021. Applicable standards for Banana products, UNBS, Kampala, Uganda. https://webstore.unbs.go.ug//store.php?src=3984&preview



3.2.8: Employment along banana value chain

Just like for most agricultural value chains, few studies (if they exist) have been done to assess current labour markets and employment potential that can be tapped in.

However, UBOS reported that there approximately 3.48 million households (representing 47% of total agricultural households) grow bananas 1. Production provides employment for both family workers and hired labourers. Although statistics are not readily available, we know that several people are directly employed as bicycle traders, brokers, lorry traders/wholesalers, workers in processing entities, retailers, loaders/off loaders.

Banana sub-sector also has a multiplier effect on support sectors were several people are employed in: (i) as input suppliers, (ii) lorry drivers providing transport service, (iii) providers of different tools and equipment, (iv) financial service providers, (v) extension officers and many others.

1 – Uganda Bureau of Statistics (UBOS), 2018. Uganda National Household Survey 2016/2017, UBOS, Kampala, Uganda.

3.2.9: Return on Investment along banana value chain

Current gross margins at banana farmer level under traditional system, was determined based on the following variables/assumptions (43)

- The farmer already owns the land to be used for cultivation.
- The farmer does not use improved planting materials
- The farmer does not use fertilizer or manure
- The farmer does not mulch
- The farmer does not use herbicides
- The farmer does not stake banana plants bearing fruit
- The farmer does not practice weevil trapping

Figure 28 shows that a typical banana farmer using traditional practices in Isingiro district makes a gross profit of UGX 151,700 per acre (32.0% of total revenues received). The major cost drivers for banana farmers are weeding (Accounting for 23.4%), ploughing (accounting for 23.2%), digging holes (accounting for 13.9%) and support poles (accounting for 13.9%).

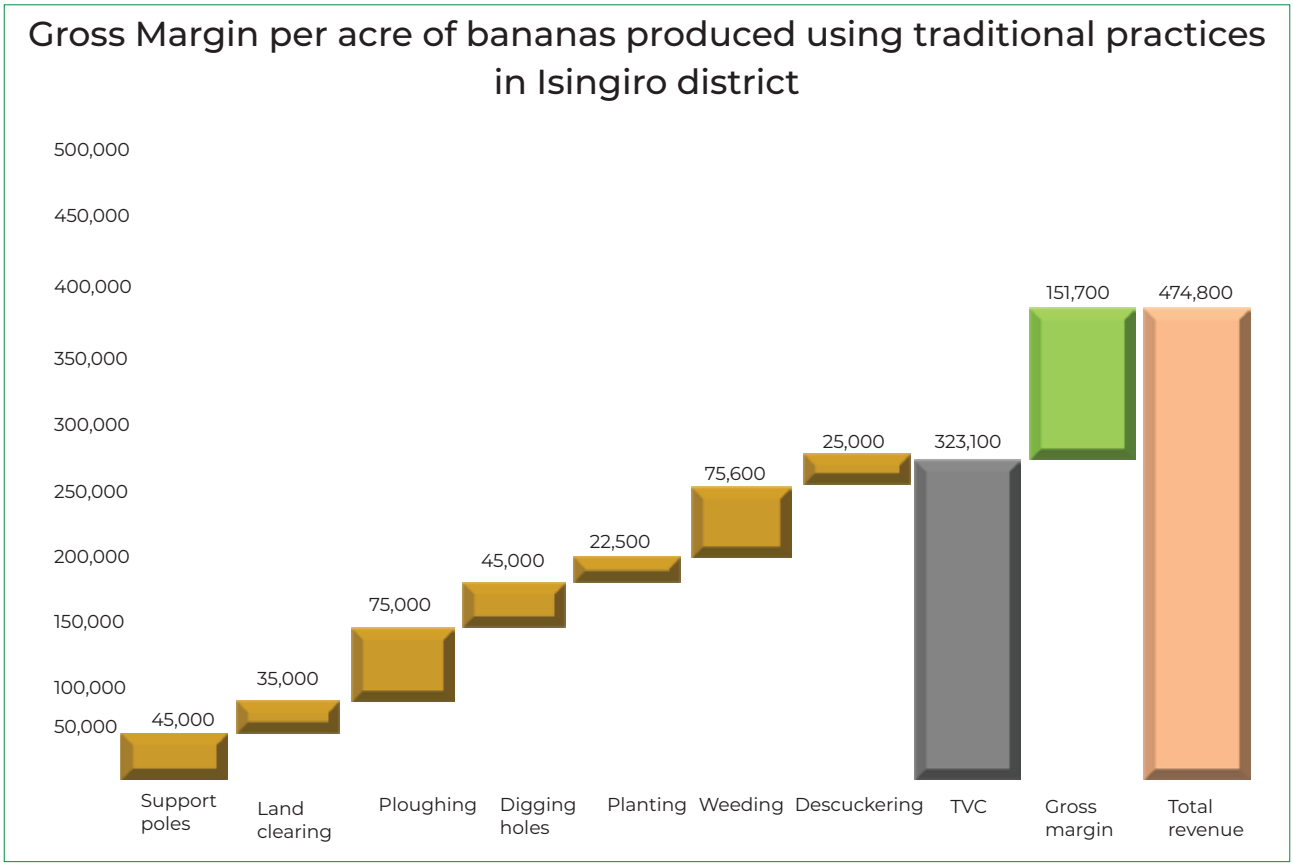

Figure 28: Gross margins at banana farmer level using traditional practices in Isingiro district

3.2.9.2: Gross margins at banana farmer level using low input system in Isingiro district (scenario 2)

Current gross margins at banana farmer level under low input system, was determined based on the following variables/assumptions [43].

All the other assumptions remain the same as traditional system except that the farmer uses improved planting materials, stakes plants and practices weevil trapping.

With low input system farmer's gross profit increases from UGX 151,700 per acre (under traditional system) to UGX 2,113,700 per acre (69.2% of total revenues received) as shown in Figure 29. The major cost drivers for banana farmers are poles and staking (accounting for 16.5%), trapping weevils (accounting for 12.8%), ploughing (accounting for 12.7%) and suckers (accounting for 12.0%).

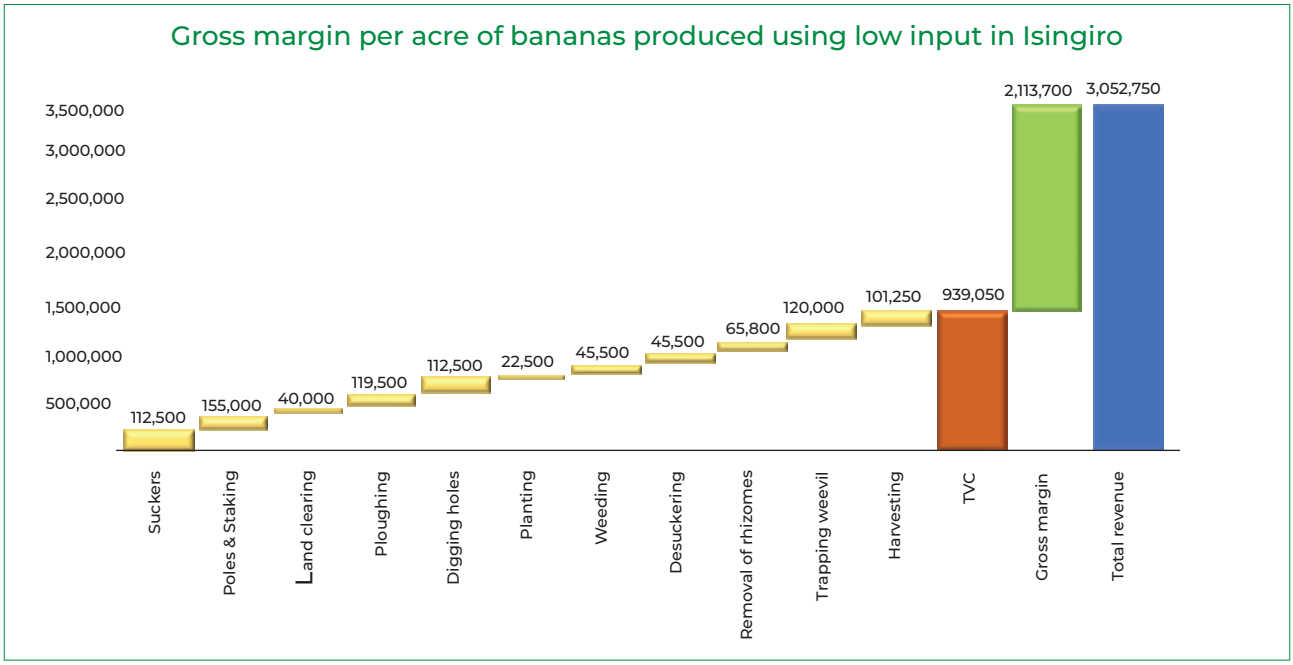

Figure 29: Gross margins at banana farmer level using low input practices in Isingiro district

3.2.9: Return on Investment along banana value chain

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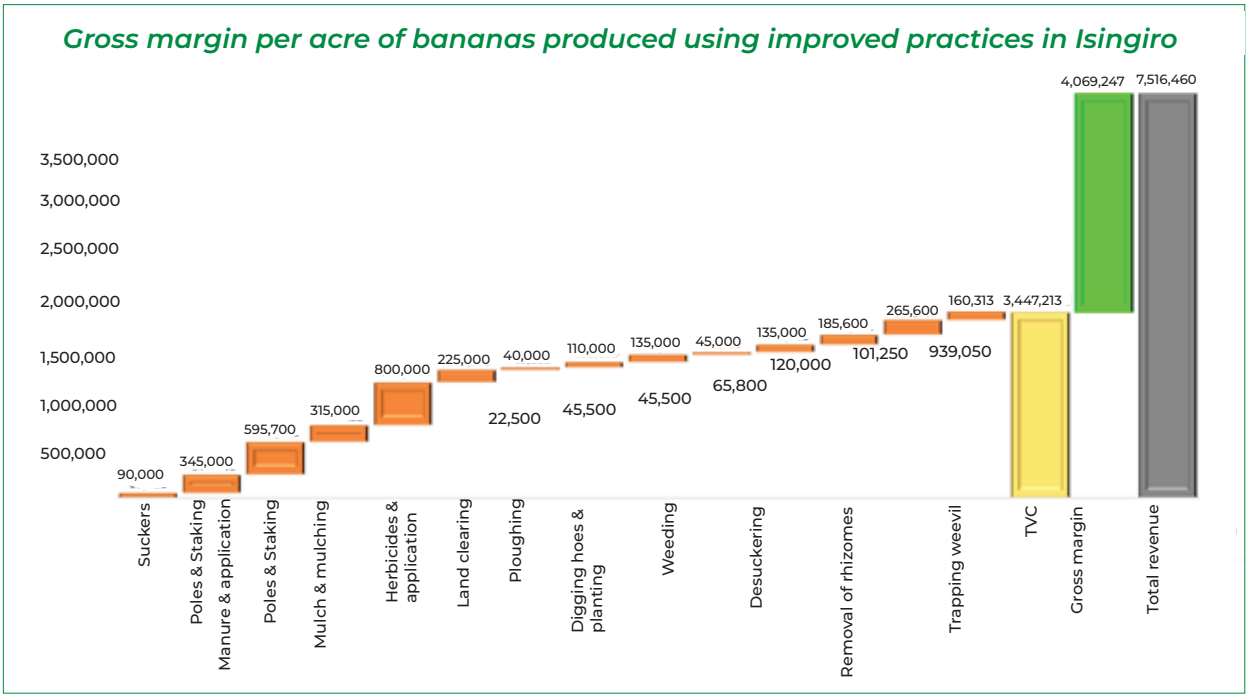

Figure 30: Gross margins at banana farmer level using improved input practices in Isingiro district

3.3: Attractiveness of banana value chain in Uganda

3.3.1: Porters five forces of banana value chain in Uganda

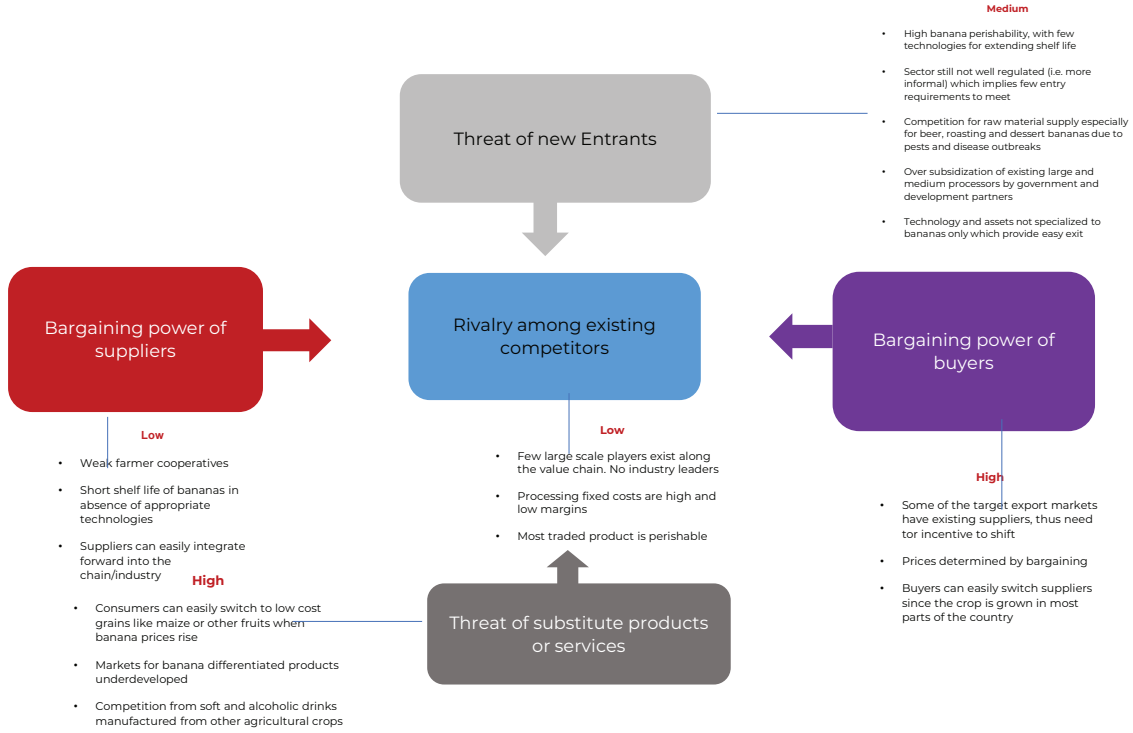

Figure 31: Banana sector attractiveness in Uganda

43- Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), 2021. Profitability of agricultural enterprises, MAAIF, Kampala, Uganda.

3.4: PESTLE ANALYSIS

	Political	Economic	Social	Technological	Legal	Environmental
Positive	▪ Banana is among the 10 prioritized value chains in Uganda ▪ High political will to support banana value addition through Presidential Initiative on Banana Development (PIBID)	▪ Growing middle class increasing purchasing power ▪ Existing current and potential export markets such as Middle East.	▪ Population increase and urbanization ▪ Bananas are a staple crop in Uganda thus, an existing huge domestic market ▪ Job creation in rural areas ▪ Contribute to rural local economic development through tax contribution leading to bringing social amenities such as health centres, schools closer	▪ Availability of developed technologies	▪ Presence of national banana program under NARL	▪ Banana byproducts can be used to make bio- fertilisers
Negative	▪ Political disputes within the Great lakes region affecting market access. e.g civil wars in South Sudan ▪ There are few on-going projects by government and development partners targeting banana, mainly focus on breeding	▪ High cost of capital from formal financial institutions ▪ Increasing demand for meeting phytosanitary and sanitary measures in export markets which increases operational costs ▪ COVID impacts affecting international markets penetration	▪ Increase demand for convenience among formal working segment which may reduce demand for bananas ▪ Youths are not interested in agriculture which has increased labour costs	▪ Low commercialization and adoption of developed technologies ▪ Abiotic and biotic stress affecting productivity of most demanded varieties ▪ Limited adoption of technologies for extended shelf life	▪ Banana sector does not have sub-sector specific policies and supportive framework	▪ Poor banana waste (peels) management especially in towns leading to pollution of water bodies ▪ Unpredictable weather (drought stress and hailstorms) lowering banana productivity ▪ Bananas are heavy feeders leading to rapid soil fertility reduction

Figure 31: Banana sector attractiveness in Uganda

3.5: Banana Value chain SWOT Analysis

		Strengths (S)	Weakness (S)
	Internal factors / *External Factors*	▪ Uganda is among the top producers of bananas globally ▪ New banana cultivars developed by NARL ▪ Bananas are grown in most agro-ecologies ▪ Huge domestic and regional banana market	▪ Underdeveloped banana processing sector characterized with poor technologies and practices. ▪ Low on farm productivity ▪ High post harvest losses that affect 14.9% of the volume of cooking bananas produced, translating into a loss of 1.1 million tons per year ▪ Weak regulation of the sub-sector and dominance of brokers (informality) ▪ Weak market development for diversified banana products ▪ Weak input system and unorganized or weak farmer institutions ▪ In ability to meet phytosanitary and sanitary measures to penetrate export markets ▪ Bananas are almost 80% water which makes dried products price uncompetitive compared to substitutes ▪ Limited information of banana substitute markets to competitively position banana subsector
		SO Strategies	**WO strategies**
Opportunities (O)	▪ Banana plantlet business presents an opportunity for rural entrepreneurs especially youths ▪ Emerging banana markets especially in the Middle East ▪ Productivity is still below potential which present opportunities in varietal improvement, and development of management protocols ▪ Growing export markets ▪ Existence of harmonized standards within EAC to ease trade ▪ Existence of niche market for organic certified bananas in markets like USA	▪ Establish appropriate supportive frameworks and policies for banana sub-sector ▪ Investment in market research to guide further investments in innovations ▪ Strengthen partnerships within regional trading blocs or bilateral agreements to increase market penetration ▪ Develop new products based on different banana varieties because organoleptic properties, nutrient content and texture vary widely across varieties	▪ Strengthening value chain coordination/alliances for industry self regulation, advocacy and improved information sharing with the value chain ▪ Train farmers on improved farming practices especially innovative pests and disease management ▪ Investment in micropropagation facilities closer within production areas ▪ Invest in adequate infrastructure for pre-packaging, transportation, cold storage, packaging and distribution, ▪ Promote appropriate financing mechanisms/schemes for investment in processing and enabling timely access to quality agro-inputs by farmers ▪ Enhance the shelf life of bananas, which is likely to reduce losses due to ripening and bruising through promotion of varieties with intrinsic longer shelf-life (such as Kibuzi) or loss reduction technologies ▪ Promote weight-based pricing system
		ST Strategies	**WT strategies**
Threats (T)	▪ High perishability of bananas ▪ Population boom leading to land fragmentation ▪ Unpredictable weather patterns (drought and hailstorms) ▪ Competition from banana substitutes leading to price volatility ▪ Pests and disease outbreaks especially banana wilt. ▪ Price fluctuations due to seasonality of supply	▪ Adopting genetic engineering to supplement conventional breeding to control pests/ diseases and promote desired sensory attributes	▪ Institute policies on land consolidation ▪ Investment in breeding for climate-resilient banana cultivars, and other biotic and abiotic stress especially banana Xanthomonas wilt (BXW), Fusarium wilt ▪ Promotion of sucker staggering for continuous supply across the year



4. NARO's (NaRL's) performance and capacity gaps in relation to addressing key value chain issues

Banana research in Uganda is spread headed by National Agricultural Research Organisation (NARO) through one of its 16 semi-autonomous Agricultural Public Research Institutes i.e. National Agricultural Research Laboratories (NARL), located at Kawanda. Under NARL, there is a special program (i.e. National banana program), mandated to generate banana varieties that improve of the banana production, productivity and utilization. The program was created in 1989 to address soil fertility, and pest/disease challenges that threatened production in major banana growing areas.

Over years, the program has collaborated with other institutions such as Makerere University, the International Institute of Tropical Agriculture (IITA), Bioversity International, Bill and Melinda Gates Foundation and many others to undertake joint research at local, regional and international level to improve banana productivity and utilization as shown in Table 6 [43].

To enhance adoption of developed research products, NARO has promoted developed varieties. However adoption rate remain low (below 10%) in comparison to local varieties, which could be attributed to: (i) limited awareness or information flow among value chain actors, (ii) limited acceptance of improved varieties among consumers due to inferior sensory properties, partly attributed to use of conventional breeding methods which introduces undesirable attributes but also limited involvement of end users during breeding cycle (oftentimes are looped in towards the end)

Table 6: NARO's (NaRL's) performance and capacity gaps analysis	
Key issues affecting dairy industry within NaRL mandate	Ongoing efforts by NaRL
Banana productivity is still below potential	• Seven improved banana (matooke) hybrids which yield almost four times compared to the local varieties grown under similar growth conditions and their taste is comparable to the local varieties • The main cooking and beer brewing banana varieties with potential for high banana juice yield in southwestern Uganda have been identified and mapped. The 4 cooking banana varieties are Kibuzi, Mbwazulume, Ntalagaza and Nshasha; and the 6 beer brewing varieties are Mbidde, Musa, Kisubi, Kayinja, Mufunyakobe and Fhia 23. Most important is that one banana variety that is market-preferred and with the best juice and wine producing attributes and well adapted to the local agro-ecological conditions has been selected for use by the industries
Pests and disease outbreaks especially banana wilt.	• Most of these are resistant to resistant to black Sigatoka, tolerant to nematodes and weevils, and short maturity period. These include KABANA 6H (Kiwangaazi, M9), KABANA 7H (M2), NAROBan 1, NAROBan 2, NAROBan 3, NAROBan 4, and NAROBan 5
High post harvest losses that affect 14.9% of the volume of cooking bananas produced	• Cost-effective temperature-controlled technology (charcoal cooler) to enhance the shelf life of bananas, which is likely to reduce losses due to ripening and bruising, and to promote sale of bananas in peeled, labeled, and packaged.
Underdeveloped banana processing sector characterized with inferior product quality	• One (1) enzymatic banana juice extraction method has been developed. This method, which uses Pectinase enzyme at 0.08% (by weight) can propel the banana juice processing cottage industries to a much higher level. Use of the method greatly reduces labour, reduces fuel energy, reduces extraction time and enhances the quantity and quality of banana juice and wine produced.
Climate change impacts	
Limited knowledge and skills on improved banana production practices	• Produced banana agronomy extension training guides
	• Under banana research, two biotechnology research products: Hybrid M9 [Kabana 5] and Nakitembe, enhanced with pro-vitaminA [pVA], were approved by National Biosafety Committee. The two varieties have further been advanced to four multi-locational confined field evaluation trials representing banana agroecological zones in Buginyanya, Mbarara, Bulindi and Kawanda
	• Trails for GMO banana are ongoing at Kawanda with close supervision by National Biosafety Committee (NBC)

43- Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), 2020. FY 2019-2020 Annual Performance Report, MAAIF, Kampala, Uganda.

5.0: Strategic analysis and recommendations for NARO

For greater impact, research should be driven by the current and future dairy market dynamics. Such dynamics include the following:

- Urbanization which might call for convenience favoring the peeled banana market and shelf life extended banana products
- Calls for proper waste management within upcoming towns could drive the peeled cooking banana trade
- Incomes and population growth expected to positively influence banana consumption
- Youth population and changing lifestyles and culture could lead to decrease in banana consumption per capita due to recent shift to cereal based foods such as rice and maize. Therefore, prices of other carbohydrate substitutes will have a big influence of banana sub-sector performance.
- New markets such as middle East will drive exports especially for apple bananas and bogoya.
- Research on pest, diseases and climate tolerance will have a big bearing on production of bananas
- Reducing landholding as a result of population pressure could lead to reduced production

Existing and emerging opportunities

- Uganda is among the top global producers of bananas, however export and domestic trade in value added products is limited
- Although there emerging processors, the processing potential is largely unexploited
- Current untapped banana export potential for Uganda stands at US$ 5 million. This is in form of fresh and dried bananas [44].
- United Arab Emirates (UAE), Belgium and Netherlands have the greatest potential for Uganda's fresh or dried bananas. Of the US$5 million untapped potential, UAE alone accounts for US$1.2 million, Netherlands accounts for US$ 576,000

and Belgium accounts for US$402,500 (Figure 32). However, in terms of the highest demand potential, Belgium presents the biggest opportunity. To gain a bigger share than US$402,500 for Belgium market, Uganda will have to compete with leading exporters such as Guatemala, Colombia, Ecuador,Costa Rica, and Cameroon.

- Other markets that Uganda can tap into and potential global competition from lead exporters are presented in Figure 33 and 34.

Untapped Potential Export for Uganda's Banana Exports

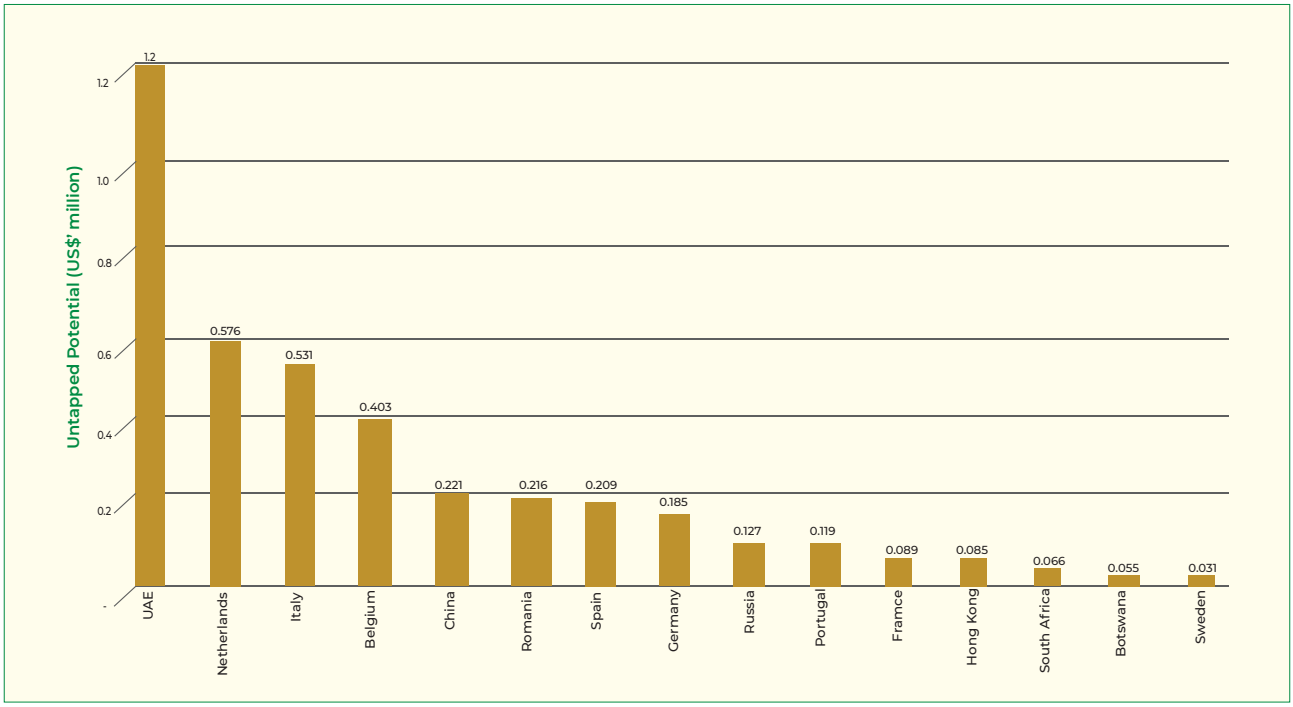

Figure 32: Uganda's banana exports untapped potential

44- International Trade Center (ITC), 2021. ITC Export Potential Map, ITC, Geneva, Switzerland. https://www.exportpotential.intracen.org.

6.0: Export markets with highest untapped potential for Uganda's banana products

Countries with greatest potential to export Bananas (fresh or dried) to World are Ecuador (US$3.2 billion untapped potential), Philippines (US$2 billion untapped potential), Costa Rica (US$ 1 billion untapped potential), Colombia (US$979.3 million untapped potential) and Guatemala (US$608.3 million untapped potential).

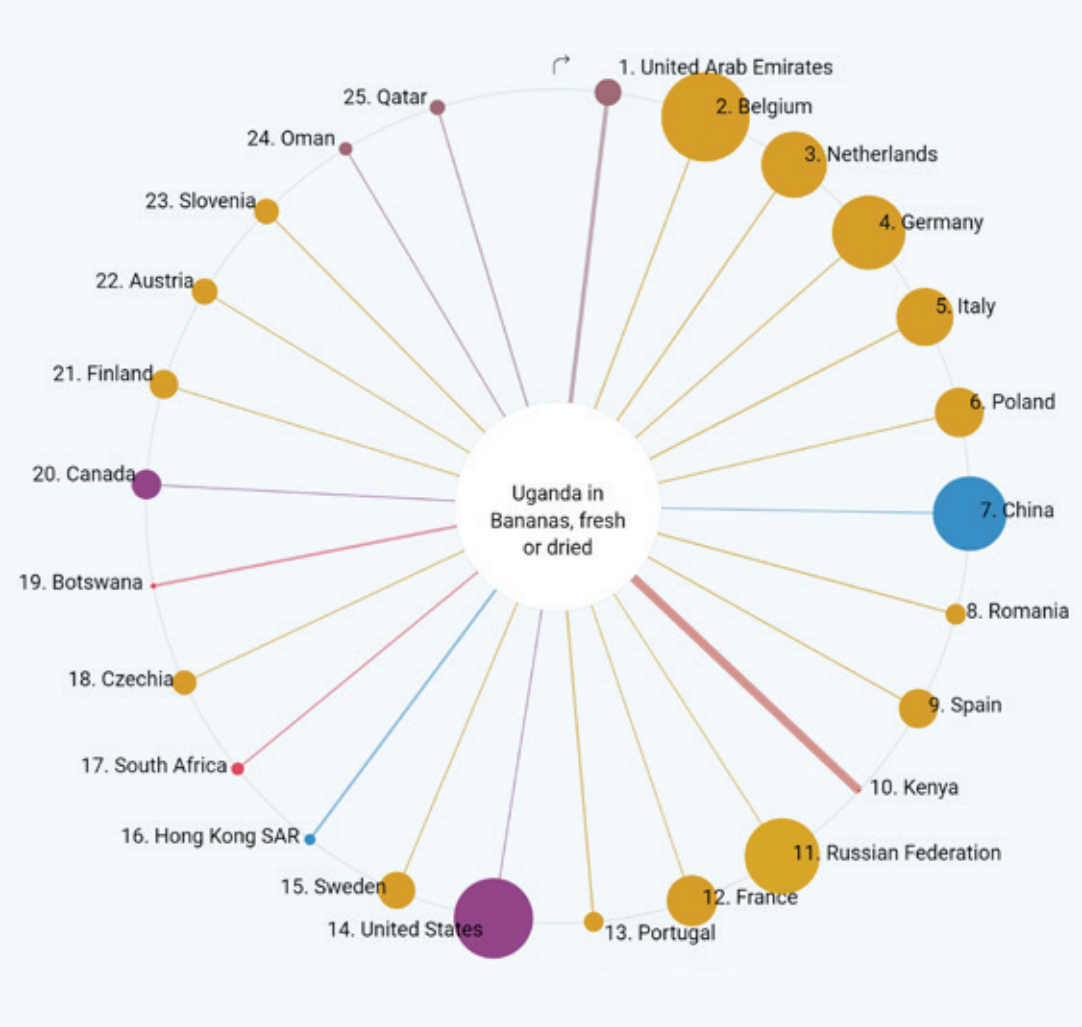

Figure 33: Ranking of markets by untapped potential for Uganda

N.B: Number (1 to 25) represents the ease of market access by Uganda's products, while the size of the bubble represents the size of available

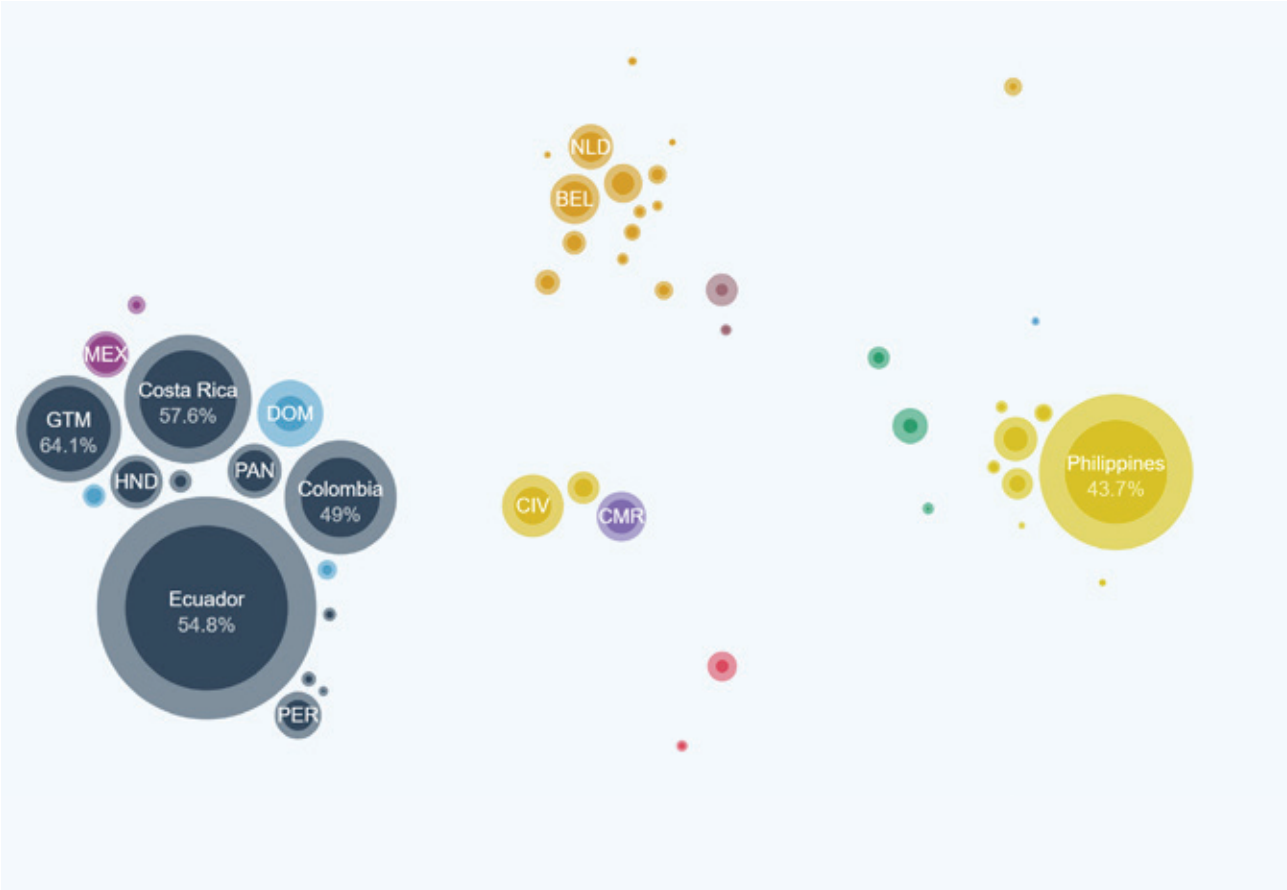

Figure 34: Countries with greatest export potential for fresh or dried bananas.

N.B: % shows how much of the export potential is met

7.0: Key bottlenecks Limiting Commercialization of Developed Technologies

Technology and knowledge are critical in fostering value chain efficiency and competitiveness. However, technology development in itself is not enough. Commercialization and the distribution of the technology, ensures that innovations are scaled-up and sustainable. First, commercialization is the process by which products, knowledge/services, and technologies are introduced to the market for purchase. Apart from patenting and licensing, other forms of technology transfer can also be in form of contract research, consultancy, personal exchange, spin-offs, incubators, science parks and joint university-industry supervision of PhDs [45].

- Although the technologies have been developed, value chain actors, especially farmers are not putting them in practice. This results in a large difference between the average productivity of value chain actors and crop or herd potential due to.
- Weak linkages between research and private sector players who play a critical role in commercialization of such technologies. Furthermore this is worsened by the limited distribution networks by research institutions and capability to market such technologies.
- Sometimes the developed technologies are not necessarily superior (in terms of user preferences) or responding to evolving market needs than what is already existing. Real needs of users are met due to limited involvement of relevant stakeholders during technology development process which is critical for buy-in.
- Information asymmetry, partly attribution to weak research – extension – end user linkages to facilitate timely and effective dissemination of research products for enhanced awareness and adoption.
- Focus has been more on knowledge transfer or dissemination of research results (through publications, trainings, workshops, seminars, grants, and fellowships) rather than technology commercialization

- Mass production (producing the product at a commercial scale) is often the most expensive aspect of the development process as it usually requires investment in a facility, equipment, and workers
- Breeding focus has been more inclined towards improved resistance and agronomic characteristics, with less emphasis on consumer tastes and preferences
- Limited funding directed to research. Breeding cycle is very long and costly
- Limited quality assurance and control during mass production which may result into inferior products and can pose a reputational and financial risk to the research institution
- Limited access to demonstration trails by end users i.e. often times, trails are done at research stations which are distant from end users. It is important to note that adoption occurs in a social context that has local characteristics, an aspect that should be taken into consideration from the development until the transfer of technology

8.0: Success factors for commercialization research products

In 2017, Partnering for Innovation, a USAID-funded program, conducted a study to assess the critical success factors for commercialization of already existing publicly-funded agricultural research products, services, and technologies across its eight partnerships [46]. Critical success factors highlighted by the report include:

- Clearly defining the role of the research institution as a resulting product is handed off to a company, including how its role is funded. It is important to determine the role the research institution will play in the commercialization process (manufacturer of the product in case of inhouse production/spin-off, licensor, consultant, supplier/service provider, etc.) and how that role will be supported financially (project funding, fee-for-service, royalties, etc.).
- Address intellectual property from the beginning. There are three aspects to consider in regard to intellectual property: a) ownership of the research itself (public domain or owned by the research institution), b) protection of the company's own proprietary information, and c) implications for further research or development work
- Establishing quality control during mass production. One of the risks in commercialization is that the company might not produce a quality product. Research institution should seriously consider building in a certain level of quality training and assurance. During the technology transfer process, companies may need technical assistance with quality control and/or regulatory compliance. Research institutions may also incorporate quality requirements as a condition of licensing agreements. These services can be paid for either through the royalty payment structure or on a fee-for-service basis.
- Recognize that research is just one part of R&D. Commercialization takes considerable time and resources. Companies invest significant resources and take risks to develop products resulting from publicly-funded research. Research institutions often have limited awareness of the work companies do to bring a product to market – including building a facility, designing and setting up the production process, building a supply chain, establishing distribution/logistics channels, marketing, and regulatory compliance.
- View the smallholder farmer as a customer. During the commercialization process, there is a shift in thinking from viewing the farmer as a participant/beneficiary to viewing the farmer as a customer. For the product to sell, a company needs to understand smallholder farmer needs and wants, and convince the customer that the product addresses those needs and wants better than alternatives. The customer will not buy the product simply because it is there or because the researcher has shown that it remedies the research question he/she set out to answer. While the researcher may incorporate some aspects of this thinking into his/her research, there is a definite shift in thinking during the commercialization process with the company seeing the farmer primarily as a customer.

- Understand the motivation, and the responsibilities, of the Researcher. There is a need to Understand the motivations for researchers, their institutions, the companies they work with, and donors to design research processes that result in smoother commercialization. While technology transfer offices can be helpful in navigating legal issues and providing general advice for working with commercial partners, the researcher ultimately "champions" and then manages the commercial relationship with a company. Similarly, on the company side, having a champion who advocates for the idea and sticks with it through the challenges is important. This necessitates a commitment from the company's management to dedicate the necessary financial, time, and staff resources.
- Value relationships and networking. Establishing a platform for networking and relationships between researchers and commercial entities is very important. When available, entities such as accelerators, like business incubators or centers for innovation, can play a valuable role in connecting researchers and companies, and helping to bridge the gap between the language of science and the language of business. Being more purposeful and explicit in communications and networking may bring more research to the commercial market.
- Involve the private sector in research early on. Early engagement of private sector in development process is very critical as it brings different perspective and idea. There are different forms that private sector involvement can take, both formal and informal. At a higher level, advisory boards or stakeholder groups can provide a forum for companies to share their perspectives on the bigger picture issues that they see and provide input on the strategic direction of research. At a more technical level, they can provide feedback on the direction of the market and feasibility.

9.0. Lessons learnt from elsewhere on commercialization of similar research products

Key lessons highlighted from elsewhere regarding technology commercialization include [47] :

- ***Companies should play the leading role in commercialization.*** Embedding a culture where ties with industry are the norm. Research institutions or other organizations play supporting roles, but companies need to take the lead when the innovation passes from the research phase to the development phase. Companies have the expertise to plan, budget, and finance this work and know what is realistic for their company to achieve. There is a need to change from knowledge-driven toward demand-driven research. Understanding the customer (not farmer but end user/consumer) has always been one of the key determinants of successful commercialization of new technology in agriculture.

- ***Donor and/or host government funding plays an important role in commercialization to benefit smallholder farmers.*** This support can be direct or indirect. Examples of direct support may include financing parts of the company's development work (supply chain, mass production, marketing, etc.) needed to produce the product at a price the smallholder farmer can afford or product test or enter markets, and can "crowd in" commercial investors and other sources of financing . While indirect support may include training, technical assistance, and other services to smallholder farmers for companies to work with a smallholder supply chain or smallholder customer base that already has a certain level of knowledge.

- ***There is often a communication barrier between researchers and company representatives.*** Researchers and businesses bring different perspectives, motivations, and objectives. While they can, and do, come together around common issues, they often struggle to effectively communicate with each other and understand the other's perspective. Research is often driven by intellectual curiosity and the pursuit of knowledge, while business is market-driven. The involvement of a third party (such as a donor, NGO, consultant in a project context, or incubator) or an internal expert (such a professor from the university's business school or a company's research department) who understands both perspectives can be helpful to bridge the gap.

- ***Commercialization is an ongoing process that requires a long-term view.*** . It is not a short-term project, although short-term project funding can play a role in advancing specific aspects. It takes years to get it right – eight to ten years for commercialization to

be completed. Design programs that recognize the financial and time-horizon realities of commercialization.

- ***Develop systematized structures and procedures to engage with the private sector on research early and at a strategic level as part of the R&D process.*** Companies should provide input into strategic priorities for both basic and applied research – even if there is no immediate potential for commercialization of results. Such engagement can take the form of more formal, standing advisory boards or less formal, ad hoc stakeholder convenings for input on the design of specific programs. Keep in mind that different companies within the same industry will often have different views.
- ***Ensure that donor funding allows for co-creation and co-development.*** Donors that plan to support research with the intention of commercialization and/or to support commercialization directly, should engage with companies during the design phase. Ultimately, commercialization needs to be company-led, and companies can provide valuable input on realistic timeframes and processes, key challenges, and the most impactful use of donor funds
- ***Strengthen linkages between research institutions, companies, and broader agricultural development programs with complementary interests.*** Development programs can be vehicles for companies to more easily reach potential smallholder customer or supplier base with technologies they are commercializing. Networking and access to networks is therefore useful in the commercialization process.
- ***Support the development and use of intermediaries (such as TTOs, accelerators, incubators, business and science parks, NGOs etc) to bridge the gap between researchers and businesses.*** These intermediaries help to facilitate partnerships, address communication barriers, and work out mutually agreeable terms on roles, intellectual property, and compensation. In some case, research institutions have established technology transfer offices (TTOs) to act as knowledge brokers who position themselves between academia and industry, support academics in the commercialization process, and help attract resources. These mainly help researchers with weak networks with the industry to market the technologies.
- ***Design programs that recognize the financial and time horizon realities of commercialization.*** When supporting research for which commercialization is the desired outcome, donors should build in funding support for technical assistance and the costs associated with initiating this process on the research institution's side – and recognize the time required to achieve the desired result. It cannot be assumed that promising innovations will be commercialized without further effort to engage with companies. Project design should consider the trial-and-error nature of commercialization and be flexible to accommodate the unexpected and foster adaptive management of unexpected challenges or issues. Commercialization is an ongoing process that requires a long-term view. Further, Facilitating access to funding for commercialization is very critical because mass production of technological innovations requires large capital outlays, and consequently access to capital/financial markets is critical to the success of discovery and commercialization of new technology
- ***The transfer of technology by itself is not enough to promote transformation.*** It is rather necessary to exchange knowledge with farmers and build research collectively

47 - United States Agency for International Development (USAID), 2018. Success Factors for Commercializing Agricultural Research: Lessons from Feed the Future Partnering for Innovation. A Companion Guide for Project Managers, USAID, Washington USA.

10. Proposed roadmap for unlocking commercialization of research products

Generally, for research to be effective, there is need to foster dialogue between society, companies and researchers. Its paramount to encourage both private companies and public research institutions to engage in innovation development process. Interactions between different players during research process are presented in Figure 35 as proposed by Da Silva et al., 2019 [48].

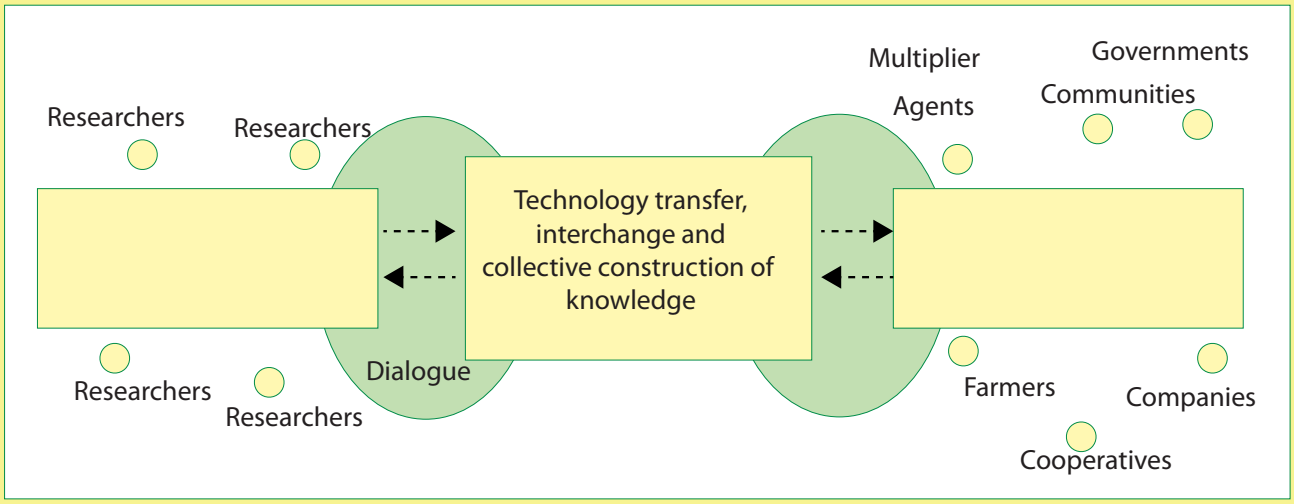

Figure 35: Generic framework for technology development and transfer (adopted from Da Silva et al., 2019)

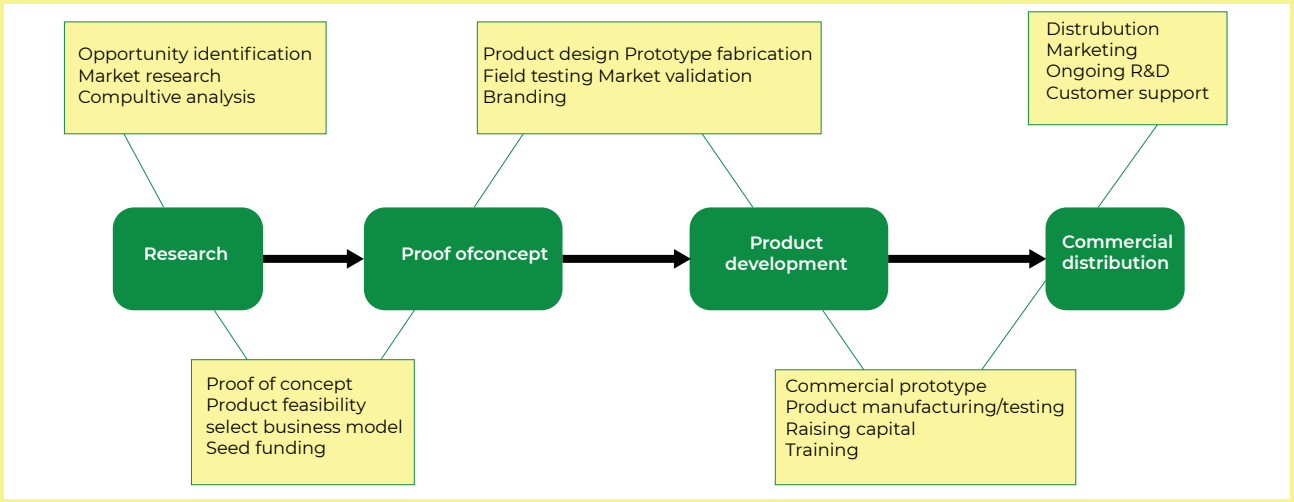

Figure 36: Major phases and steps in technology commercialization process (adopted from USAID, 2017)

48- Da Silva S. S. Feldmann P. R. Spers R. G. and Bambini M. D. 2019. "Analysis of the process of technology transfer in public research institutions: The Embrapa agrobiology case. Innovation & Management Review." Vol. 16 No. 4, 2019. pp. 375-390. DOI 10.1108/INMR-05-2018-0024



11.0: Key Activities involved in Commercialization of existing Research Products

Partnering for Innovation, a USAID-funded program (2018) highlighted the following key activities to be critical during commercialization of existing technology from public research institution [46]

Research:

- Opportunity Identification: Identifying a potential research question to shed insight or even solve an agricultural development challenge with a product, service, or technology innovation.
- Market Research: Answering research questions about market trends and consumer preferences.
- Competitive Analysis: Identifying potential "competitors" to researching agricultural challenges or developing products to solve them.
- Proof of Concept: To provide verification that an initial concept, method, approach, product, service, etc. will eventually be put into practice or use.
- Product Feasibility: To assess whether a proposed concept, method, approach, product, service, etc. will be practically realizable.
- Select Business Model: Planning for what type of business model will best create value, sales, and profit for a new product or service; usually based on market research.
- Design Requirements: Documentation of the minimum physical and functional needs of the basic product/service design to perform its purpose.
- Seed Funding: Identify and secure funding for limited production or manufacture of a new product or service, usually to test its market readiness and to make adjustments based on market response.

Proof of Concept:

- Product Design: Designing initial product models.
- Prototype Fabrication: Manufacturing initial product models.
- Field Testing: Testing initial product models in real-life situations with potential customers.
- Market Validation: Verifying, through field testing, that the initial product model is viable for mass market sales. Sometimes includes adjusting or reconfiguring product design.
- Branding: Assigning a particular name to the product for marketing and sales purposes.

Product Development:

- Commercial Prototype: The final product/service prototype that matches all requirements including for branding.
- Product Manufacturing/Testing: Testing and finalizing the product/service for mass market distribution and sales.
- Raising Capital: Identifying and increasing funds for covering manufacturing and other costs related to products and services.
- Business Launch: Formal designation of an operational product line or business.
- Training: The process of teaching the workforce to understand and sell products/services.

Commercial Distribution:

- Distribution: Developing and maintaining commercial distribution channels, or modes, for delivering products and services to end consumers.
- Marketing: Strategies and channels for raising awareness and interests from potential customers about products and services.
- Ongoing R&D: Ongoing research and improvements to products and services to improve sales and profit.
- Customer Support: The provision of information and knowledge to customers on the use of the product or service.

12.0: Specific Recommendations for the Activity

Theme	*Activity*	*Recommendations*
Continued improvement of crop genetics, bio-fortification, and integrated pest and disease management for both crops and livestock, in response to market-demand	Facilitate the release and commercialization of varieties developed under previous and ongoing research efforts	• Organize periodic networking events to bring together researchers with value chain players and enablers • Strengthen linkages with extension agencies and development partners to leverage networks for catalysing technology commercialization • Advocate for conducive investment climate to incentivize private sector to commercialize innovations such as taxation policy, and subsidy scheme for new products to lower product price for market demand generation while covering development costs • Facilitate access to capita for product development • Establish trails on farmer plots for easy buy in.
	Develop improved crop and animal production and management technologies in response to emerging threats and market demands	• Undertake market research for identifying market demand in advance of research project and attempts to scale up and commercialize specific technologies with proven market demand • Adopt interactive development of knowledge and technologies with intended end users rather than development of technologies for potential users • Focus on breeding for varieties with more export potential such as dessert bananas • Breed for climate-resilient, extended shelf life and biotic stress especially banana Xanthomonas wilt (BXW), and Fusarium wilt, while prioritizing consumer preferences • Intensify research for improved processed products quality
Strengthening NARO's institutional sustainability in the marketplace	Consolidate previous gains in institutional and human capacity development to align research with market needs, and mobilize domestic resources that will displace current development partner funding	• Develop and implement policies, legal frameworks and guidelines for management of IP, technology transfer/commercialization and partnership with industry • Establish Technology Transfer Offices to support researchers through the formal and administrative aspects of technology commercialization • Build capacity of staff/researchers in modern technology transfer and commercialization process, • Strengthen linkages with business incubators and science parks to sharpen entrepreneurship • Equip NARS with adequate equipment and funding of research daily operation expenses (consumables) • Establish innovation fund/vouchers to support spin-offs/start-ups or SMEs commercialize developed products



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14.0: Data gaps that might require in-depth analysis

Missing Information	*Potential Source*
Domestic Markets - Informal cross border trade in bananas? Volumes and DRC markets or towns where most traders pick it from - Uganda's import and export slide was not worked on - Need clear description of how bananas are imported from DRC and how it ends up with final consumer? - Which banana products are showing more future prospects and why? - What needs to be done to tap into the potential?	Interview with cross border traders PIBID & Exporters
Production - What is the average size of medium scale farmer in South Western Uganda? - How does the supply chain of supermarkets look like? Who supplies supermarkets?	
Export markets - Which varieties are exported most and to which markets? - What are the opportunities in the export markets? - Key challenges faced by the banana exporters? - What lessons do we pick from exportation of value-added products? i.e. PIBID, AfriBanana	Exporters PIBID & Exporters
- What is the processing capacity of different processors? i.e. installed vs utilization capacity - Why is processing into secondary or tertiary products still limited? - What kind of innovations are needed to meet current and future market trends?	
- What are the current and future innovation (technological and knowledge/practice) needs at each node of the banana value chain? - What should be done to increase utilization of new innovations along banana value chain?	Different VCAs

Support institutions	Farmers
- Who are the major distributors of banana agro-chemicals? or which agro-chemicals are mostly used in banana production? - Why are we having low adoption of developed clean planting materials? - Why is the low adoption of agro-inputs in general? - What are the key technologies used by banana farmers and who is the supplier? - Who are the suppliers of banana processing equipment? - Do we have local fabricators manufacturing banana processing equipment? Which challenges are they facing or users facing? - Apart from Makerere University, do we have other institutions, training professionals who support banana sub-sector? - Major sources of finance for the different value chain actors? - Which are the major financial institutions providing credit to dairy sector? - What are the challenges with financial access? - What are the on-going projects in the banana sub-sector both by government and development partners? - Why are developed cultivars not widely adopted by farmers? - Which lessons do we pick from PIBID in relation to development of processing capacity of banana value chain? Highlight challenges, processes and opportunities - Do we have umbrella organisations that bring different banana value chain actors together? If so mention them and their mandate.	Processors NARL Different VCAs NARL PIBID

Missing Information	*Potential Source*
Enabling environments - Operating fees for the different value chain actors? - What's the cost of trading licence from LGs?	Different VCAs PIBID & Exporters
- Number of people employed along the banana value chain?	
- Gross margin analysis at different nodes of the banana value chain beyond production?	Different VCAs PIBID & Exporters
- Past and on-going efforts by NaRL to address key value chain challenges? - How have they been scaled up and commercialized? - Which challenges have been encountered in identification, development and commercialization of different dairy technologies and practices? - What needs to be done to increase efficiency at each stage of research development? - What is the proposed model for increasing commercialization of innovations and ensuring self-sustainability of NARL? - What are the key recommendations to the project for? - Facilitating faster release of already developed or on-going research products? - Development of new technologies in response to market trends and climate threats? - Improving institutional capacity of NaRL to be more sustainable and not solely depend on government and development funding?	NARL Director Banana Researchers and private sector players

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