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FINANCIAL INCLUSION FOR RURAL MICROENTERPRISES (FIRM)

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**REPORT ON INVESTMENT OPPORTUNITIES FOR VALUE
ADDITION ON AGRICULTURE AND LIVESTOCK PRODUCTS
IN MERU COUNTY- BANANA PROCESSING PLANT**

FIRM-RFP-113

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MERU COUNTY
**INVESTMENT &
DEVELOPMENT
CORPORATION**

FINANCIAL INCLUSION FOR RURAL MICROENTERPRISES

BANANA PROCESSING PLANT

Location : Mitunguu

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List of Abbreviations

BQ	Bills of Quantity
CIF	Cost Insurance Freight
Ha	Hectares
IRR	Internal rate of Return
JKIA	Jomo Kenyatta International Airport
KIRDI	Kenya Industrial Research and Development Institute
NEMA	National Environmental Management Authority
NPV	Net Present Value
PGI	Protected Geographical Indication
PLC	Power Logic Control System
PTO	Protected Designation of Origin
ROI	Return on Investment
TSG	Traditional Specialty Guarantee

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Executive Summary

Agro processing provides a solution to the agricultural food production losses experienced in the farming sector. These losses are a big disincentive to farmers in Meru County. It presents a loss in family incomes and perpetuates poverty in the rural areas. Food losses occur at different levels of the supply chain – planting, crop management, harvesting, post harvest management, processing, and distribution either in retail or wholesale and at the consumption stage.

This report presents an investment proposal for the establishment of a banana processing plant at Mitunguu area, Meru County. It represents the second stage of the process i.e. processing and value addition. This plant will process banana puree, banana flour and banana crisps as the main products. Other product lines that could be added in future (with minimal additions to the main processing line) are; Starch, Gin and Vodka. The proposed plant will have an intake capacity of 8,000 Kilograms per hour at full operation.

The proposed equipment will be sourced from Netherlands. These are fully automated processors from- intake to packaging, eliminating the need of a large work force.

The design of the plant has taken into consideration renewable energy tapping to reduce on industrial waste pollution and save energy costs. A banana waste energy production plant has been incorporated into the design. This can be expanded in future to produce manure and animal feed

though offsite (away from food processing site). From the financial analysis and the farmer production potential, the proposed project is viable and will offer high returns to the investors.

The plant will require a total cash outlay of KShs. 658,864,305.58. This includes the cost of construction and processing machine installation and other fixed and operating costs for the base year. This plant is expected to employ 48 workers directly and provide a market to the banana farmers in Meru. It will be Power Logic Control System (PLC) controlled thus requiring very limited human intervention in the process.

The proposed site (Latitude -0.137587, Longitude 37.810284) is 2km from Mitunguu town which is 59 Kms to the Isiolo International Airport. The site has abundant underground fresh water as well as adequate supply of water for irrigation from Mt. Kenya. It is located on the newly tarmac Meru – Ishiara Road (C92);

The proposed location is in the heartland of banana farming in Meru. Farmers in Mitunguu use irrigation on their farms thus are able to harvest throughout the year. This will guarantee the processor an all year round supply of raw products.

On social benefits, the local community within the immediate vicinity will benefit from the factory's health facility, opportunities to invest in housing and other economic and trade activities that accrue due to increased population (factory workers) and incomes.



1. Objectives of the Report

The objective of this report is to present the viability of the proposed banana processing plant establishment. This report primarily considers the business case for production of Banana Puree, Banana Flour and Banana Crisps/waffles.

2. Methodology

The study and proposed design of the factory was conducted in four phases as described below:-

2.1 Phase one consisted of a prefeasibility study conducted in Mitunguu and the surrounding areas to establish the availability of banana fruit for processing on an industrial scale.

2.2 Phase two was a survey of the proposed site and necessary amenities. It included a study of the impact of the waste management to the environment and neighboring settlements.

2.3 The third phase consisted of designing architectural requirements for the proposed factory. The Architectural designs were made based on, future expansion needs, lessons learnt from selected exiting processors and machine manufactures' specifications. It also considered and benchmarked on best practices in food processing locally and internationally.

2.4 In the fourth phase, the team identified the processing plant and equipment

(including price and manufacturer's specification), determined the necessary additions /accessories that require frequent changes. Also we sought out prices of finished products and benchmarked with existing processors of similar target products locally

3. Background of Banana Farming

a) Introduction

Banana is an important food crop in several tropical developing countries. There are 12 countries with a production of over 1 million tonnes annually, ranging from India (12 million tonnes) to Venezuela (1 million tonnes). Columbia, Costa Rica, Ecuador and Philippines are the major exporters while China is a significant net importer.

The traditional importers have been the industrial countries (Western Europe, North America and Japan) however, a number of developing countries have become significant importers. FAO¹ estimates that these trends are likely to continue and their share could rise further to 33 percent by 2030, as developing countries will be increasing further their per capita consumption and imports. The industrial countries will continue to hold a dominant position as major importers, with their consumption per capita increasing further, although at a slower pace than in the past.

b) Banana Production in Kenya

Banana is an important source of income and food security among producers in Kenya. This is mainly due to the

1 BANANA MARKET REVIEW and BANANA STATISTICS 2012-2013: Market and Policy Analyses of Raw Materials, Horticulture and Tropical (RAMHOT) Products Team ; FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, Rome, 2014



introduction of tissue culture technology that has eliminated most of the banana diseases and also reduced the maturation period. Bananas account for 36% of the fruit produced in the country, and 11.1% of the total value of domestic horticulture. Farmers earn USD 148 per year, contributing between 30-70% of household income. The subsector employs approximately 500,000 people.

There are two main banana types in Kenya- dessert or fruit bananas and cooking or plantain bananas, with different geographic origins; dessert bananas originate in Kirinyaga, Murang'a and Meru, whilst plantains are produced in western Kenya mainly Kisii.

The main varieties grown include: dessert banana cultivars - Grandnain, Gross Mitchel, William's hybrid, Lactan, Valery, Chinese Cavendish, Giant Cavendish,

Dwarf Cavendish and Apple banana; cooking cultivars which include: Gradi Shisikame, MutaHato, Uganda Green and Ng'ombe and multipurpose cultivars such as Muraru and Goldfinger.

The leading counties in banana production in Kenya are Meru (14 percent), Kirinyaga (12 percent), Embu (10 percent), Bungoma (8 percent) Taita Taveta (7 percent) Kisii (7 percent) and Muranga (6 percent).

Meru, Kirinyaga, Embu and Taita Taveta recorded production of 47.28, 57.7, 48.8, and 50.66 tonnes per ha in 2014, which could be attributed to access to water for irrigation, adoption of superior varieties (Tissue Culture), availability of clean planting materials and exposure of farmers to modern agronomic practices. Table 1 below shows the national production among the main producing counties.



Table 1. National Banana Production among the Main Producing Counties.

	2012			2013			2014		
	Area (ha)	Production (Ton)	Value (KSh. '000)	Area (ha)	Production (Ton)	Value (KSh. '000)	Area (ha)	Production (Ton)	Value (KSh. '000)
Meru	6,194	288,803	2,675,480	6,493	307,013	3,422,330	6,146	215,580	2,475,820
Kirinyaga	3,434	185,402	1,818,220	3,627	209,601	2,288,660	3,768	192,230	2,206,497
Embu	3,026	147,791	1,479,680	3,363	164,374	1,646,528	3,634	177,924	1,782,248
Bungoma	3,029	57,143	1,084,520	3,413	65,166	1,231,072	3,980	75,234	1,428,277
Taita Taveta	2,450	126,727	1,296,067	2,569	130,154	364,001	2,513	129,739	1,236,000
Kisii	3,856	85,700	1,238,400	3,795	85,022	1,151,060	3,962	85,780	1,231,400
Muranga	5,696	94,981	941,920	5,819	99,737	1,122,677	5,874	101,753	1,141,552
Tharaka Nithi	2,049	80,900	1,039,330	2,137	75,920	963,720	2,148	79,823	1,139,761
Total Kenya	48,022	1,331,958	16,478,500	50,718	1,437,565	17,751,007	52,102	1,430,217	18,164,448

Viewed from an efficiency perspective, Taita Taveta produces 51.62 tons per Ha, Kirinyaga 51.01 per Ha while Meru produces 37.2 tons per Ha. In 2014, Meru had 2,378 Ha more than Kirinyaga and 3,633 Ha more than Taita Taveta yet it produced 23,350 tonnes more than Kirinyaga and 85,841 tons more than Taita Taveta.

Therefore, taking Taita Taveta as a standard, on 6,146 Ha, Meru should be producing a minimum of 317,300 tonnes - an increase of 47% or 101,720 tons more than the reported production in 2014.

c) Production Potential of Meru.

Meru County is currently the leading County in Kenya in the production of bananas; this is because of the climatic conditions and accessibility to water for irrigation and markets in Nairobi and other major urban centres. However, Meru is producing below its capacity. The main banana varieties grown are: Grand Nain, Gross Mitchel, Chinese Cavendish, Giant Cavendish, Dwarf Cavendish, Shisikame, Uganda Green, Ng'ombe and Gold Finger.

The minimum an acre (0.405Ha) should produce is 15,000 Kgs (15 Tons)². With 6,146 Ha, the minimum production level



should be 317,300 tonnes. To examine the circumstances of production in Meru a survey was conducted in the main growing areas. The findings are discussed below.

In this study a sample of 709 farmers was taken to analyse the production activity. On the average, the small scale farmers who are the majority of the producers have

holdings of about 0.8ha-16Ha. The sample was randomly selected with the largest farm being 20Ha and the smallest being 0.225 Ha. 11 traders were sampled in Gakoromone market, Ntharene, Mitunguu, Kariene, Igoji, Katheri 2, Kanyakine and Gikomba in Nairobi. The results are analysed below.

Table 2. Banana Production Survey Sample

	Survey Sample	Actual MOA Data (2014)
Production	19,740 Tonnes	215,580 Tonnes
Area (Ha)	564(Ha)	6,146 (Ha)
Sampled Farmers	709	
Sampled Traders	11	
Farmers weekly output	379.6 tonnes	
Traders weekly output	1,221 tonnes	
Estimated potential Current % of production	47% increase in Production at current level. ³	
Areas Sampled	Abogeta ,Abothuguchi Central ,Akachiu, Giaki, Kamako, Kanuni, Karirwara, Kathera, Kiagu, Kianjai, Kigane, Kinjo South, Mikumbene, Mitungu, Mwangathiha, Nkuene ,Nyaki East Nyaki West , Nthimbiri, Thuura, Mikinduri, Mbeu, Kariene, Kitheo ,Mlango	

Fig 4. below shows the loaction of banana farmers interviewed

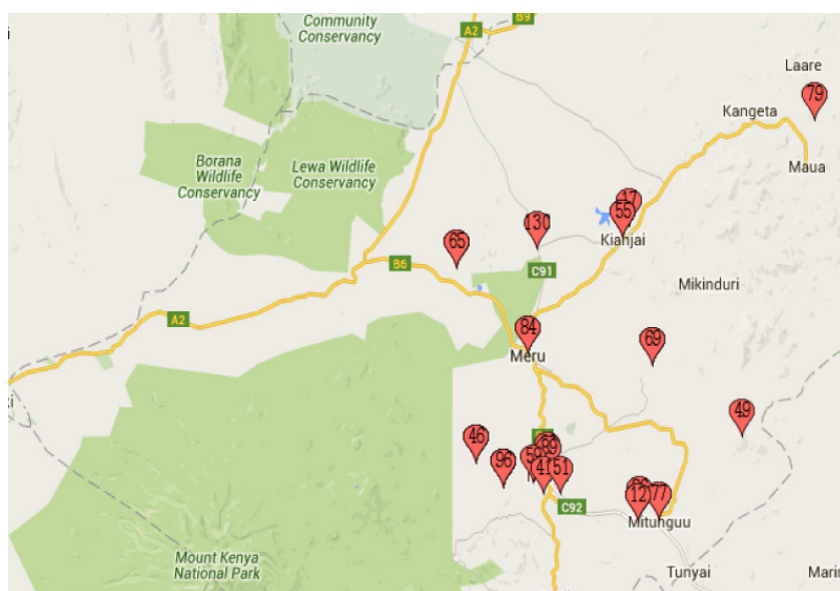


Figure 1 Location of banana farmers surveyed

² Mbijiwe – Farm manager Kaguru Farmers training Centre

³ Taita Taveta and Kirinyaga Counties generate 51.62 and 51.01 tons per HA compared to meru at 35.0 tonnes. Meru



Small scale producers are the back bone of the banana production in Meru. Irrigation in Mitunguu area and the cultivation of tissue culture cultivars has been the driver for the growth witnessed. The Sample studied produces 379.6 tonnes per week. The itinerant traders are the main players and determiners for prices at the farm level.

d) Harvesting and Bulking

Harvesting is done in the evening or early in the morning. In Mitunguu area, traders visit the farms, select and pay for bananas then hire casual laborers to harvest. The traders know farmers whose produce is ready and the quantities required by the market. Traders will transport the harvest to the road side for collection and transport to the bulking centre.

In Kariene, Kanyakine, Igoji and environs, farmers harvest and transport to the market centre to look for buyers. The area has 9 bulking Centres along the Meru Nairobi Highway. These are in Kariene, Kanyakine, Lower Churi (Mwichiune), Yururu, Ntharene, Miruriiri, Igoji, Kieni Kia Ndege, and Keeria. Each centre has a specific day set for purchasing. Produce that is not bought is wrapped and left at the market centre and will be sold to other traders at lower prices as it is considered stale. Activities at these centres include;

a) De-handing; 26 % of the farmers in Mitunguu reported that de-handing is done at the farm. In Kariene and Igoji, this activity is done by the traders at the collection market albeit on a very small scale.

b) Cleaning and grading; Traders supplying processors and supermarkets clean and sort their consignment. Some traders ripen the produce and deliver to the processors and supermarkets. Consignments for the open markets are generally not graded.

c) Transportation; several forms of transportation are used. These include motorcycles, pickup trucks and wheel barrows. Motorcycles are preferred for farms far removed from the main roads. At the various stages of the supply chain, a lot of produce is damaged and lost.

The Banana Supply Chain: Figure 2 below illustrates the supply chain of the produce in Meru. Traders / Middlemen play a central role in the banana trade. They collect from the farmers and distribute to the market (retailers, supermarkets and processors). The traders grade, clean, store and ripen the produce for the large retailers, institutions and processors. The Kiosk Retailers and hawkers collect directly from farmers and sale directly to consumers without grading.

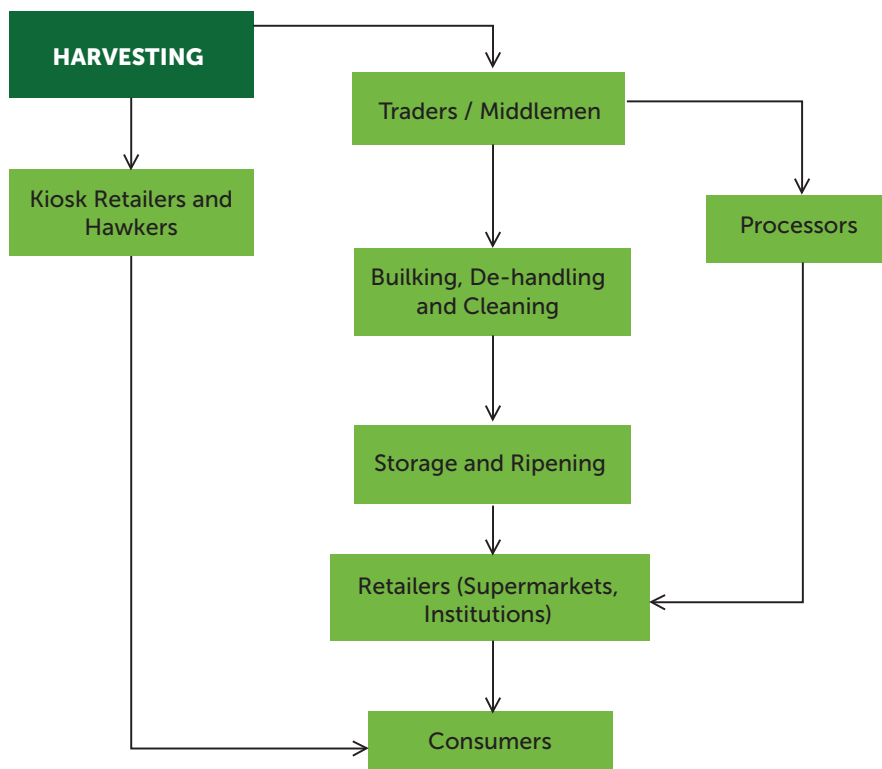


Figure 2. Meru Banana Supply Chain

The activities of each participant in the chain is detailed in Table 3 below

Table 3 Detailed description of the banana supply chain of the Sample– Meru .

Supply Chain stage	Location	Months of the year	Products	Volumes (ton)	Facilities/ Equipment	Duration/ Distance	Inputs and Services	Cost of pro-duction	Value of products
Primary production	Farm	All year round	Raw whole bunches		Irrigation pipes , Hoe and Pangas	On farm	Manure, banana seedlings/ suckers from neighbors or self , irrigation water, labour	Note 1	Note 1
Harvest	Farm	All year round	Raw whole bunches	379Tonnes per week	Knives	On farm	Casual labour paid by Trader or Farmer	Harvesting 10 KShs / bunch	200-450 KShs per banana bunch (30- 50Kg)
Post-harvest handling	Traders premises (Mitungu , Igoji, Kariene, Ntharene)	All year round	De-handled bananas or whole bunches	1,221Tonnes per week	Bags , banana leaves for packaging Plastic crates	25- 30 km from the farms to market	De-handling sorting and packing Casual labour	De-handling 5 bunch Market levy – 20KShs per day for traders 100 vehicle parking	500 - 600KShs bunch (30-50 kg)
Storage / ripening	Trader premises (Mitungu market)	All year round	Semi ripened and ripened bananas	400 Tonnes per week	Electrical powered ripening equipment Ethylene induction	8 hours per 20 tonnes. Mitungu market	Storage, Ripening	Not willing to provide	Not willing to provide
Transportation	To the traders premises and the market	All year round	De-handled and whole bunches	1,226 tons per week	Storage, owned lorry. hired lorry	285 km from Kariene to Githurai market.	Delivery Loading and offloading Packing	Not willing to provide info	Not willing to provide info

Note 1- 96% of the sample do not keep records on the costs on the farm. They do not quantify their own labour input. Note 2 – Value of the product could not be estimated as the prices fluctuate during the different production seasons.



e) Quantitative and Qualitative Losses occurring in the Banana Supply Chain.

The sample provided the following insights into losses incurred at the different stages on the supply chain.

- i) Farm level- The causes of quantitative losses on the farm occur from; (1) overproduction in relation to the inability of the market to take up all the produce, (2) impassable roads during raining seasons, (3) plant diseases, (4) rain and wind felling plants and (5) inadequate supply of irrigation water. (6) Improper crop husbandry.

Sampled farmers in Mitunguu estimated that during raining seasons, 46% of the produce is lost because traders do not venture into farms more than 10 KM off the tarmac roads. Farmers in Kariene, Igoji, and Kanyakine reported that only about less than 1% is affected. The farmers who manage to bring their produce to the market have to sell at low prices because of oversupply. About 16% of bananas delivered to the traders get physical damage due to poor handling. While diseases like banana thrips affect about 5% of the produce. During low production season, traders reported that some farmers harvest immature bananas. These are rejected at the trading centres resulting to losses at the farm.

- ii) Crop management -Most of the farmers are reluctant to reduce the suckers per stool to the recommended number of 3-5 plants. About 67% of the farms visited had an average of 7-9 plants per stool. This practice reduces sunlight and increases competition for nutrients in

the plantation affecting the quality of produce. About 2% of bananas sampled had cigar end fungal disease.

- iii) Seedlings: About 89% of the farmers reported that they get their seedling from the suckers of their old plantation or from neighbours. This practice hinders the elimination or control of diseases thus affecting the total productivity.
- iv) Transport of produce - Farmers in Kariene, Igoji and Ntharene estimated that 16% of the produce is damaged during transport. The pickups used from the farms will usually load upto 40-50 banana bunches, Motorbikes can carry 6 bunches. The bananas get bruises which accelerates decay during storage and ripening. These end up being rejected or sold at low prices. At this stage, traders estimated 15% losses. In Mitungu area, traders estimated that 5% of the produce is lost by casual labourers when loading to track/ Lorries for onward transportation. .
- v) Storage and ripening facilities –Traders in Gakoromone and in the collection centers, store bananas on floors or leave them outside overnight before being transported. Roadside traders expose the produce to direct sunlight which increases enzymatic reaction reducing shelf life. Bananas stored in temperatures above 24 degrees have a shelve life of about 7 days. During artificial ripening about 2% of the produce is wasted due to uneven ripening
- vi) FAO in 2014 estimated that 11% of the



production in Meru is lost through the reasons mentioned above, including handling and storage at retail level.

Table 4 below shows a summary of challenges affecting production and resulting to losses.

Table 4. Summary of Banana production challenges

Challenges of production	Particulars	% of respondents
	a) Access to production financing	56%
	b) Limited extension services	95%
	c) Marketing- price fluctuation and middlemen exploitation	96%
	d) Inaccessible roads during raining seasons resulting into waste	98%
	e) Limited Water for irrigation purposes	68%
	f) Expensive farm inputs, substandard or fake inputs	73.6%
	g) High Costs of labor, transport	42.5%

f) Processing

Products made of banana can be classified into three streams; (i) Pulp or semi solid products i.e. Puree, Pulp and Concentrates (ii) Dry products i.e. Crisps, Waffers, Flakes, Powder, Flour and Flavours (iii)Liquid products i.e. Beer, Juice and wine. The stem, leaves, peels and fiber are used to make artifact, mats and animal feed.

i) Surplus for Processing at Current Production Levels

Surplus produce (SP1) available for processing is the net sum of total production less domestic consumption – current production marketed (CP) as a percentage of estimated weighted loss (EL). From the sample, the weighted loss is 15 % .

$$SP1 = \sum 1 \{ (CP \times EL) / 100 \}$$

$$\{ (215,580 \times 15) / 100 \}$$

$$32,337 \text{ Tonnes}$$

ii) Potential Surplus for Processing

at improved Crop and Post Harvest Management

Surplus production available for processing with improved crop and post harvest management(SP2) the County producing on average 51.67 tonnes per ha (EP) in relation to the current area under production (cha) net of current production (CP) the available net produce for processing will be calculated as follows;

$$SP2 = \sum 2 \{ ((EP \times Cha) - CP) \}$$

$$\{ (51.67 \times 6,146) - 215,580 \}$$

$$101,720.4 \text{ Tonnes}$$

g) Recommendation

Dessert bananas stock generated with efficiency at the farm level is about 101,720 tonnes annually. This can provide a monthly raw material stock of 8,476 tonnes adequate to establish a processing plant for different products.



3.1 The Proposed Location of the Processor

The proposed processing plant will be located in Mitunguu, Imenti South Sub County.

The location of the plant has the following advantages;

- The location is in the heartland of the banana growing zone. Transport of raw materials will not be expensive and the produce can get to the firm while still fresh. Bananas are available throughout the year.
- The site has ample supply of water and electricity.
- It is on the Meru Ishiara new tarmac road.

3.2 Justification of the Proposed Project

a) Market potential

The confectionery industry is able to absorb the plant's entire production of banana puree and flavors. Currently they depend on imported products specifically

from India. The proposed products will be packaged and sold for either industrial use or ready to eat snacks.

b) Skilled Labour Availability

Fruit processing skills are available in the country with over 40 processors in Nairobi and its environs. This includes manual and skilled technical personnel. This will provide the recruitment base for the business. The Power Logic Control System technology that is used in the machines sought require minimal human intervention.

3.3 Products

It targets to produce Banana Puree, Banana Flour and Banana Crisps/waffles as the main products.

a) Product Standards

The raw banana has a variety of chemical and nutritional properties (see table 5 below) which will determine the extraction rate for each product

Table 5 General properties of the Banana Fruit

Properties	Amount	Properties	Amount
Calories	89%	Saturated	0.11 g
Water	75 %	Monounsaturated	0.03 g
Protein	1.1 g	Polyunsaturated	0.07 g
Carbs	22.8 g	Omega-3	0.03 g
Sugar	12.2 g	Omega-6	0.05 g
Fiber	2.6 g	Trans fat	0 g
Fat	0.3 g		

The plant will be expected to adhere to CODEX and other standards detailed in tables 6-9 below;



Table 6 Requirements for fried banana crisps

S/N	Parameter Requirements	Method of test
1	Moisture content, %, by mass, max. 5.0	ISO 712
2	Fat content on dry weight basis, %, max. 15 – 35%	
3	Free fatty acids on dry weight basis, %, max. 0.5%	
4	Sodium chloride (NaCl) on dry weight basis, %, max 2.0	
5	Acid insoluble ash, %, by mass, max 0.05	
6	Peroxide value, meq oxygen per gram 0.1	ISO 3960

Table 7 Specific requirements for Banana Flour

N	Compositional Requirement	Quality Limits	Method Of Test
1	Moisture, (max), %	11.00	US ISO 24557
2	Total Ash, max, %	4.00	US ISO 2171
3	Acid insoluble ash, max, %	0.40	US ISO 5985
4	Fibre, max, %	5.0	US ISO 5498
5	Particle size	Not less than 90 % shall pass through a 0.60 mm sieve for fine flour and not less than 90 % shall pass through a 1.20 mm sieve for coarse flour. Testing for particle size shall be done in accordance with EAS 82	

The banana flour shall also comply with the microbiological requirements as given in Table 8 below

Table 8 Microbiological requirements

No	Parameters	Requirements	Method of test
1	Total plate count, cfu/g, max	10 ³	US ISO 4833
2	Staphylococcus, cfu/g, max	10 ³	US ISO 6888
3	E.coli, cfu/g, max	Absent	US ISO 7251
4	Yeasts and moulds, cfu/g, max	10 ²	ISO 21527-2

Banana Puree Microbiological requirements shall be limited to the parameters in the table 9 below



Table 9 Microbiological limits for Banana Puree

Microbiological parameter	Limit
Aerobic (Standard) plate count	< 50,000 per g in any sample
Yeast	< 5,000 Colony Forming Units (CFU) per g
Mould	< 5,000 CFU per g
Coli form	< 100 per g using the MPN (Most Probable Number) technique
E. coli	< 3 per g using the MPN technique
6	Peroxide value, meq oxygen per gram 0.1

b) Extraction Ratio

Based on the banana fruit composition, the extraction ratios of the three main products will be = $\pm 2\%$

No	Composition Properties	Banana Puree	Banana Flour	Fried Banana Crisps
1	Moisture - 75%	35%	11%	5%
2	Matter – 18%	18%	9%	18%
3	Peel - 7%	0%	0%	0%
Total	100%	53%	20%	23%

c) Manufacturing Design

The input capacity of the factory will be 8 tonnes per hour of bananas with an over design to take care of future expected growth. The assumption is that banana source areas will manage to deliver the design quantity to the factory to run at optimal capacity.

a down time of 4 days in a month for maintainance. The machinery will be on an interface and PLC system. Minimum or no human intervention is required in this kind of control, trouble shooting is easy and down time is minimal during machine operation. The design process is illustrated in figure 3 below.

The factory will operate for 26 days and

Schematic Presentation of Banana Processing

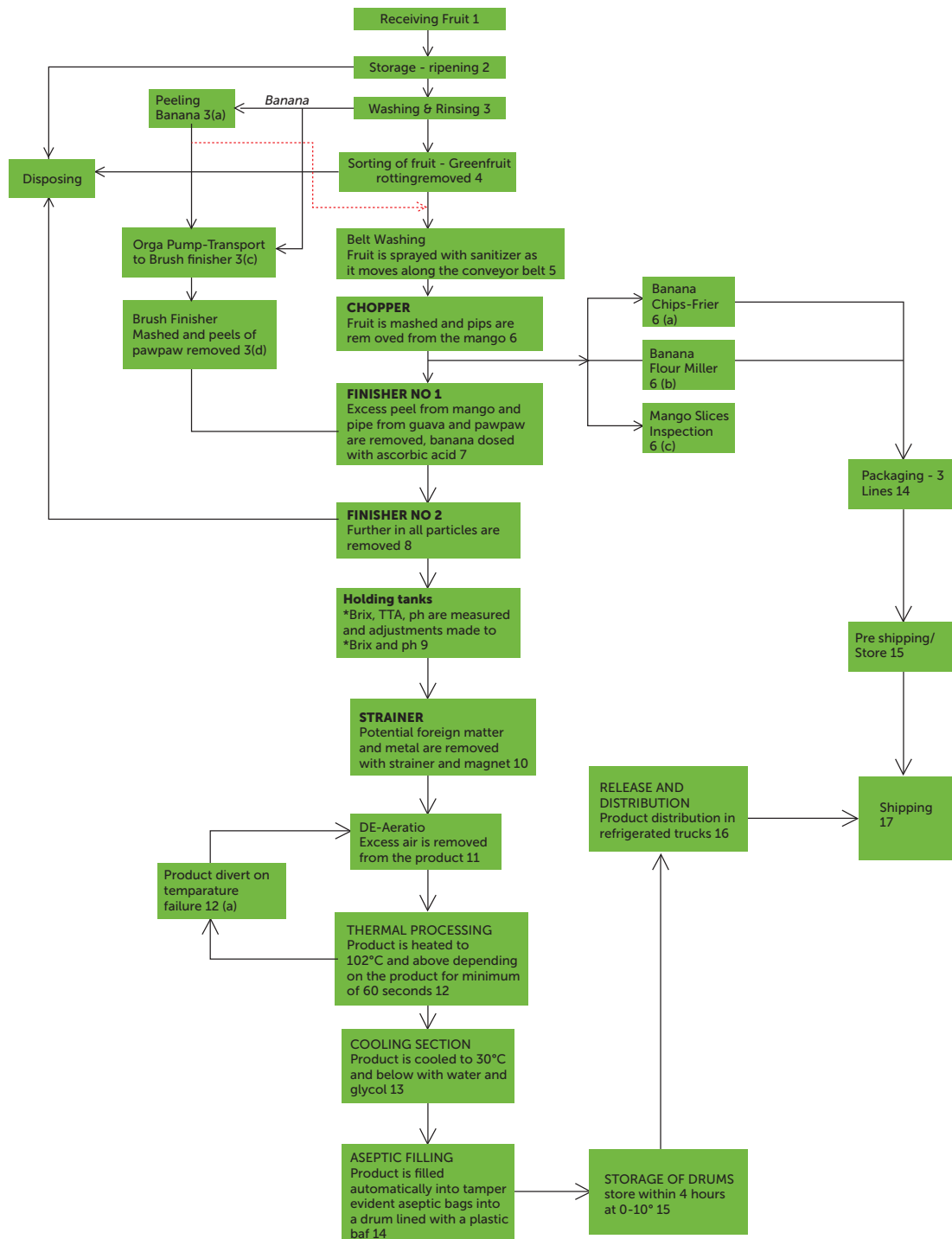


Figure 3. Fruit processing flow

**Step 1 – Receiveing of Fruit**

The factory will contract farmers to control quality and variety as well as guarantee the organic production methods.

The farmers will be trained on the best harvesting methods. Sorting is done at the home stead before delivering to the factory. The factory will organise transport

to avoid damage of the fruit enroute to the factory.

Once delivered in the factory the fruits will be cleaned and sorted. The inlet system will be a Hopper and conveyor as shown in the figure 4 below.

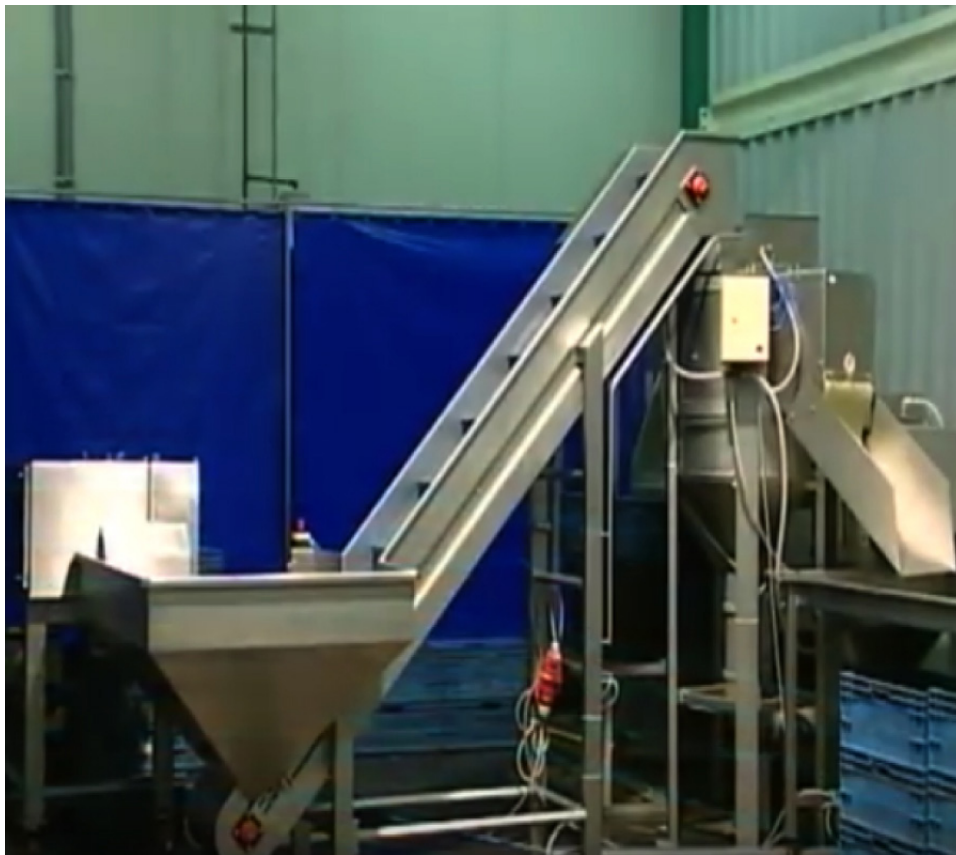


Figure 4. Banana Inlet Hopper and Conveyor System

Step 2 Storage

The fruit will be examined, sorted and stored depending on the ripening stage or the availability of the plant.

Stage 3 Washing and Rinsing.

The fruit is washed and rinsed then separated according to produce. Banana Products (Puree, Flour and Crisps)

Stage 3 (a) the Bananas are manually peeled and categorized according to the line / product required. Line 3(b) is for processing Banana Flour and banana Crisps. Line 3(c) is for processing banana Puree.

Banana Crisps and Flour 3(b) – the peeled banana will move to stage 5 where it is



sprayed with sanitizer as it moves along the conveyor belt. The fruit moves to stage 6 for chopping / slicing before it is spray dried and separated according to product. 6 (a) bananas slices are fried/ flavoured and cooled. They are packaged and stored at stage 14. Banana chops are ground into flour at stage 6(b) - packaged and stored at stage 14.

Celsius and above depending on the product for minimum of 60 seconds.- Stages 12. The product is then cooled to 30°C and below with water and glycol (stage 13) and filled automatically into tamper evident aseptic bags into a drum lined with a plastic bag (stage 14) and stored within 4 hours at 0 – 10°C ready for shipping.

4. Machinery Sources and Prices

Banana Puree (3c) – the peeled banana is transported to the brush finisher -3(d)-mashed and impurities removed. The mashed product is sent to stage 7 -Finisher 1 where the banana is dosed with ascorbic acid. This is sent to stage 8 – Finisher 2 for further cleaning. From this stage, the product is sent to holding tanks (stage 9) °Brix, TTA, pH is measured and adjustments made to °Brix and pH. The product is pushed through a strainer (stage 10) to remove potential foreign matter and metals with strainer and magnet.

Excess air is removed through de-aeration (stage 11) and heated at =>102 degrees

1. Machinery Sources and Prices

Banana processing equipment are supplied by many companies globally. The choice of a equipment will depend on;-

- The capacity of the plant/factory.
- The end product to be delivered to the market.
- The desired technology.
- Future plans for expansion.
- The budget of the plant/financial standing of the organisation.
- The desires,tastes and preferences of the markets.

Accessories that require frequent replacement, boilers and cyclones as well as exhaust fans will be purchahsed locally as recommended by KIRDI.

The table 10 below indicates the machine / accessory and the recommended source.
Table 10 Machine Costs as at 15th July 2016

A. Machinery and Materials Costing					
	Item	Quantity	Source	Price (USD)	Remarks
1	Full Automatic Fried Banana Crisps Plant (8 tons per hour)	One		2,142,564	To process fried banana crisps
2	Exhaust Fans, cyclones and factory lightings	16 cyclones and 10 exhaust fans	Local	11,000	Exhaust factory air
3	Chilling Unit (3000 M ³)	Three	UK	154,176	To freeze Puree
4	Styrofoam and Cooling system	To cover 300 M ²	Local	27,279	Wall laggings



5	Conveyor System(inputs)	Three	Netherlands	58,294	To convey raw Bananas
6	Conveyor System(outputs)	Three	Netherlands	52,965	To convey ready Banana products
7	Boiler and Heating System (Industrial diesel fired)	One	Local	186,760	To supply steam
8	Mechanical Works (Platforms, intake, packaging, storage facility, waste outlet)	Assorted	Local	47,098	Machine fittings
9	Plumbing & fittings	Assorted	Local	58,823	Inlet and outlet steam and water flows
10	Complete Sewer treatment plant and waste ducts	One	UK and Local	295,117	Waste Management
11	Miscellaneous Expenses @ $\pm 20\%$ of total cost			606,815	Contingency
			Total USD	3,640,891	
			Total KShs @ USD=KShs 102	364,089,120	
NOTE: The Automatic Fried Banana crisps plant will consist of Feeder, cleaner, picking platform, cutter, first blancher, second blancher, dewatering unit, dryer, fryer, de-oil machine, flavouring and seasoning machine, pre-cooler, quick freezer and a complete automatic form fill packaging line. The biogas digester has not been included in this quote.					
B. Banana Puree and flour lines					
	Item	Quantity	Source	Price(USD)	Remarks
1	Churning Auger	One	Netherlands		
2	Sizing Rollers	Three	Netherlands		
3	Drier	Three	Netherlands	1,225,490	
4	Crushing Auger	One	Netherlands		
5	Vibrating Auger	One	Netherlands		
6	Packaging Unit	One	Netherlands		
	Total In KShs			122,549,000.00	

5. Waste Water Treatment

The water discharged from the processor when operating at full capacity will be 12 thousand liters per hour. The factory design has incorporated the treatment of this waste to treated water and biogas

for use in the factory and a filter cake of manure for use on farms. This use of biogas and recycled water will save on operating expenses.

The sewer plant will be a combination of UK sourced equipment and locally fabricated accessories that need to be replaced frequently.



Figure 5 below illustrates the waste treatment and management plan.

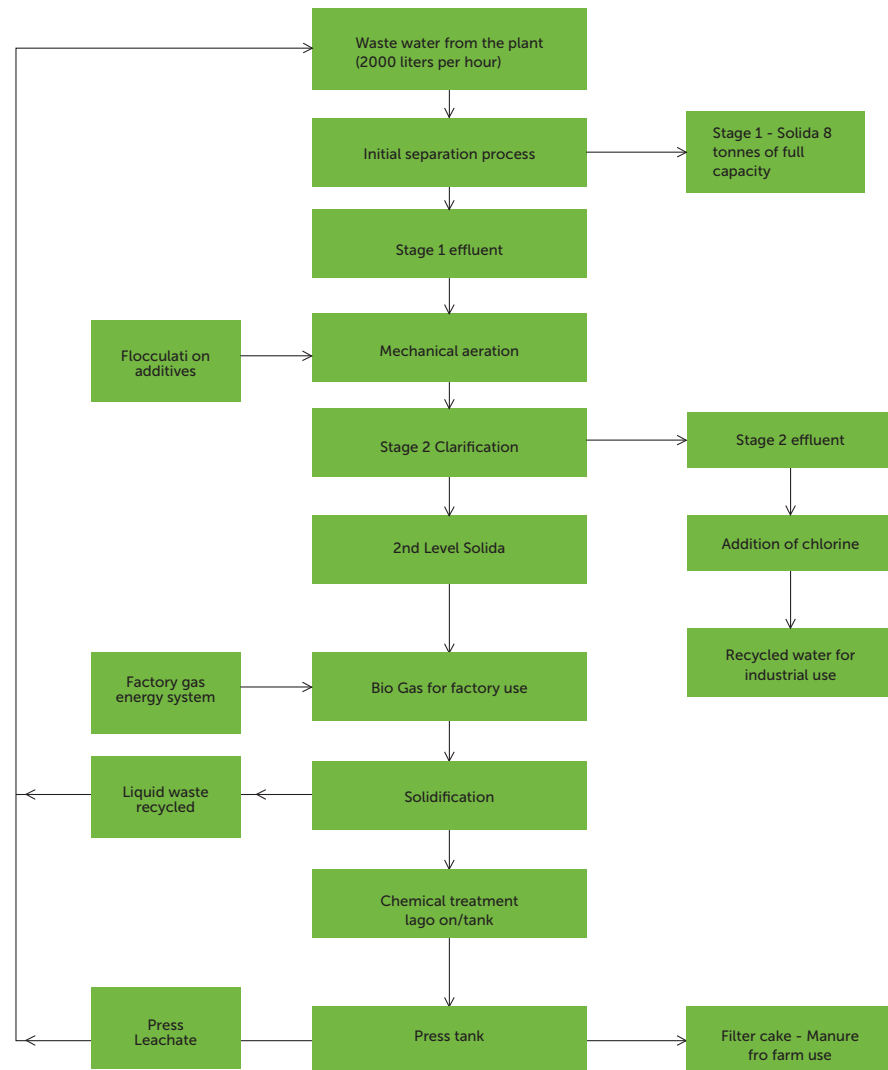


Figure 5. Waste Water Treatment Plan



6. Factory Site Plan and Costs

Location Mitunguu, Imenti South Sub County.

Area – 5 Acres. The land area has been planned to take care of future expansion. Figures 6 show the architectural drawings of the processing site complex.

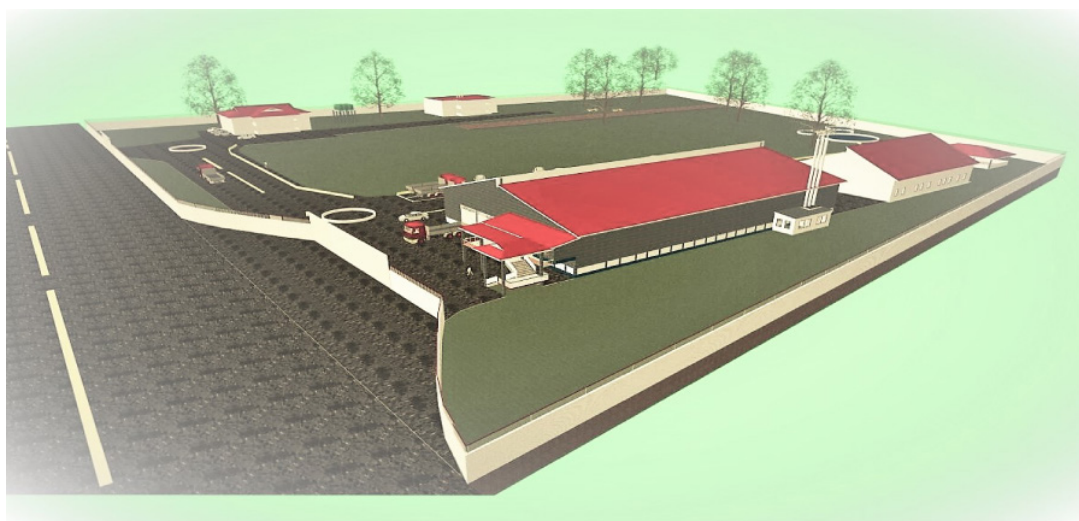


Figure 6 Architectural image of the proposed plant

7. Potential Risks facing the business

The risks facing the business can be divided into two i.e. risks facing the agro processor and the risks facing the producers of the raw materials

Agro-processors face numerous constraints including:

- i) High cost of equipment requiring meticulous level of maintenance;
- ii) Inadequate extension services to support production of raw materials
- iii) Expensive power supply coupled with frequent power cuts necessitating investment in alternative sources ;

- iv) Failure to meet food processing regulations pertaining to food safety and hygiene practices which need to be adhered to in the industry.
- v) Limited capacity to mobilize capital for equipment purchase and working capital.

Constraints faced by producers of raw material include:

- i) Frequent droughts resulting in crop failure;
- ii) Limited access to information from extension service;
- iii) Lack of commercial farming skills and poor crop husbandry resulting into low farm productivity
- iv) Lack of funding and unfavorable



- borrowing conditions
- v) Lack of adequate supply of certified seeds forcing farmers to recycle plants,
 - vi) Poor road networks making farms inaccessible ,
 - vii) Pest and diseases resulting into low productivity

8. Conclusions and Recommendation

8.1. Conclusion

The proposed project is a viable business which will contribute to modernizing agriculture in the county. The plant will provide an assured market for the numerous banana farmers thereby increasing their per capita income.

The venture is designed for banana puree, crisps and flour. The processing system will require minimum human intervention thus it is envisaged that the workforce will not exceed 48 workers in a full capacity on a 24 hour production of the three products. The country has adequate skills to install and commission the operations.

During our survey the farmers showed remarkable enthusiasm in participating in the proposed venture as it will reduce their farm losses.

The plant will require a total cash outlay of KShs. 889,242,324. This includes the cost of construction and processing machine installation, other fixed and operating costs for the base year.

8.2. Recommendations

Having studied the banana production in the county and considered the proposed

project we recommend as follows;-

- a) Implementation of the site infrastructure can be done in two phases, i.e. Phase one comprising of the machine house, boiler house, workshop, water and electricity installation, sewerage and waste water treatment plant, installing and commissioning of the processing machines. At this stage the promoters should acquire a refrigerated truck and an ordinary transport truck. Phase two would include the completion of the office block, staff amenities shop, health centre and road works in the complex.
- b) The promoters should target to have a full capacity operation of 8 tonnes an hour within 36 months of commissioning the project.
- c) Farmer education on production practices and product handling should be a continuous process to guarantee quality of raw materials.

9. Financial Plan

The financial projections contained in this section is based on the following foundation

The plant will require a total cash outlay of KShs. 889,242,324

9.1 This includes the cost of construction and processing machine installation, other fixed and operating costs for the base year.

9.2 The Cost of machinery is based on actual prices CIF upto the port of Mombasa as at July 2016. These are from specific manufactures.

9.3 Costs of local assembly parts are from Nairobi's industrial area.

9.4 The BQs are based on actual costs of



civil and engineering works as at July 2016. Site inspection visit and soil sample was conducted in July 2016.

9.5 Prices of raw banana were sourced from Mitunguu market banana farmers and traders.

9.6 Prices of the finished products were sourced from the retail stores and the market in Nairobi.

9.7 Visits were conducted to other processors in Nairobi to establish the physical requirements.

9.8 Architectural designs were made based on the client's description of process, future expansion needs, lessons learnt from selected site visits and machine manufactures' specification. It also took into account the basic industrial safety and standards in Kenya and globally.

9.9 The processing machine has a capacity of 8 tons per hour at full production.

Financial projections & Analyses

Detailed financial analysis are attached to this main report as a separate document.



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