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**PRE FEASIBILITY STUDY REPORT ON INVESTMENT
OPPORTUNITIES FOR VALUE ADDITION ON AGRICULTURE
AND LIVESTOCK PRODUCTS IN MERU COUNTY**

FIRM-RFP-113

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MERU COUNTY
**INVESTMENT &
DEVELOPMENT**
CORPORATION

FINANCIAL INCLUSION FOR RURAL MICROENTERPRISES

POTATO PROCESSING PLANT - MARITATI, BUURI SUB COUNTY

Location Maritati, Timau – Buuri Sub County
Location of site – Latitude: 0.09712 (0°
5'49.65" N): Longitude: 37.31817 (37° 19'5.4" E)

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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
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.

Meru potato farmers produced 157, 503 Tonnes in 2014 in an area of 14,916 Ha. During the prefeasibility study, a sample of 618 farmers with holdings totaling to an area of 2,613 Ha were found to have produced 27,500 Tonnes in the 2015 season. From the survey and other studies previously on the sub sector, farmers in Meru lose 46% of their produce mainly due to use of uncertified seeds, poor crop and post harvest management. These practices hinder efforts of managing crop diseases. Transport and poorly managed marketing systems also contribute immensely to the occurrence of losses. Despite these challenges, study concluded that the County has adequate production of ware potatoes for processing without disrupting the existing market of fresh potato produce.

This report presents an investment proposal for the establishment of a potato processing plant at Maritati, Buuri Sub County in Meru County. It represents the second stage of the process i.e. processing and value addition. This plant will process Frozen Chips, Cubes and Potato Flakes as the main products. Other product

lines that could be added in future (with minimal additions to the main processing line) are Crisps, Flour, starch, Gin and Vodka. The proposed plant will have an intake capacity of 6,000 tonnes per hour at full operation. This has been proposed to avoid capital expenditure in the likely event of a surge in farmer produce.

The plant promoters are driven by the need for a 100% organic process in the raw material production. Thus they will have contracted farmers whose processes will be controlled to ensure quality, consistency and traceability of the final product.

Standardization and quality of the final product is a key parameter. This will be determined by food processing standards, including but not limited to (i) Fair trade, (ii) Kenya Bureau of Standards (iii) European Union - Protected Designation of Origin (PDO). Protected Geographical Indication (PGI) and Traditional Specialty Guarantee (TSG) and (iv) USA – standards for grades of potatoes for processing.

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 Dutch potato sector is highly mechanized. It is the leading processor of dehydrated potatoes in Europe.

The design of the plant has taken into consideration renewable energy tapping to reduce on industrial waste pollution and save energy costs. A potato waste energy production plant has been incorporated



into the design. This can be expanded in future to develop 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 if fully implemented at the beginning, will offer high returns to the investors.

The plant will require a total cash outlay of KShs 520,672,464. This includes the cost of construction and processing machine installation and other fixed and operating costs for the base year.

The purchase price of raw potatoes will not exceed KShs 30,000 per tonne. At a selling price of \$900 (KShs 91,800/=) per tonne of frozen chips the business will need sales revenues of \$50,558 (KShs 5,156,916/=) or 56 units monthly at a price of Kshs 91,800 per unit. The prices used are international USD rate as the promoters are targeting the export market. The prices used in this analysis are compared with the UK retail market and online stores.

These projections have considered the fact that it may take the plant about 3 seasons of potato harvest to reach the proposed capacity of 6,000 tonnes per hour.

This plant is expected to employ 40 workers directly and provide a market to the potato farmers in Meru. It will be PLC controlled thus requiring very limited human intervention in the process. Potato flakes in Kenya are virtually nonexistent. A local company will enjoy first mover advantage and it will be awarded with near-monopoly status and high margins. A local manufacturer

will have a great potential to export its products due to the abundance of inexpensive raw material.

For future expansion the promoters can expand the contracted farmers reach to take in other potato varieties that are available in Meru to expand the product lines.

The proposed site is 2.7 Kms from the Meru-Nanyuki Highway (A2). It is 50Kms from the new Isiolo airport and 250 Kms to JKIA, Nairobi. It is well served by a large water bore hole supplied by the Buuri Multipurpose co-operative whose members will be the plant's contracted farmers. The Maritati Power substation is 2.5 Kms from the site. This will guarantee adequate supply of electrical power.

The County Government support to this venture includes the donation of the project land and guarantee to upgrading of the 2.7 Km access road from Maritati Centre to the processing site.

The proposed location is in the heartland of potato farming in Meru. Secondly farmers in Buuri sub county use irrigation on their farms thus are able to harvest two times annually compared to the rain fed farming in other part of the County. This will guarantee the processor an all year round supply of raw products.

On social benefits, the immediate vicinity local community will benefit from the factory's health facility, investment in housing facilities and other economic and trade benefits that accrue due to increased incomes. The Buuri multipurpose co-operative will benefit from increased water supply sales to the processing plant and increased member income from guaranteed raw potato sales.

Figure 1 Global Livestock herd 2011-2013 (Data FAO -2015.Graph by Erickson International)



1. Objectives of the Report

The objective of this report is to present the viability of the proposed potato processing plant establishment. This report primarily considers the business case for production of Potato flakes and frozen chips /cubes. These are the promoter's intended products.

The ware potato is a rich source of starch phosphorus, calcium, iron and some vitamins. Apart from use of fresh potatoes for domestic consumption, the potato is dehydrated into flakes slices, sticks, cubes or powder to impart better shelf life.

2. Methodology

The study and proposed design of the factory was conducted in five phases.

2.1 Phase one was a preliminary meeting with the plant promoters to understand their vision and inspect the proposed site , establish the source of electrical power and water, take measurement of the site and study the impact of the waste management to the environment and neighboring settlements.

2.2 The second phase consisted of soil structure sampling, to determine the ground formation, review the architectural design and agree on the site plan.

2.3 The third phase was to complete the architectural designs and develop the BQs. The 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 as well as food processing standards in Kenya and globally.

2.4 In the fourth phase, the team sourced the processing plant (including price and manufacturer's specification), determined the necessary additions /accessories that require frequent changes, as well as designed the adjustment that will be required to meet the plant's specific needs, sought and identified them locally.

2.5 With this information, the international market prices of finished products (potato flakes and frozen chips) were sourced from the promoters and benchmarked with Tesco Supermarket UK (online) and online stores. Local surveys were conducted to determine market in Kenya. This was the fifth phase.

3. Background to potato farming in Meru

3.1 Introduction:

The total world potato production is estimated at 364.808.768 tonnes in 2012 (FAOSTAT, 2014). China is the biggest potato producer together with India account for a third of all the global production. Kenya was ranked 24th with 2.9Million tonnes

3.2 Potato Production in Kenya

The ware potato is mostly grown in the highland areas surrounding Mt. Kenya namely; Meru, Embu and Kirinyanga; parts of Laikipia and both sides of the Aberdare range which include parts of



Nyeri, Muranga, Kiambu and Nyandarua counties. Other areas include Mau Narok, Molo, Tinderet, Nandi Escarpment and Cherangani Hills. Kericho, Kisii and around Taita hills also grow potatoes too but in small acreages.

For the last 5 years, production of potatoes has staggered around 2.3 M to 2.9 M tonnes recording a 9% increase from 2.3 M tonnes in 2009 to 2.5 M tones in 2013. During this time, seed planted rose from 104,000 tonnes to 108,000 tones

recording a 4% rise. The area under potatoes in 2014 was 115,604 ha yielding 1.6 million tonnes valued at KShs 22.84 billion. Compared to 2013, the area in 2014 increased by 11 percent while the quantity decreased by 2 percent due to unfavorable weather with the value reducing by 752 million. The price of potatoes per Kg declined from an average of KShs 31.1 in 2013 to KShs 30.9 in 2014 resulting to a reduction in value from KShs 23.6 billion to KShs 22.84 billion. (See table 1 below).

Table 1 Potato Production in Kenya

Year	2010	2011	2012	2013	2014
Area (ha)	121,542	135,924	99,475	104,560	115,604
Production					
Tonnes	2,725,936	1,846,576	1,436,718	1,667,690	1,626,027
Yield (tons/ha)	22.4	13.6	12.3	12.4	11.7
Price					
Retail (kg KShs)	18.9	29.2	36.4	31.1	30.9
Wholesale (110kg bag KShs)	1,383	2,542	3,765	2,989	3,100
Total Value (KShs. billion)	*	*	18.9	23.6	22.8

Source: Ministry of Agriculture, Livestock and Fisheries Economic Review of Agriculture [Era] 2015

3.3 Potato Production in Meru

Potatoes are generally grown as a commercial crop in Meru although up to 60% of the crop is consumed in the growing areas. The potato per capita consumption in Meru County is estimated at 30 kg per annum. This is, indeed, the national average based on the 2005 production and population statistics. The crop is mainly cultivated by smallholder farmers with the average land size of 0.4 per hectare (GTZ Survey 2013). Production under smallholder system is low ranging from 7-11 tonnes per hectare.

Meru County farmers have secured a niche market, supplying potatoes to most of the dry lands of northern Kenya, such as Marsabit. They also supply markets in Meru and Embu Counties, Nairobi and Lower Eastern parts of Kenya.

The last three years have witnessed a drop in the acreage under potato. The overall area under potato farming reduced in 2013 by 38% and 2 % in 2014. Production dropped by 56% and 1 % in 2013 and 2014 respectively. See table 2 below.



Table 2 Potato Production in Meru County 2012 – 2014

ITEM	2012	2013	2014
Area (Ha)	21,038	15,240	14,916
Production (MT)	249,142.7	159,539	157,503.5

Source: Ministry of Agriculture, Livestock and Fisheries Economic Review of Agriculture [Era] 2015

A baseline survey of the potato growing areas - Imenti Central and Buuri Sub counties- was conducted to establish the reasons for the trend in Table 2 above. Institutional factors and the potential

of the farmers to sustain a processing factory were also considered. A sample of 618 farmers was used. The findings are summarized below in Table 3 below.

Table 3 Potato Production Survey Sample Summary

		Survey Sample			Actual MOA Data (2014)	
Production		27,500T			157,503.5T	
Area (Ha)		2,613			14,916	
Estimated potential Current % of production						
Sampled Farmers (households)		618				
Areas Sampled, Imenti Central & Buuri	Ruiri-Rwarera, Rwompo, Utune, Timau Ngushishi Gathuine-Mujujune,Ntugi-Karanene-Kibirichia Health Centre-Kibirichia Market, Katheri-Gathiranga-Forest ,Kiirua Murunguma-Kiringo- Gitimene Market-Murunguma -Mujwa Nthunguri-gwa Kamau, Kisima-Ngare Ndare-Forest, Katheri Mau mau-Marete, Mucheene Forest Block 12.					
Composition of potato growers sampled						
Potato Growers Group	% farmers	No. Farmers	Size of Farm (Ha)	Average potato area per farm (Ha)	Total Potato area (ha)	% area of County's Total Production
Small Scale	69.90	432	0.9	0.81	350	2.35%
Small/Medium scale	20.55	127	10	9	1,143	7.66%
Medium /large scale	9.22	57	20	18	1,026	6.87%
Large scale	0.32	2	50	47	94	0.63%
Total	100	618			2,613	17.50%

Source Field survey – Erickson International



About 69 % of the sample farmers have an average holding under potato of 0.81 Ha which accounts of 2.35% of the total Ha under the crop in the County. The

total area sampled was 17.50 % of the area under potato production in the county. Figure 1 below illustrates the area covered in the survey.



Figure 1 Location of potato farmers sampled

a) Production Patterns

About 70% of the sample farmers produce two potato crops in a year because of bimodal rainfall except those in Buuri Sub County who exercise substantial off-

season farming using irrigation (82.2%). The long rainy season runs from March/ April to June/July, while the short rainy season is from October to December. Table 4 below illustrates these patterns.

Table 4 Potato Planting and harvesting Seasons in Meru

	Potato Planting Seasons											
	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Short rains	H	H								P	P	
Long rains			P	P			H	H				
Irrigated	P	P			H	H		P	P		H	H

P=Planting, H =Harvesting: Source Field Survey – Erickson International



b) The Ware potato value chain in Meru:

Small holder farmers with farm sizes averaging less than 2 hectares dominate the potato sub-sector in Meru. They account for 69.9% of the farmers sampled. Land ownership is predominantly freehold. Much of the produce of the small scale farmers is on leased forest lands. The average farm size of surveyed potato farmers was 0.2-1.8 hectares, while the average area of land given over to potato growing

was 0.6 hectares, or 35.4 per cent of their overall farmland. The main varieties grown in Meru are: Shangi, Asante, Sherekea and Tigoni Red.

The Ware potato value chain is dominated by Farm Traders (Brokers) at the production level and market traders at the marketing stage. Most of the production is done by small scale farmers. Figure 2 below illustrates the ware potato value chain in Meru.

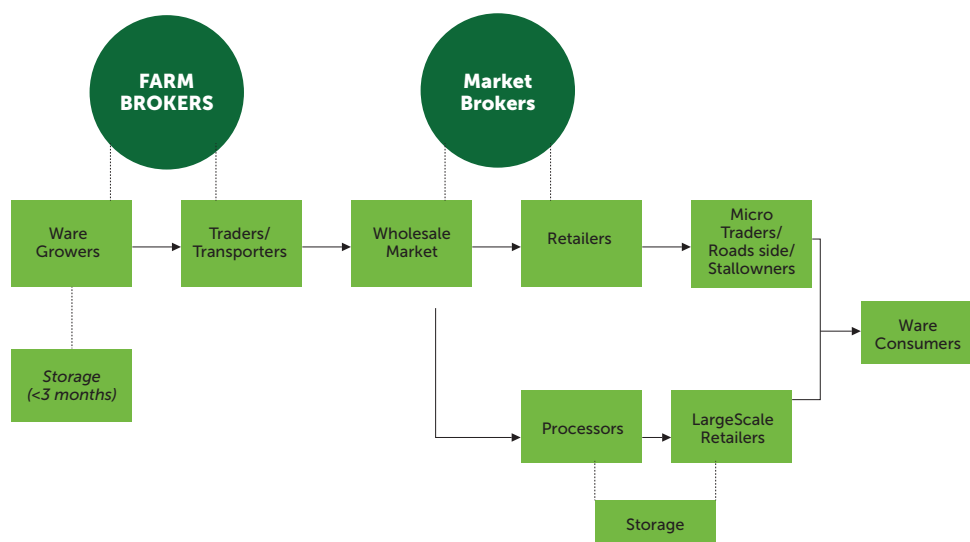


Figure 2 Ware potato Value Chain in Meru

i) Farm Traders Market

In the value chain Farm Traders act as intermediaries between farmers and the local and national traders and keep in close contact with the farmers to keep abreast with quantities and varieties farmers have. Traders work in groups and each group deals with 30 – 70 farmers. Traders get a fixed commission from the farmers. The bigger volume

of potatoes (about 91%) is marketed through this route. The Traders dictate the price which range from KShs. 800 to 2,500 for the 50 kg bag depending on the season.

ii) Post Harvest Handling

Most farmers reported sorting and grading potatoes at harvest. This mainly involved separating out small potatoes



for seed and domestic consumption. The medium and large potatoes are bagged for sale. About 51% of the farmers store potatoes to await better prices (GTZ Survey 2013). In the same survey, farmers reported experiencing losses of up to 119 Kg/ha or 0.8 % of the production during storage.

Some farmers have constructed stores of cement floors, wooden walls and corrugated iron roofs. At higher altitudes where the climate is colder, farmers store potatoes outside the house covered with dry potato leaves, which can be effective for up to three months.

iii) Potato Marketing

Potatoes are currently marketed through informal value chains that add limited value to the final product. The sequence of transactions is dominated by a multiplicity of intermediaries with little cooperation or integration and practically none implementation of standards or regulations.

iv) Contract Market/Group Marketing

A few farmers in organizations/groups prepare potatoes for the market as per the specifications of the buyer with whom they have signed contracts. The buyers that sign contracts with farmers are mainly the supermarkets and processors. Potatoes are packed in crates and transported in refrigerated tracks to reduce losses. Prices are stable throughout the contractual period and average about KShs. 3,000 per the standard 50 Kg. bag.

v) Marketing information systems marketing organization

The potato market infrastructure is,

largely, informal lacking in: coordination, cooperation, transparency in market information flow and mainly controlled by a cartel of traders. A marketing system that rewards quality and standards is required to reward farmers and other stakeholders for their efforts.

vi) Institutional support

The National Government has made efforts to develop appropriate policies, structuring of the potato marketing, develop standards and introduce regulations, but this has not had an impact yet. The Kenya Government and the private sector sought to improve packaging by introducing the Legal Notice No. 44 of 2005 and 113 of 2008 which specify a wide range of standards regarding packaging, transportation, processing, storage and consumption. The implementation of the law has not resulted into real changes as it was not properly enforced.

vii) Distribution Systems

The potato sub sector lack formal and structured distribution systems along the value chain. Farmers lack organized potato collection centers which could also serve as inputs supply outlets. Formal wholesale/cold storage centers to feed big consumers: processors, exporters, institutions and supermarkets are also lacking. Such facilities can also stabilize prices.

viii) Farmer Financing/Banking

Provision of affordable and accessible financial services is critical to the potato sub sector. However, most of the credit facilities are inaccessible to potato farmers due to high interest rates, low level of awareness and low credit



portfolio of certain agricultural lending institutions. Rural SACCOs and informal lending systems have become important vehicles for farmer finance because they are designed to address the farmers' needs.

ix) Farmer Support Systems

The critical farmer support systems were found lacking or inadequate are: extension services, road infrastructure, market information services and credit services. Access to short term credit for input supply and working capital has improved mainly due to entry of a significant number of micro finance institutions and rural SACCOs into rural Kenya. These financial facilities have not reached the majority of the smallholder farmers who need to make farming a business.

The level of farmer education, number of extension visits are significant variables in the improvement of efficiency in potato farming. It is,

therefore, necessary to expand farmer training for improved management. Priority should be given to innovative approaches to extension like group training, farmer-led extension and provision of communication technologies to support agricultural extension.

- c) Quantitative and qualitative losses occurring in the Ware Potato supply chain in Meru
- Kenya loses KSh19 billion annually due to poor production and processing of potatoes. In 2014, the National Potato Council estimates that a total amount, KSh12 billion was lost through poor harvesting methods while another Sh6 billion was lost through poor marketing process. Other constraints include diseases such as brown rot and late blight, lack of crop rotation where farmers cultivate potatoes on the same piece of land over and over again and poor storage facilities.

This situation is replicated in our sample as illustrated in Tables 5 and 6 below;

Table 5 Quantitative & qualitative losses in potatoes

Factor	Products that are not marketable/ consumable, e.g. spoiled, rotten, damaged, green potatoes	Loss	
Farming	a) Diseases	1%	17%
	b) Poor Seeds variety no proper germination	0.50%	
	c) No use or inadequate use of fertilizer , fungicides	5%	
Harvesting	a) Volunteer crops- crops left in the field	3%	
	b) Harvesting tools cause damage	5%	
	c) Premature harvesting or harvesting in wet weather	0.50%	
	d) Casual labour	2%	
Transport	a) Packaging bags (WPP) become heated (affecting sugar content)	0.50%	



	b) Several stages of loading and unloading prior to reaching the end customer,	0.50%	7%
	c) Losses due to a lack of access roads or poor road conditions	4%	
	d) Inadequate means of transport, donkey carts -due to poor road	2%	
Storage	a) Lack of storage facilities or simple stores	3%	8%
	b) Rot during storage	1%	
	c) Germination during storage	4%	
Marketing	1. Lower prices due to market oversupply/fluctuations	4%	14%
	2. Rejects by Traders at sorting	5%	
	3. Green potatoes due to sunlight and inadequate packaging material	2%	
	4. Reduction of prices due to low quality (green/cut potatoes) financial losses.	3%	
	Total Estimated Losses in the sample		46%

Source; Field survey – Erickson International

NB: Traders have to pack an extra 20kg on each bag to offset the losses the traders incur at the market. Traders in Gakoromone market reported that after buying from farmers the latter would sale directly in the market at lower prices thus undercutting them.

The sample of 2, 613 Ha reported an annual production of 27,591.6 tonnes. The losses at each loss at each level are tabulated below.

Table 6 Losses by the sample

Factor	% loss	Kgs Loss from sample
Farm and Harvesting Losses	17%	4,690
Transport	7%	1,931.4
Storage	8%	2,207
Marketing	14%	3,862
Total	46%	12,691.22

Source; Field survey – Erickson International



4. Potato Processing

The need for processing potatoes is a direct result of meeting the culinary demands of international tourism, and changing food habits among the local populace as a result of urbanization and lifestyle changes. Secondly from the farmers' perspective processing guarantees a market, helps to stabilize market prices and increase the family incomes.

The most common products in the Kenyan potato processing industry are fresh potato chips (French fries), followed by potato crisps and frozen chips. Consumption of potatoes has been on the rise with increasing urbanization and the growth of the fast food industry. It is approximated that over 60% of the fresh produce grown and traded by urban traders in Kenya is absorbed by fast food outlets such as restaurants and street market stalls.

4.1 Characteristics of Potatoes to be processed

A processing potato must have a high specific gravity and low sugar content. High specific gravity is necessary because it indicates how much water must be evaporated from the potato during the dehydration process. High specific gravity potatoes make the best French fries and dehydrated potato products. Lower temperatures or shorter frying time will yield a limp product with poor rigidity; longer frying time or high temperature of oil affects the color of the product (Zak and Holt, 1973).

4.2 The proposed Maritati Potato Processor

The proposed processing plant will be

located at Maritati in Buuri Sub County. This is a community driven initiative involving the Buuri Multipurpose Co-operative. It targets to produce potato flakes, frozen potato cubes.

The location of the plant has the following advantages;

- a) Location is in the heartland of the potato growing zones and can take both irrigated as well as rainfed produce. Transport of raw materials will not be expensive and the produce can get to the firm while still fresh.
- b) The site has ample supply of water from the Buuri Multipurpose Co-operative (50Mts cubic per hour) and is 2.5 Kms from the Maritati Kenya Power sub-station.
- c) It is 2.7 Kms from the Meru Nanyuki Highway, 50 KM to Isiolo International airport and 235 Kms to JKIA in Nairobi.
- d) The proposed plant will use contracted farmers to produce potato varieties suitable for frozen potato chips and potato flakes. This control will ensure that farm production is 100% organic as well as guarantee consistency in quality that reaches the factory. Trial planting tests have been successfully completed.
- e) Buuri farmers harvest potatoes twice in a year using irrigation. This will guarantee continuous supplies to the factory even when the rest of the County is dry.

4.3 Justification of the proposed project

a) Market potential.

Potato flakes processing in Kenya is virtually nonexistent. A survey of the major retailers in Nairobi indicated that this product is not stocked. Some store managers had not heard of it. A



local company will enjoy first mover advantage and it will be awarded with near-monopoly status and high margins. The price of the finished product is KShs 91.8 per kilogram. This provides high margins to the investors. (See financial analysis). A local manufacturer will have a great potential to export its products due to the abundance of inexpensive raw material.

Potato flakes and flour are used as potato substitute in confectionery and processing industries to make potato snacks, potato chips, mashed potato and potato pie to name just a few. Major intermediary products are flakes, flour and starch. Potato starch is widely used in paper and textile industries. Starch is also used as stabilizer, binder, filler, texture and gelling agent. Potato dehydrated products are lightweight, easy to transport and require less storage space. Maximum shelf-life is around 18-24 months.

Commercial users import potato flakes and flour to meet this demand because of almost zero local production. It is very convenient and cost saving for restaurants and bakeries to use potato dehydrated products to make mashed potatoes and other products.

b) Labour market

Potato processing skills are available in the country with over 40 processors in Nairobi and environs. This includes skilled 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.

The proposed site of the processor is in the main potato growing Zone in Meru. The local farmers adequate farm management skills. Technical knowledge on seed varieties will be sought primarily from Kisima Farm (a global leader in potato seed production.) located about 10 Kms from the site and the department of agriculture in the County.

4.4 Products

The potato tuber has various varieties that are ideal for a host of processed products. This specific processor will produce primarily Frozen potato cubes and potato flakes targeting the export market as well as the domestic market.

a) Quality standards and application

The raw material production will be 100% organic, using certified seeds at the farm level. The following standards shall be applied.

- i) Fair trade practices
- ii) Kenya Bureau of standards regulation on food processing
- iii) European Union – (PTO) Protected Designation of Origin. (PGI) Protected Geographical Indication and (TSG) Traditional Specialty Guarantee
- iv) USA – standards for grades of potatoes for processing

b) Manufacturing Design

The input capacity of the factory will be 6,000 tonnes per hour with an over design to take care for future expected growth. The assumption is that potato source areas will manage to deliver the design quantity to the factory to run at optimal capacity.

The factory will operate for 20 days and a down time of 4 days in a month for



maintenance. The machinery will be on an interface and power logic control (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.

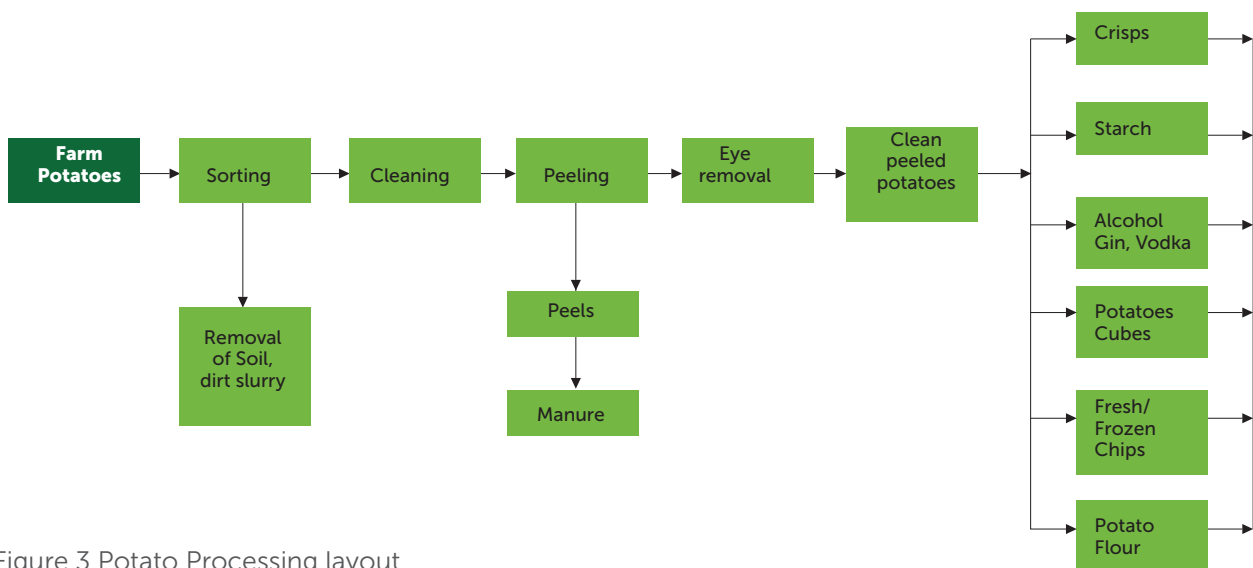


Figure 3 Potato Processing layout

i) Step 1 – Farm potatoes - Collection from the farm

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

The harvesting of potatoes in Meru is done by hand using hoes, jembes, sticks and the potatoes put in bags for transport to the home stead for sorting. 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 modes to avoid losses at this stage.

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

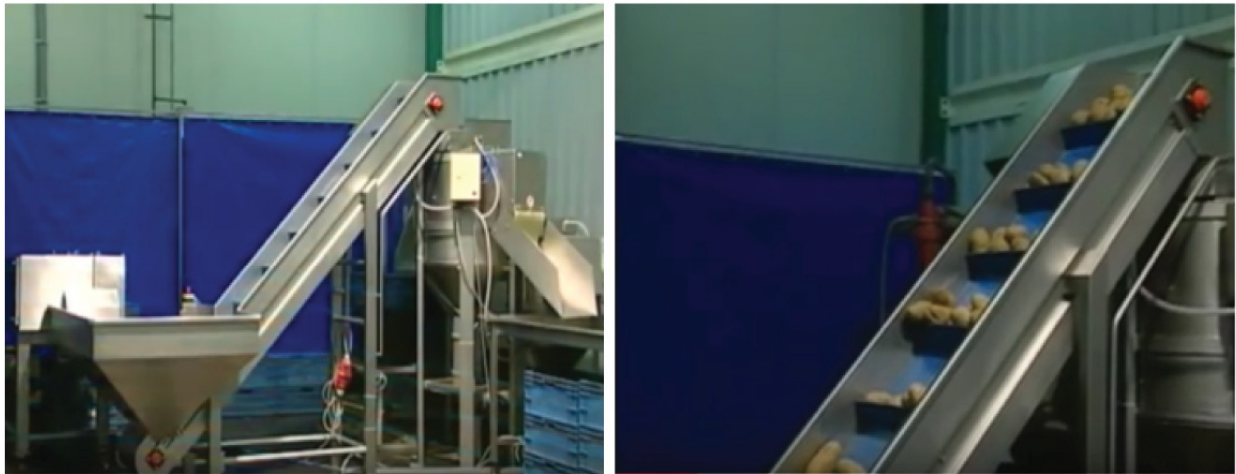


Figure 4 Potato Inlet hopper and conveyor system

ii) Step 2 Potato Peeling

Rotary Fixed Roller Peeler- The potatoes are introduced to the fixed rotary rollers which moves it forward as it peels. The spacing between the rollers can be adjusted so that grading can be done. The peels and small potatoes then fall on a belt convey which moves it to another production area. This type of conveyor is ideal for potatoes which have not been graded or if the potatoe use is more than one as in this case.

iii) Step 3 Potato Eye Removals

The peeled potatoes are inspected and eyes removed before the next processing stage. The potatoes are introduced to a fixed table by a conveyor or to a rotating belt conveyor depending on the capacity of the plant. Human labour is used to at this point.

iv) Step 4 Potato Products processing

Step 1 – 3 is the same for all potato processed products. In the processing, different machine types will be used for specific results.

a) The products;

i) Frozen Chips

Frozen chips are popular with restaurants and supermarkets. The fries are processed at the factory, then packed to the desired packaging and frozen. The frozen potatoes are then transferred to the market using a refrigerated vehicle. The frozen chips can be precooked in the factory using industrial fryers, packed to the desired packaging and frozen to the desired temperature. Depending on the market demand frozen fries can be supplied raw or precooked.

The process: The potatoes are cleaned and sorted, then introduced to a steamer which removes the peel through a drum fitted with brushes .chopping is done using rotary mechanical slicers or a hydraulic system. The cut potatoes are transported using a conveyor system which moves it to a camera for size and colour check. The substandard are removed using an air jet. The potatoes then fall to a water tank where sugar leaves the potato so that they have the same taste when they cook in a



process known as blanching. The potatoes go through hot water, then cold water; this causes the potato taste to be more pronounced. The raw chips take a different conveyor for packaging.

For fried potatoes, the next step is to the fryer where they cook for about two minutes in non-hydrogenated oil. The potato fries then flows through a conveyor belt fitted with holes to remove the excess oil. The fries then pass into a freezer area (-5°C and -13°C, then deposited on an oscillating conveyor which deposits them in chutes. From the chutes they are weighed packed and stored.

ii) Potato Cubes

Potatoes cubes can be produced and packaged, frozen and send to the market directly. The process is similar to the chips with the departure at the slicing stage.

iii) Potato Flakes

Potato flakes have wide range of uses

including thickening agent, extruded products, fabricated potato chips, snack pellets, battered breaded products, and potato powder. A survey on potato flakes established that there exist only two brands of potato flakes in Kenya, an imported brand from the United States of America and a locally packaged brand.

The process of converting potato into flakes involves many stages culminating in drum drying of potato slurry or mash which can be compared to precooked starchy baby foods, casein, and milk, maltodextrins and fruit pulps.

In normal circumstances, potato slurry is spread on the surface of a heated drum with steam condensing inside the drum. Heat is transferred through the metal of drum and moisture is evaporated usually with appropriate scraping device from the dried slurry adhering on the drum. Figure 5 below

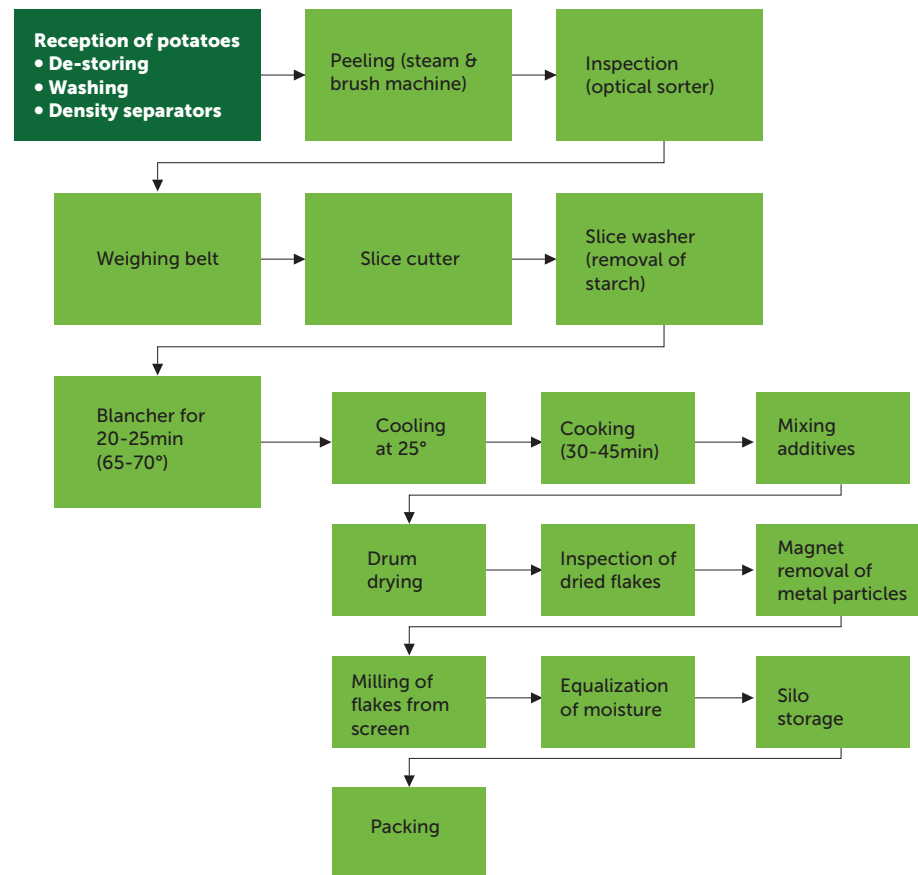


Figure 5 Potato flakes production process

Flakes production process involves washing, peeling, and cutting, blanching, cooling, Cooking and drying of raw potatoes.

The yield ratio of raw potatoes to flakes or flour is approximately 5.7:1. There is a higher recovery ratio of flakes and flour from fresh potatoes and lower recovery ratio from stored potatoes. Re-hydration ratio of flakes to mash potato is 1:5. Potatoes with high solid contents and low sugar are best to produce dehydrated products. For locally available potato varieties for making flakes, Dutch Robjin is the best variety for flakes followed by Desiree and Tigoni with regard to overall acceptability.

iv) (c) Other products

(C-1) Crisps

The Crisps making process begins with the potato tuber being stored, cleaned, peeled, inspected, sliced, frying of slices, Crisps inspection, Crisps flavoring, Crisps packaging, warehousing, and finally transportation to the market.

During the storage of potatoes the starch could break to simple sugars hence producing Crisps with dark colors. Different conditions are required throughout the year to ensure the quality of the Crisps is consistent.

During processing key parameters namely moisture, colour, slice thickness and



temperature should be noted. Starch gives crisps its taste, colour and texture. To obtain the golden crisp colour, the potato must be stored correctly, which depends on the weather (wet, dry, cold or hot). other agronomic practices are the variety and how well the growth was in the field.

Crisps Frying-Fryers are drying systems that reduce the moisture content in the potato slices from around 76% to around 1.6%. Fryers usually have three sections 1) the first section has a set of paddles that drives the slices forward. 2) The second section has a sub merger belt which pushes the slices under a surface of oil. 3) The third section is the takeoff belt. Fryers use very hot vegetable oil to fry the potato slices. The oil is heated to around 182°C.

Flavouring-The fried crisps are then flavoured. The flavor and colour of the crisp is the first attraction to a customer.

Packaging- The fried crisps are packaged to printed reels packets using a form fill machine or to pre formed packets. The packets can have air inside to prevent crushing during transportation. A preservative can be added to prevent the crisps going bad. Baling is then done and the product is ready for marketing.

(C-2) Gin and Vodka

Vodka is produced after fermentation and distillation of the byproduct of potatoes cubes. These are floated on warm water and introduced yeast in a tank for the fermentation and distillation. Vodka is produced as a base spirit and paired with the right botanicals. When Vodka is distilled and flavored with botanicals it produces Gin.

Distilled Gin is produced by redistilling ethanol of agricultural origin with an initial strength of 96% ABV (the azeotrope of water and ethanol) in presence of berries and other natural botanicals. These include Juniper, coriander, angelica, orange peel, lemon peel, cardamom, grains of paradise, cubeb berries and nutmeg. Typically a fine gin contains six to ten botanicals.

(C-3) Starch

Starch is a polysaccharide and is produced by all plants as a source of energy. A potato is made up of starch, water, and other materials. The amount of starch a potato contains is called it "percentage solids". 76% of a potato is water, 23% is starch and 1% is other materials. Potatoes starch powder is produced when the potatoes extract is evaporated. Modified potato starch is used in the food, feed, paper, building, textile and adhesive industries. Potatoes are cleaned, graded and grated. Centrifugation is carried out and two lines of flow occur. Line one is the starch flow line while line two is the proteins flow line.

Starch line-The fibers are removed by sieving and the product is concentrated. The concentrate is the cleaned to form starch milk which is passed through a drier to form dry starch

Proteins line- The protein is then coagulated, centrifuged, evaporated and finally protamylasse is formed .The centrifuge can be dried to produce potato proteins.

(C-4) Potato Flour

Potato flour is made from whole potatoes (most of the time even the peel is included). The potatoes can be raw or



cooked. Either way they are first dried then ground into flour. The result is heavy cream coloured flour with a distinct potato flavor. The flour readily absorbs liquid and is good for use in gluten free flours in small quantities. Potato flour is used to as a choice in savor gluten free bread or rolls.

5. Machinery Sources and prices

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

- a) The capacity of the plant/factory
- b) The end product to be delivered to the market
- c) The desired technology
- d) Future plans for expansion
- e) The budget of the plant/finacial standing of the organisation

f) The desires,tastes and preferences of the markets

Among reknown brands and companies world wide dealing with potatoes processing equipment are ; i) Kiremko, ii) Gillenkirch, iii) Vanmark ,iv) TS(Dutchtecsource), v) Miedema, vi Insort, vii) Idahosteel, viii) Herbert, ix) Heat and Control, x) Tomra, xi) Tummers, xii) Tong Engineering.

The Recommended machines are a combination of Netherlands and UK for Frozen Fries. The flakes processor will be obtained from Netherlands.

Accessories that require frequent replacement , boilers and cylones as well as exhaust fans will be purchahsed locally.

The table 7 below indicates the machine / accessory and the recommended source.

A. Frozen Fries Line Machinery and Materials Costing					
	Item	Quantity	Source	Price (USD)	Remarks
1	Full Automatic Fried Potato Chips Plant (15 tons per hour)	One	Netherlands	2,142,564	To process frozen fries
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 cooked potatoes/To freeze packed fries
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 potatoes
6	Conveyor System(outputs)	Three	Netherlands	52,965	To convey ready potato 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 Potato chips plant will consist of Feeder, cleaner, friction peeler, 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. Potato Flakes Line					
	Item	Quantity	Source	Price(USD)	Remarks
1	Churning Auger	One	Netherlands		
2	Sizing Rollers	Three	Netherlands		
3	Drier	Three	Netherlands	1,225,490	The price is for an extension of a flakes line when the fried frozen line is already in place
4	Crushing Auger	One	Netherlands		
5	Vibrating Auger	One	Netherlands		
6	Packaging Unit	One	Netherlands		
	Total In KShs			22,549,000.00	



6. Waste Water Treatment

The water discharged from the processor when operating at full capacity will be 12 thousand liter 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 sources equipment and locally fabricated accessories that need to be replaced frequently.

Figure 6 below illustrates the waste treatment and management plan.

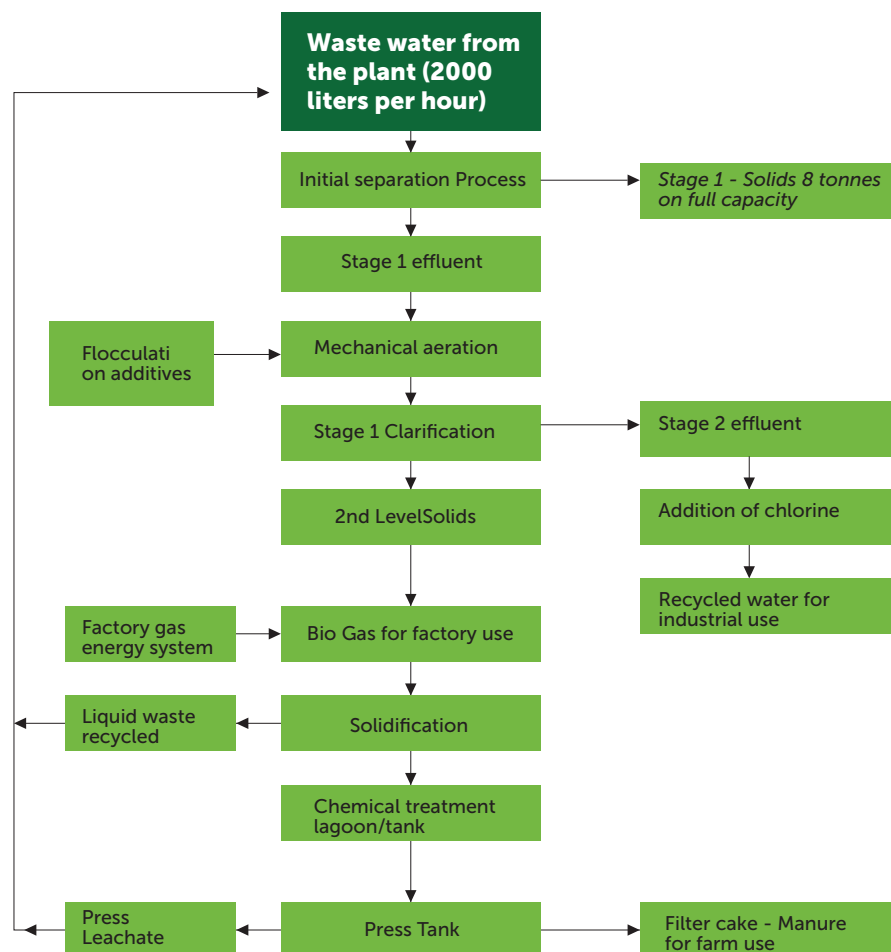


Figure 6 Waste water treatment plan



7. Factory Site Plan and Costs

5°49.65" N): Longitude: 37.31817 (37° 19'5.4" E) Area – 7 Acres. Figure 7 illustrates the site plan and correct survey map.

Location Maritati – Buuri Sub County
Location of site – Latitude: 0.09712 (0°

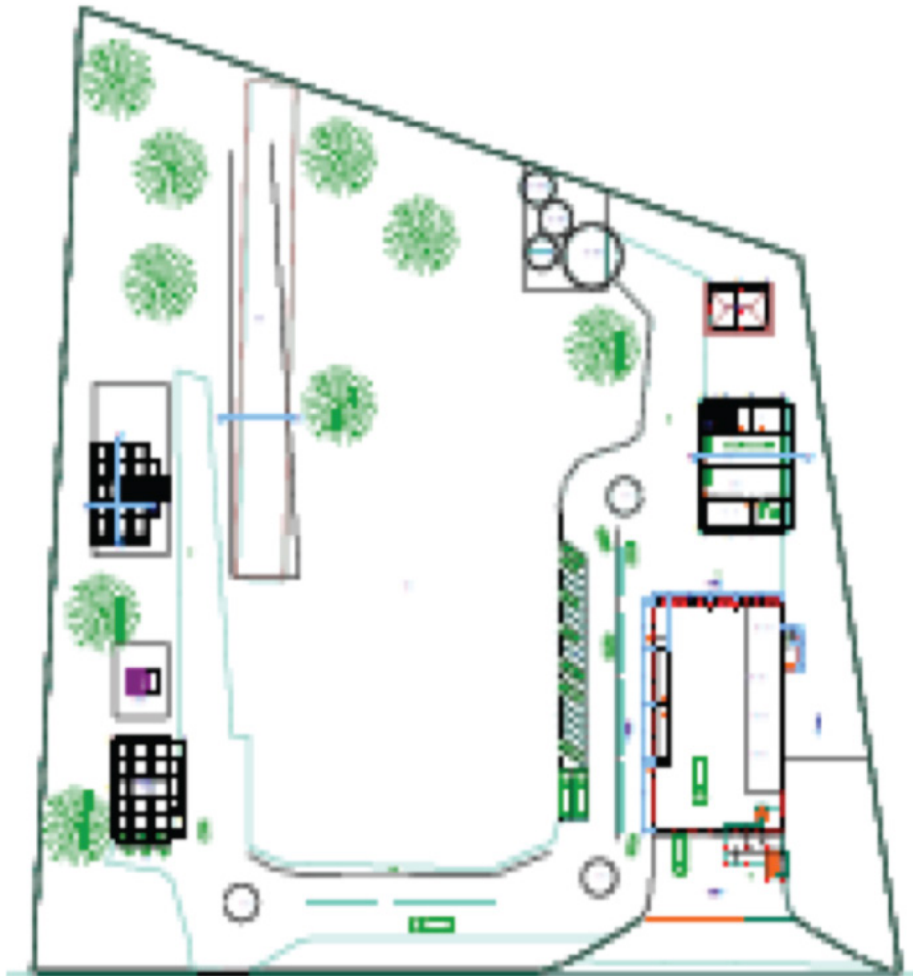


Figure 7 Site Plan



Figure 8 Site Plan on completion Main Factory, Workshop, Waste water and renewable energy Offices and Health Centre

Legend : a – factory entrance gate; b - machine house; c – workshop; d- waste treatment plant ; e – water recycling lagoons; f - boiler house ; g- water tower; h-administration office, staff health centre and canteen; j – main gate.

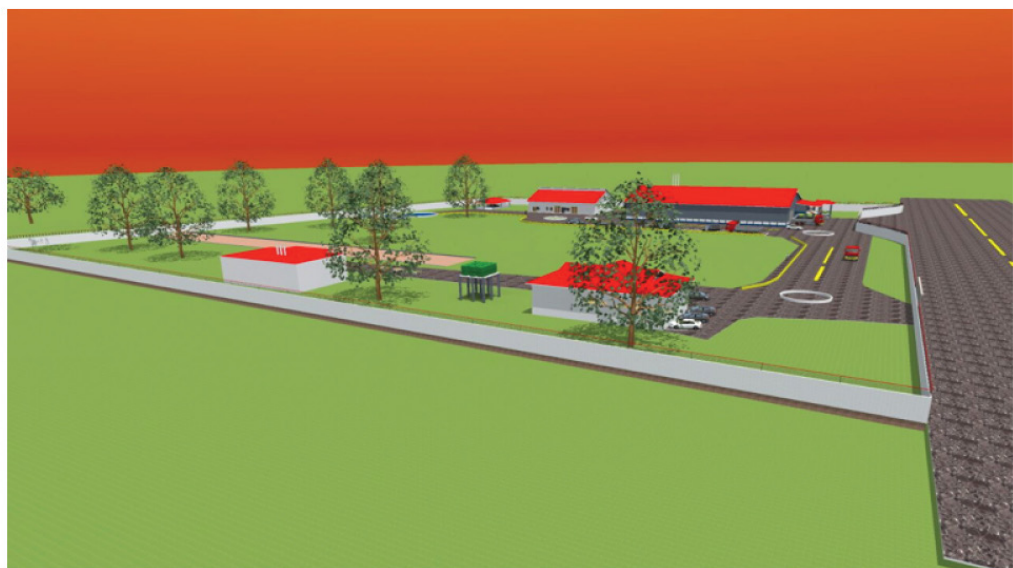


Figure 9 Side view of the site plan

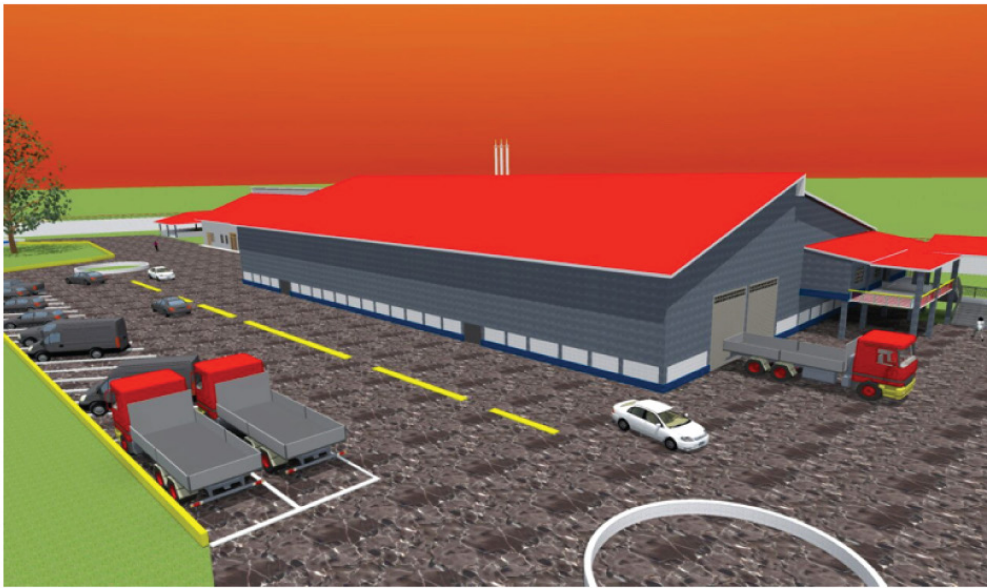
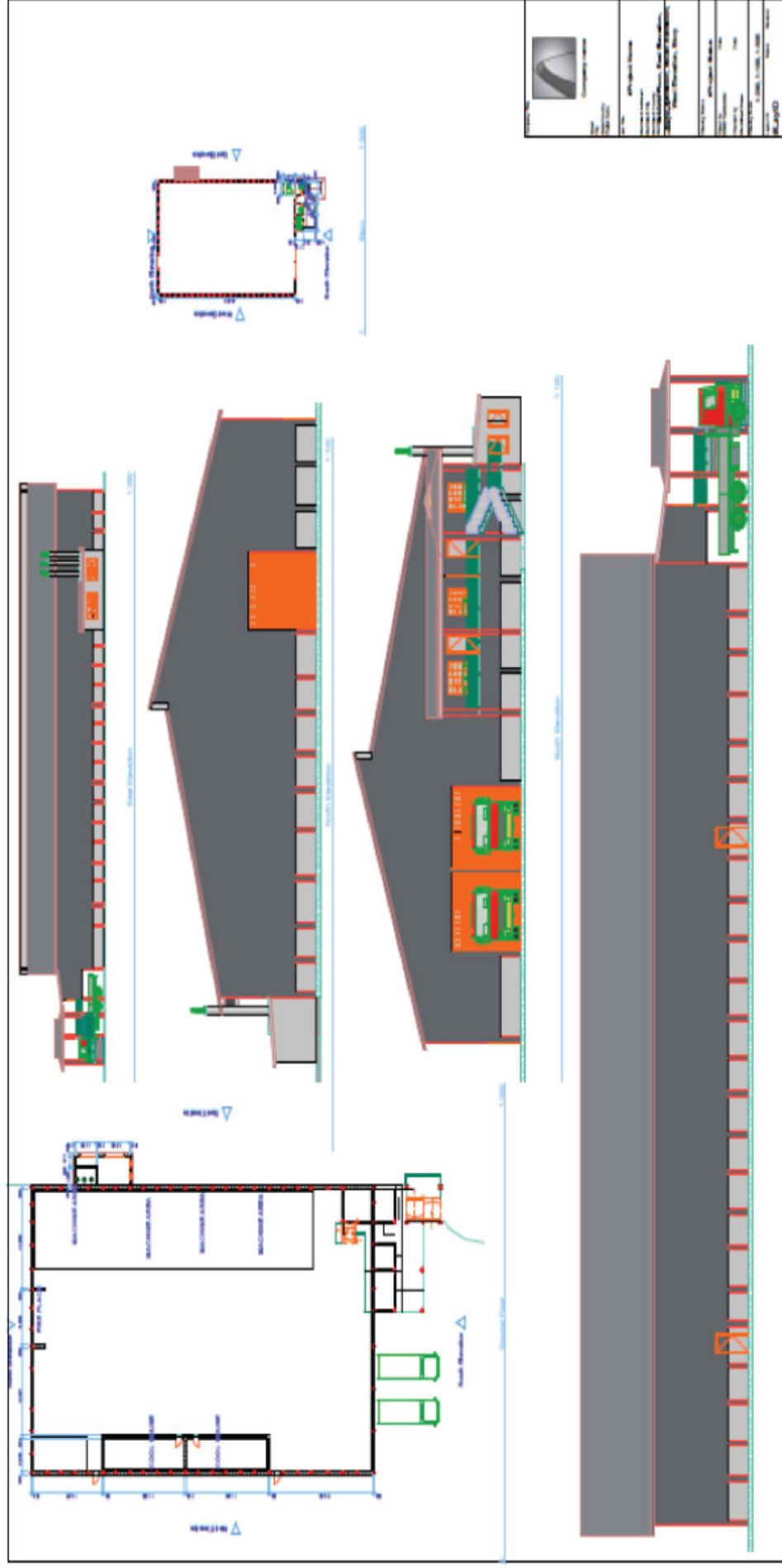


Figure 10 Main Factory Building



Figure 11 Main Factory Aerial View





8. Conclusions and recommendation

8.1. Conclusion

The proposed project is a viable business which will contribute to modernizing agriculture in the county. At full capacity, the plant will generate a livelihood to the numerous potato farmers and other service providers who will be contracted as suppliers.

The venture is designed for potato flakes and frozen chips/cubes. The processing system will require minimum human intervention thus it is envisaged that the workforce will not exceed 100 workers in a full capacity on a 24 hour production of the two products. The country has adequate skills to install and commission the operations.

There is enthusiasm of farmers who are ready and willing to participate in the venture as raw material producers.

The plant will require a total cash outlay of KShs 520,672,464. This includes the cost of construction and processing machine installation, other fixed and operating costs for the base year.

In the first year of production at a price of KShs 91,800/= per tonne of potato chips, the plant will need sales revenues of

\$606,696 (KShs 61,882,992/=) or 672 units to break even at a price of KShs 91,870 per unit.

8.2. Recommendations

Having studied the potato 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. It is expected that the county government will upgrade the 2.7 Kms connection to the Nanyuki Meru road (A2).
- b) Farmer education on production practices should be a continuous process to guarantee quality of raw materials.
- c) The organic farming methods could be expanded to other varieties of potatoes to provide raw materials for the expansion of other product lines i.e. Flour, potato, starch and Gin.



9. Financial Plan

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

9.1 The projections are based on the premise that both operating lines will be installed and commissioned at the same time.

9.2 The plant will require a total cash outlay of KShs 520,672,464. This includes the cost of construction and processing machine installation, other fixed and operating costs for the base year.

9.3 The cost in (1) above includes the value of the land granted to the venture by the County Government.

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

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

9.6 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.

9.7 Prices of raw potato were sourced

from Maritati Multipurpose Co-operative and the promoters.

9.8 Prices of the finished products (potato flakes and frozen chips) were sourced from the promoters marketing study report, Tesco Supermarket UK (online) and Alibaba online store

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

9.10 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.

9.11 Farmers will produce the same potato variety for two products and should be able to expand production in three years to fully utilize the installed capacity of the factory.

9.12 The promoters may consider expanding the product lines to include other products for local market. These include starch and potato flour.

1. Financial projections Summary

A detailed financial analysis is attached to this main report as a separate document





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