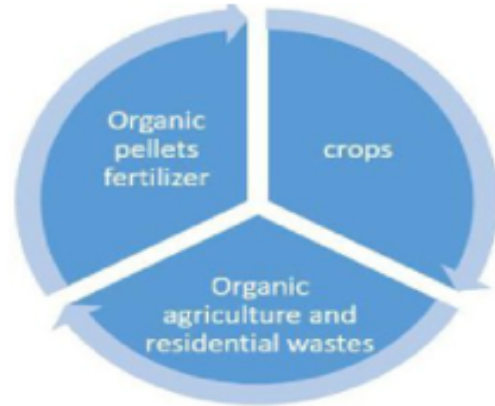
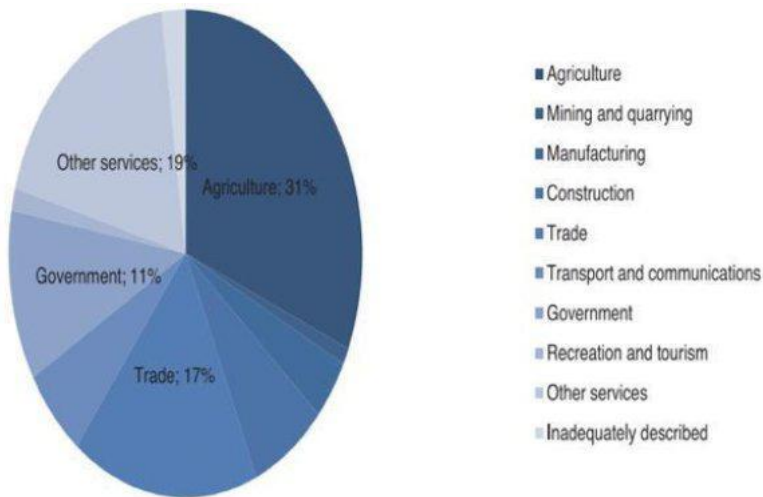


## 1. SOLUTION SUMMARY

Pellet Group seeks to increase the use of fertilizer for the farmers by providing access to affordable and environmentally friendly fertilizer. Our proposed solution consists of the use of organic waste from urban residences and restaurants to manufacture organic fertilizer in the form of pellets. Our approach also contributes to reducing dependency on agricultural related imports and ensures proper waste management.



## 2. CONTEXT



The implementation of our proposed solution will address this shortfall; it will start in 3 communities within Gasabo District where our processing facility will be based. We decided to base our facility within Gasabo for the following reasons:

- 1) Most residential places in this community are directly affected by poor waste disposal
- 2) There are three (Masaka, Murindi, and Kabuga) agricultural communities in Gasabo District which will be our potential customers.
- 3) The infrastructure (roads, electricity) in this community is favorable for our activities
- 4) It is easy to secure a space for our facility as one of our member's family owns a plot of land in that community.

According to the statistics from the Rwanda Development Board, 80% of Rwandans have direct involvement in agriculture while the sector only contributes 30% to the country's GDP.

At the same time, there is an increase in the number of urban centers whose waste disposal practices are poor. These practices are associated with other secondary consequences that threaten human lives as the waste that is poorly handled become hosts of pathogens.

Our proposed solution is to help communities to properly manage their organic waste while benefiting their neighboring communities whose majority depend on agriculture.



By July 2019, the waste was estimated between 500 tons to 800 tons per day in which 40% are organic wastes in Kigali city and it is estimated to increase by 63% over the next 10 years to approximately 1300 tons per day by 2030 (Rajashekar, Bowers, and Gatoni, 2019).

### 3. SOLUTION OVERVIEW

**Wicked problem:** Over the past 25 years, the Rwandan government has been relying on importing inorganic fertilizer. This has resulted in poor affordability and access to the farmers due to high costs. The ineffective distribution channel, which includes importing process and transportation, increases the price of the fertilizer to the level where farmers cannot afford it.

In Rwanda, there are many growing urban centers which face the problem of waste disposal where cleaning companies mainly throw away organic waste they collect from residences, restaurants, and hotels in various landfills of the country.

#### Collection of raw materials (Organic waste)

As Pellet group, we will be putting one recycle bucket in each residence to deposit the organic waste. The number of buckets per house may change due to quantity of organic waste generated by particular house. Then we shall use a small made in Rwanda moto vehicle designed to carry packages to collect those waste from each house working with us, and then bring those waste to our processing facility.

For this particular aspect, we carried out a **compliance survey in Gasabo** which is a growing urban community neighboring three agricultural communities to determine the willingness of people to give us the organic waste they generate in their daily activities. We surveyed 100 families and we evaluated the following aspects: do they generate organic waste?, would they allow us to bring our buckets at their residences?, would they be willing to put waste in those buckets?, would they separate their residues and only put organic waste in those buckets?, and finally would they allow our employees to come at their place to pick those waste?. We expressed each response in percentage for the better understanding of the results.

**Conclusion of the survey:** The level of compliance is good to provide necessary conditions for the operation of our activities in Gasabo district, and the aspect of separating waste will tend to be always as we train them and improve their knowledge on differentiating different type of waste, and incentives of \$0.02/Kg

Additionally, farmers do not use the crop residues they accumulate in each and every agriculture season.

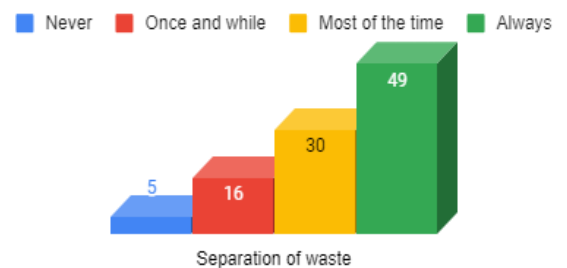
However, these wastes could be the source of soil nutrients because they are rich in nitrogen, phosphorus, potassium and other minerals the soil needs for the growth of crops.

**Proposed solution:** Firstly, we are going to collect organic waste from the home residences, marketplaces, restaurants, and crop residues from the farmers. Secondly, we will use those organic wastes to make organic fertilizer in the form of pellets which will be more affordable for the farmers and friendly to the environment.

#### Compliance survey in Gasabo community, Rwanda



This means that out of 100 families, 93% responded that they accumulate organic wastes in their residences, 92% agreed to receive our buckets at their homes, and 97% would be comfortable with our employees going to their houses to pick organic waste.



In this aspect, we wanted to know the frequency in how those families would be able to careful separates waste and put in our buckets organic waste only. 49%,30%,16%,5% responded with always. most of the time. once and while, and never respectively.

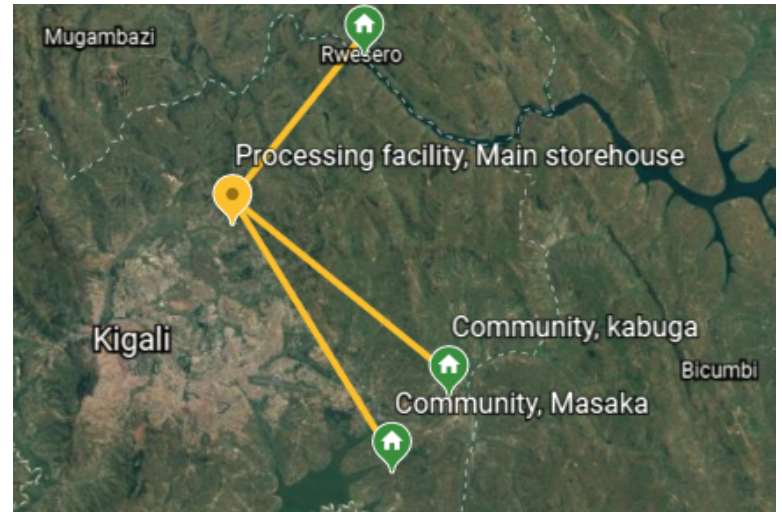
### Marketing and selling our final product

As Pellet Group, we will be having general storehouse at our processing facility to attend to orders of the farmers from neighboring communities.

Normally farmers travel to Agro-shops to buy inorganic fertilizer. Similarly, they will also travel to the selling center of the pellet fertilizer.

Our business is already officially registered, so we will be permitted to sell our pellet fertilizer anywhere in the country, but as we target to have our first production in early of 2021, we will focus in the mentioned three neighboring communities at the beginning of our project. (Murindi, Masaka, and Kabuga).

### Location of main storehouse and targeted communities, Rwanda



As Pellet team, we decided to produce organic fertilizer for Rwandan farmers, and we believe that the solution is not only going to increase their agricultural production, but also conserving of their soil as well.

#### Organic Pellet Fertilizer

- Favors the efficient complete cycle of nutrients like Nitrogen, Phosphorus, and Potassium
- Contributes beneficial microorganisms to the soil that will assist its structure over time, which makes it able to hold water and nutrients
- They generally require less frequent reapplication
- They are environment friendly fertilizers since it contains naturally occurring nutrients.

#### Minerals or Inorganic (synthetic)

- These types of fertilizers require frequent application
- Over-application can lead to fertilizer burn, and run-off into local water sources (water contamination)
- Constant application leads to destruction of existing microorganisms in the soil
- They have high potential in causing global warming due to mixed gases released during production and volatilization

#### Compost

- It takes too much time to have a good final product (12-16 weeks)
- The composting process involves the release of ammonia gas which leads to decreased level of nitrogen in the final product
- It is not recommended for people without skills because if optimal temperatures are not achieved it may lead to creation of favorable conditions for the growth of pathogens that cause human diseases.

### Packaging of the final product

For our large scale operation in Rwanda, we shall be using wax paper bags of 20 kilos to maintain our alignment with principles of being friendly to environment.



In 2018, after an interview with Dr. Johan Perret, a soil professor at EARTH University, we realized the potential of producing such kind of fertilizers for African farmers whose access to synthetic fertilizer is limited due to high prices. According to various soil biologists such as Laegreid (1999), drying raw materials to produce organic fertilizers helps in the disinfection process and ensures the final product that is free from any infection.

In our case, all organic matter collected is dried up to 65 °C – 72 °C which destroys fungi, bacteria or any other microbes that might be present in the raw materials

*Pellet production system*



**4. IMPACT ASSESSMENT**

**Need:** In 2019, The Ministry of Agriculture of Rwanda reported the demand of 49,000 megaton (MT) needed to fertilize arable land in Rwanda to improve agricultural productivity.

**Solution:** our approach has a unique value as it tackles three agricultural challenges at once, mainly, efficient waste disposal, increasing access to organic fertilizers to farmers and reducing agriculture related imports.

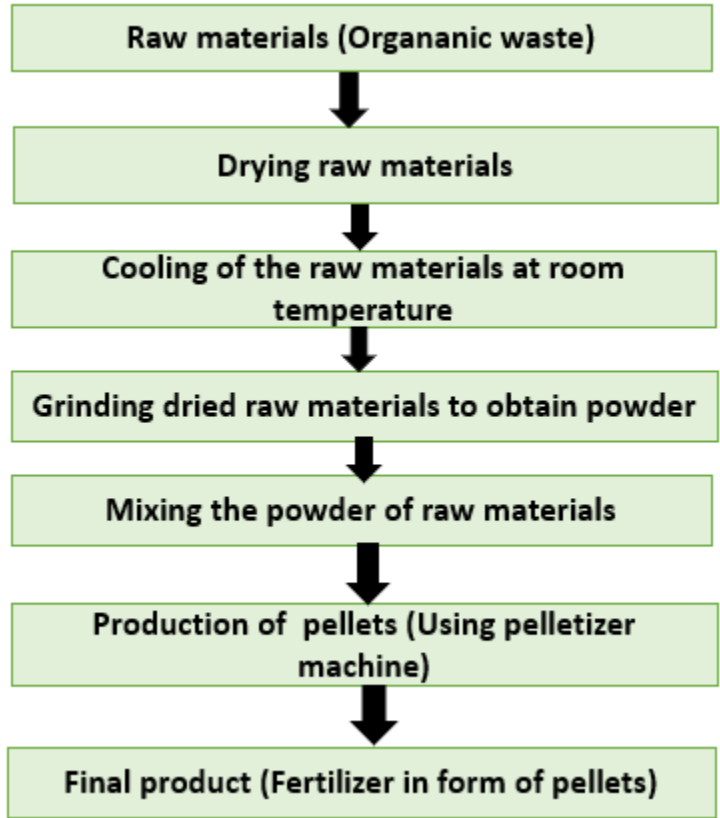
Our fertilizer will supply the required nutrients for most crops grown in Rwanda (beans, coffee, maize and potatoes) As a team, we are motivated to increase farming production, reduce the price of fertilizer, lower soil degradation and reduce hunger among Rwandans.

Using surveys, we will assess the impact by tracking the increase in productivity among farmers who used our fertilizer. Among the users of our fertilizer, we plan to increase their production by 50% (as proved possible by our prototype). For the country, our proposed solution will help ensure a reduction in agriculture-related imports, increase in food security, as well as improvement in proper waste management.

Furthermore, as we scale up, we will expand our selling and distribution facilities around the country. we hope to export the surplus to other countries in Sub Saharan countries of Africa too.

In 2018, we conducted and tested the feasibility of our solution at EARTH University. We collected organic wastes from student residences, the cafeteria, cow and sheep dung and the leaves of the nitrogen-fixing plant (found in Rwanda) called Moras (*Murus alba*). We dried each component separately, ground it into a powder, and then mixed all of them together to produce a good quality fertilizer in the form of pellets, rich in nitrogen, phosphorus, and potassium. Then it was used in experiment to compare it with synthetic fertilizer (N-P-K) on production of maize. The results showed that there the pellet fertilize increased the yield by 50% as compared to the control (unfertilized plants). Additionally, this fertilizer is affordable, and environment friendly.

**Process of making organic fertilizer in form of pellets**



C	N	C/N	P	K	Ca	Mg	S
%							
35.96	2.82	12.76	0.72	1.86	2.27	0.81	0.50
Fe	Cu	Zn	Mn	B			
mg/kg							
179.94	24.27	76.47	467.22	26.39			



Organic pellet fertilizer has the potential to supply the nutrient requirement for most crops grown in Rwanda. We realized the foliar analysis of the organic fertilizer and we obtained the above results.

Crops	N	P	K	Ca	Mg	S	B	Cu	Fe	Mn	Zn	Mo
	%						mg/kg					
Avocado	1.6 - 2.0	0.08 - 0.25	0.8 - 2.0	1.0 - 3.0	0.3 - 0.8	0.20 - 0.60	50 - 100	5-15	50 -500	30 - 500	30 - 150	0.1 -1.0
Rice	2.6 -3.2	0.09 - 0.18	1.0 - 2.2	1.2	0.2 - 0.3	0.16 - 0.75	6 - 7	8 -25	70 -150	150 - 800	18 -50	0.6
Bananas	3.5 - 4.5	0.20 - 0.40	3.8 - 5.0	0.8 - 1.5	0.25 - 0.8	0.25 - 0.8	10 - 50	6 - 25	76 - 300	100 - 1000	20 - 200	0.6
Maize	2.3 - 3.0	0.12 - 0.20	2.0 - 2.5	1.0 - 2.5	0.25 - 0.4	0.10 - 0.20	40 - 75	10 - 25	70 - 125	50 -300	12 - 30	0.1 - 0.5
Coffee	2.3 - 3.0	0.12 - 0.20	2.0 - 2.5	1.0 - 2.5	0.25 - 0.4	0.10 - 0.20	40 -75	10 - 25	70 -125	50 - 300	12 - 30	0.1 - 0.5
Beans	5.0 - 6.0	0.35 - 0.75	2.2 - 4.0	1.5 -2.5	0.3 - 1.0	0.25 - 0.70	20 - 75	7 - 30	50 - 300	50 -300	20 -200	0.2 - 0.6
Chile	4.0 - 6.0	0.35 - 1.00	4.0 - 6.0	1.0 - 2.5	0.3 - 1.0	0.21 - 0.80	25 - 75	6 - 25	60 - 300	50 - 250	20 -200	0.5 - 0.8
Irish potatoes	4.5 - 6.0	0.29 - 0.50	9.3 - 11.5	0.76 - 1.0	1.0 - 1.20	0.25 - 0.75	25 - 75	7 -20	50 -100	30 -250	45 -250	0.8 -3.3
Pineapple	1.5 - 1.7	0.1	2.2 - 3.0	0.8 - 1.2	0.3	0.25 - 0.70	30	10	100 - 200	50 - 200	20	0.8 - 3.3
Carrots	2.1 - 3.5	0.2 - 0.50	2.8 - 4.0	1.4 - 3.0	0.3 - 0.5	0.30 - 0.40	30 -100	5 -15	50 -300	60 - 200	25 - 250	0.5 - 1.5

Source: WOLF, B; JONES,JB; MILLS,H.1990. Table of plant analysis interpretation

**The production capacity of the Pellet group:**

As Pellet group, we will be working 8 hours a day, 5 days a week, 48 weeks a year. We estimated based on the size of the communities at the beginning to produce 2000 kilograms of the fertilizer with the ratio of 40/60 fertilizer/raw materials. This means we will process 160 tons of organic raw materials to produce 96 tons of finished organic pellet fertilizer in a year.

## 6. ECONOMIC ANALYSIS

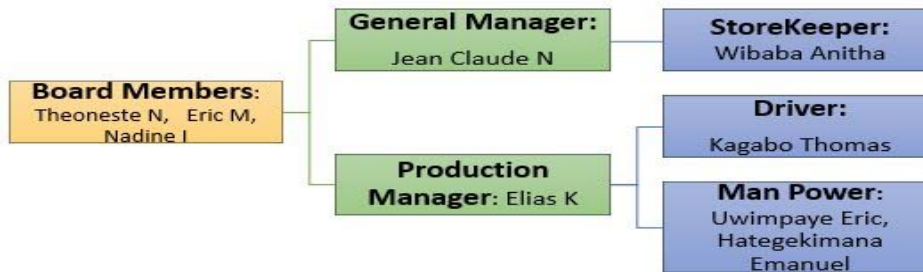
<b>Total investment</b>	<b>\$23,974</b>								
<b>Revenues</b>	<b>1st year</b>			<b>2nd Year</b>			<b>3 year</b>		
		P/U (\$)/20 kg	Amount (\$)		P/U (\$)	Amount (\$)		P/U (\$)	Amount (\$)
Income	Q(tons)			Q(tons)			Q(tons)		
Fertilizer	96	8	\$38,400	105.6	8	\$42,240	116.16	8	\$46,464
<b>Fixed costs</b>	Quantity	Amount (\$)		Quantity	Amount (\$)		Quantity	Amount (\$)	
Building	1	\$2,000							
Drying oven	1	\$4,000							
Grinding machine	1	\$3,000							
Pelletizer machine	1	\$6,000							
Warehouse	1	\$134			\$134			\$134	
Buckets	100	\$700							
Transport	1	\$1,500							
<b>Variable costs</b>									
Raw materials		\$3,200			\$3,520			\$3,872	
Electricity		\$1,000			\$1,100			\$1,150	
Maintenance		\$500			\$500			\$500	
Salary		\$1,440			\$1,440			\$1,440	
Packaging		\$500			\$500			\$500	
<b>Total costs</b>		\$23,974			\$7,194			\$7,596	
Gross profit			\$14,426			\$35,046			\$38,868
Tax			721.3			1752.3			1943.4
Net Profit			\$13,705			\$33,294			\$36,925
ROI	57%			107%			117%		
Break-Even point (number of bags of 20kg)		2,997	>> We need to sell about 60 tons of fertilizer to get our initial investment						
Payback Period (years)		1.3	>> Within 1 year and 4 months, our net profit accumulation will be equal to initial investment						

### Cost of production

We need \$ 23, 974 to start with our first production. We will be buying raw materials at \$0.02 per kilogram, which is equal to \$3200 for all 160 tonnes needed to produce 96 tonnes in one year. For the collection of organic waste, we will be using a small made in Rwanda motor vehicle designed for carrying packages that will cost us \$1500. Others fixed, and variable costs that will be needed in our production were listed in the table below. However, in a plan, as we scale up, we will run our processing plant on green energy (solar). Based on the calculation, we only need 0.1 megawatt(MW) which can be generated from an affordable solar power plant.

### Organization plan

At the beginning of the company, we shall be focusing on having small staff to reduce the operational costs of the project



## Pellet Group Model Canvas



### 7. MATERIAL ANALYSIS

ANALYSIS	WHY THESE MATERIALS	SOURCE OF MATERIALS	RECYCLABLE LITY/BIODEGRADABLE	SOCIAL EQUITY
<b>TECHNOLOGICAL/BIOLOGICAL MATERIALS</b>				
<b>Pelletizer equipment (Dryer, Grinder, Compost mixer, packaging machine)</b>	They are necessary, and the only option	Purchased from China and will be expanded by locally making them in Rwanda	Reusable	Empowering women by training and employing them
<b>Multilayer paper bags for packaging</b>	Needed for packaging	Made in Rwanda	Biodegradable	Promoting Made in Rwanda packaging materials

Organic waste	Main input and we will be collecting 8 tons/day	Collected from people's residences and restaurants	Will be used to manufacture fertilizers in the form of pellets	Help residents to properly dispose of the domestic waste
Main nutrients Contents (Na, P, K, Mg, Fe)	Important components of fertilizer	From crop residuals	Absorbed by crops	Prevent water contamination

## 8. BARRIER ACKNOWLEDGEMENT

**Seed capital:** The implementation and one-year functioning of our company need an estimated capital of \$23,974. However, there is a source of funding through pitching our project to the Ministry of Agriculture in Rwanda and the Rwanda Development Board (RDB) that support young entrepreneurs.

### STRENGTH

- Affordability of the product in terms of being near to our customers, and provision of the products at lower prices.
- Customer care to our clients through follow up on the effectiveness of our fertilizer.
- Pellet products are friendly to the environment
- We have good packaging with waxed paper bags which is more portable, and that will ensure that fertilizer is safe up to the customer's house
- Pellet also find digital marketing useful to reach out to the customers easily.

## 9. SWOT ANALYSIS

### WEAKNESS

- Advertising would be costly, as a new firm in the agricultural industry we will need to advertise our product to create awareness for the product. We plan to use social media networks as a way of reducing the cost of advertisement.
- Youth, there will be a problem of lacking access to collateral security to obtain financials. However, Pellet limited plans to work with financial institutions that do not require collateral security to borrow money in Rwanda.

### OPPORTUNITY

- There is high demand of fertilizer on the Rwandan market
- The campaign for made in Rwanda products provides a great opportunity for Pellet fertilizer
- Government support for young entrepreneurs will boost productivity and act as a motivation for other youth to start their businesses

### THREATS

- Competition with other fertilizer producers who have been on the market for so long. However, through field research and advertisement will plan to show people the impact of our fertilizer.
- Inconsistent access to electric energy. If this issue persists, Pellet will apply the use of solar panel energy.

### Advisors:

- **Dr. Johan Perret**, Professor of soil management and precision agriculture at EARTH University, Costa Rica.
- **Dr. Theogene Barayavuga**: conducts research in mechanical engineering at Xi'an Jiaotong University in China

