EX-ANTE EVALUATION OF ECONOMIC AND ENVIRONMENTAL EFFECTS OF USING PRECOOKED BEAN PRODUCTS BY SCHOOLS IN RWANDA

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A Thesis submitted to the Graduate School in partial fulfilment for the requirements of the Master of Science Degree in Agricultural and Applied Economics of Egerton University

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DECLARATION AND RECOMMENDATION

Declaration

This thesis is my original work and has not been presented in any university or institution of higher learning for any award.

Signature …….. Date ……....

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KM17/11739/16

Recommendation

This thesis has been submitted to the Graduate School of Egerton University with our approval as the university supervisors.

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DEDICATION

This research work is dedicated to my family and friends.

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Above all, praise and glory to the Almighty God for his everlasting love and mercy towards me.

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ABSTRACT

Food security is a major concern of the world, especially among the poor in developing countries. Pulses, including dry beans, play a crucial role in ensuring food security, particularly in Sub-Saharan Africa where over 200 million people depend on beans as part of their main diet. In Rwanda, dry beans are an important staple food and constitute the primary source of protein for about 90% of Rwandan households. Unfortunately, dry beans are a slow-cooking food, requiring a lot of time and fuel to be ready for consumption. This makes them an indirect cause of deforestation and air pollution. To counteract this disadvantage, the concept of precooked beans was introduced in Rwanda in 2009, although their use has been dismal. The current study, therefore, sought to identify challenges hindering their use and evaluate potential economic and environmental effects of their use among boarding secondary schools in Rwanda. A multiple sampling technique was used to acquire proportionate sample of 64 boarding secondary schools. A structured questionnaire was used to collect data from caterers of those schools. Data was processed and analysed using management tools such as SPSS, STATA and Ms Excel for descriptive statistics, logistic regression and partial budget analysis, respectively. The results showed that the major constraints to the use of precooked beans in schools were lack of sufficient information, perceived high price, unavailability and the sustainability claims about precooked beans industry. Factors such as the education level of caterer, type of institution, geographical location of institution, size of institution and perceived high price of precooked beans had a statistically significant influence on the willingness of schools to use precooked beans. Partial budget analysis revealed that in average, in a school of 478 students, the total cost of consuming precooked beans was Rwf 1,588,535 (USD 1,847) per month, which is Rwf 270,919 (USD 315) higher than the total costs of consuming dry beans. In relation to environmental effects, results showed that in average, precooked beans consumption in one school of 478 students would save about 27.04metric tons per month. This implies that the use of precooked beans in secondary schools would reduce the imbalance between annual wood demand and supply by 17.1% on average. Thus, the government should recognize the environmental benefits of precooked beans adoption in schools and consequently subsidize precooked beans in schools to an affordable price. Further, it should come up with policy to enlighten schools about the damaging effects of environmental degradation.

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LIST OF ABBREVIATIONS AND ACRONYMS

AERC	African Economic Research Consortium
BNR	National Bank of Rwanda
CIAT	International Center for Tropical Agriculture
DRC	Democratic Republic of Congo
EAC	East African Community
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	Food and Agriculture Organization Statistical Databases
IDRC	International Development Research Center
Kg	Kilograms
MINEDUC	Ministry of Education
MINIRENA	Ministry of Natural Resources
NAEB	National Agriculture Export Development Board
NISR	National Institute of Statistics of Rwanda
REMA	Rwanda Environmental Management Authority
RoR	Republic of Rwanda
Rwf	Rwandan francs
SPSS	Statistical Package for Social Sciences
SSA	Sub-Saharan Africa
STATA	General Purpose Statistical Software Package
USAID	United States Agency for International Development
USDA	United State Department of Agriculture
WHO	World Health Organization

CHAPTER ONE
INTRODUCTION

1.1. Background of the study

Food security is a major concern of the world, especially among the poor people living in Sub-Saharan Africa (SSA) and other developing areas of the world. It is for this reason that the second Sustainable Development Goal (SDG) aims at attaining zero hunger in the world (WHO, 2015). In 2016, the number of undernourished people was estimated at 815 million worldwide with 224 million of the undernourished people living in Sub-Saharan Africa (FAO, 2017). This high level of food insecurity in SSA is mostly attributed to increased population, which leads to higher demand for food than supply, thus causes rise in food prices (FAO, 2017). Climate change is also considered as the major source of food insecurity in SSA for it causes severe droughts and floods which bring about heavy losses to agriculture and hence food production (Sasson, 2012). Another key cause of food security in SSA has been identified as post-harvest food loss and waste for about 1/3 of food is lost during production or transportation (FAO, 2016a).

In addressing global food security, pulses have been recognised by United Nations as the potential crops to play this role (FAO, 2016b). Pulses are an affordable source of protein as compared to animal products, and a good source of minerals (FAO, 2016a). Besides, pulses contribute significantly to climate change mitigation. That is, they supply their own nitrogen and contribute nitrogen to ensuing crops through their fixation of atmospheric nitrogen in soils. This, in turn, reduces required fertilizer, hence, lowers greenhouse gas emissions in agricultural production (Singh *et al.*, 2016). Furthermore, pulses minimise food wastage as they can be stored for long periods without being spoiled (FAO, 2016a). Pulses or grain legumes include among others dry beans, soybeans, cowpeas and lentils.

Dry beans are particularly important because of their naturally nutritious nature. They are a good source of protein, carbohydrates, fibre, vitamins and essential minerals such as manganese, phosphorous, potassium and magnesium (Akibode and Maredia, 2011). They have low saturated fat content (Messina, 2014). They are, therefore, of particular importance in the diets of low-income households around the world which cannot afford to buy animal products (Akibode and Maredia, 2011). Hence, they are often referred to as “poor man’s meat” (Larochelle and Alwang, 2014). Common beans have the advantage of providing a range of food products as they can be consumed as leaves, fresh pods, fresh grains and dry grains

(Nsengiyumva *et al.,* 2017). Fresh pods protein is high in lysine, which makes it a good complement to starches like maize, cassava and rice (Munywoki, 2017).

Moreover, beans provide many potential health benefits, including reducing cardiovascular, cancer and diabetic risks (Winham *et al*., 2016). Dry beans have a low glycemic index due to their richness in complex carbohydrates and vegetable protein and this makes them a perfect food for managing insulin resistance, hyperlipidemia and diabetes (Foster-Powell *et al.,* 2002). It has also been reported that consuming dry beans four or more times per week reduces heart disease risks by 22% (Winham *et al.,* 2016). Further, apart from playing a crucial role in reducing the risks of chronic diseases, dry beans have been reported to have an anti-obesogenic activity due to its effects on cholesterol metabolism (Zhu *et al*., 2012).

Among pulses, dry beans are the second most produced pulse worldwide after soybeans, whereby in 2016 their production was 26,833,394 metric tons (FAOSTAT, 2018). They are produced across the world with the major production being from Asia and Latin America (Sousa, 2017). Though the largest quantity of dry beans is produced by middle and developed countries, dry beans are mostly consumed in under-developed and developing countries (Rezende *et al.,* 2017). In Africa, dry beans are the most important grain legume with their production coming primarily from small-scale farmers in Sub-Saharan Africa and assumed largely for subsistence (Wortmann *et al.,* 2004). In 2016, dry beans production in Africa was estimated to 6,489,138 metric tons (FAOSTAT, 2018). Dry beans are one of the most popular traditional diets in East African countries and over 200 million people living in Sub-Saharan Africa depend on them as a primary staple (Malyon, 2014).

In Rwanda, dry beans are the third most produced crop after bananas and cassava. In 2016, dry bean production was 437,673 metric tons (FAOSTAT, 2018). They are grown in all the regions of the country, contributing greatly to the employment and income of about 80% of small holder farmers (Akibode and Maredia, 2011). Dry beans serve as an important staple in Rwandan diet and constitute the primary source of protein for about 90% of Rwandan households, with the daily per capita consumption of 80 grams per person on average (FAOSTAT, 2012). Indeed, Rwanda and Burundi have the highest per capita bean consumption in the World (NAEB, 2012). As such, beans, in Rwanda, are one of the crops that are part of the government's Crop Intensification Program (NAEB, 2012) to ensure food security for all.

However, despite these comparative advantages and consumer preference for freshly cooked beans, cooking traditional dry beans is considerably time and energy consuming. Dry beans

take approximately three hours to cook (Aseete *et al*., 2018) and consumers incur considerable costs to buy energy necessary to prepare them. Wood, either in the form of firewood or charcoal, is the main source of energy for their cooking for about 80% of Rwandan population (Uwisengeyimana *et al*., 2016). In rural areas, though generally the amount of money incurred in getting cooking fuel are minimal, women spend many hours collecting firewood to cook dry beans (Aseete *et al.*, 2018). Those fuels directly cause deforestation, and air pollution from carbon emission, which in turn lead to environmental degradation, climate change and poor health.

Since the last decade, deforestation has been of much concern for the government of Rwanda. In fact, from 1990 to 2007 the country has known a massive deforestation due to rapid population growth which has resulted in several negative effects including soil erosion, flooding and climate change among others (Nduwamungu, 2011). From 2008, the government has been addressing this problem of massive deforestation through afforestation and reforestation (USAID, 2017). However, despite great efforts that are being put in conserving forests, the population's demand for wood, either in form of timber, firewood or charcoal, is far greater that the supply (MINIRENA, 2017). This high demand for forest products leads to overexploitation of forest especially in private owned forests and this in turn leads to deforestation.

To deal with the issue of deforestation resulting from cooking purpose, the government collaborated with the private sector through its Programme of 'Made in Rwanda' in which it is encouraging and supporting private investment. Hence, in 2009, Rwanda Agribusiness Industries Limited introduced precooked beans as a solution to increased wood use, though the company closed in 2015 due to mismanagement (Farmfresh, 2017). In the same year, a new company producing the same product, Farmfresh Food Company, was started in Rwanda and continued the precooked beans production (Farmfresh, 2017).

Precooked beans are processed beans which require 5 to 15 minutes to be ready for consumption (Aseete *et al*., 2018). Although precooked beans industry has enough processing equipment to sustain the market, its products are not familiar to consumers, thus their current production is about 100 metric tons per month (Farmfresh, 2017). Precooked beans industry sources raw material (dry beans) from Sarura Cooperative and hence contribute significantly to the socio-economic benefits of the cooperative members through improving their income and providing employment (Farmfresh, 2017).

Precooked beans are produced using electricity and since they are pressure-cooked in bulk, using energy efficient facilities, low energy is used to cook them. Therefore, their use can be financially and environmentally profitable (Aseete *et al.*, 2018). Precooked beans in Rwanda have a great number of potential consumers including over 1.2 million people counted in the middle class (Farmfresh, 2017) and institutions serving beans to a large group of people. Thus, the use of precooked beans by those consumers would considerably ease the pressure that is being put on forests. Furthermore, time otherwise spent in cooking dry beans would be significantly saved and can be used for other economic activities.

Institutions feeding large groups of people such as schools are one category of big consumers of beans. By consuming beans in bulk they use huge quantities of firewood (REMA, 2009). Thus, by shifting from consuming traditional dried beans to consuming precooked beans, they are also likely to reduce considerably the wood fuel used to cook beans. Moreover, all costs associated with getting the wood fuel, the quantity of water required, the amount of labour used for cooking beans as well as the time spent in cooking beans will be significantly reduced. This, in turn, will greatly help the government to conserve the environment.

1.2. Statement of the problem

Today, the government of Rwanda is greatly concerned with the problem of deforestation, driven by high demand for wood products, especially charcoal and firewood. The concern arises from the feeling that deforestation is a main source of climate change which is hindering agriculture production, thus compromising attainment of food security. One area of specific concern is the high and inefficient wood fuel use in at least 90% of households and institutions in the cooking of some food products including dry beans. Though beans are central to attainment of food security, the long time it takes to cook them is in particular a major cause of massive deforestation. To counter this, precooked bean products were introduced in Rwanda in 2009. However, their rate of use is still low and this may be due to the fact that their benefits are not well known. This study, therefore, intended to identify challenges hindering the use of precooked bean products among boarding secondary schools in Rwanda. Likewise, it intended to evaluate the environmental and economic benefits that would result from shifting from dry beans to precooked beans consumption.

1.3. Objectives of the study

1.3.1. General objective

The general aim of this study was to promote environment friendly consumption patterns among Rwandan institutional consumers through revealing potential economic and environmental benefits of using precooked beans.

1.3.2. Specific objectives

i. To identify constraints hindering the use of precooked beans among schools.
ii. To determine factors influencing the willingness of schools to use precooked beans.
iii. To evaluate potential economic and environmental effects of shifting from dry beans to precooked beans among schools.

1.4. Research questions

i. Which constraints have hindered the use of precooked beans among schools?
ii. What factors influence the willingness of schools to switch from dry to precooked beans?
iii. What are the economic and environmental implications of using precooked beans?

1.5. Justification of the study

Energy is considered by the Government of Rwanda as a key factor of sustainable development. However, most of the energy sources in Rwanda such as hydro sources, methane gas, solar and peat deposits are not yet fully exploited. As such, wood is still the main source of energy for 80% of Rwandan population, being used mainly for cooking purpose. This has resulted in a massive deforestation across the country as well as indoor air pollution, with consequent effects on the environment. To counteract this, one of Rwanda' s Vision 2020 energy targets is to reduce wood fuel consumption from 94% to 50%. To achieve this target, the government is encouraging the use of gas and other alternatives. However, due to the long duration of beans preparation, it is too costly to cook them using gas. As a result, they are still mostly prepared with wood. This represents a great limitation to the achievement of the wood fuel target since beans remain the staple food for households and institutions in the country.

Findings from this study contribute towards the development of short and long-term policy interventions aimed at lowering pressure on the forest resources in the country. Also by

informing about the benefits of precooked beans, the findings of the study encourage people to shift from consuming dry beans to consuming precooked beans. Thus, this study contributes towards conserving environment, saving time of individuals and institutions and sustaining the manufacturer's business. Moreover, the results of this study also provided insight towards further studies in related areas.

1.6. Scope, limitations and assumptions of the study

1.6.1. Scope of the study

The study was carried out in sampled boarding secondary schools across the country and the results can be generalised to other institutional consumers of beans.

1.6.2. Limitations of the study

The collected data was limited to cross sectional data. Another limitation of this study is that it does not involve individual consumers while they are the potential consumers of precooked beans too.

1.6.3. Assumptions of the study

The study assumed that all the sampled boarding secondary schools consume beans. It also assumed that all the sampled boarding secondary schools have not yet used precooked beans, reason why the study is an ex-ante evaluation. Further, the study assumed that all respondents have at least a secondary school education level.

1.7.Definition of terms

Institutional consumers: refer to institutions that usually feed people they are in charge of. In this study, institutional consumers are boarding secondary schools and people to be fed are students.

Dry beans: known as *Phaseolus vulgaris* L. are common beans that have been dried in order to preserve them for future use.

Precooked beans: refer to packed beans that have been processed using pressure cooking and that require 5 to 15 minutes to be reheated before consumption.

Ex-ante evaluation: is the examination of the anticipated impacts of a planned programme or project.

Compatibility: refers to the degree to which a given innovation is perceived to meet consumer needs.

Complexity: is the degree to which consumers perceive an innovation as relatively difficult to understand and use.

Relative advantage: refers to the degree to which an innovation is perceived as being better than the preceding or competing product(s).

Caterer: in this context is defined as the person who makes decision of what to buy for students' food consumption (i.e head masters/mistresses or caterers).

CHAPTER TWO
LITERATURE REVIEW

This chapter presents studies that have been done related to the objectives of the current study and the gaps to be filled by the current study.

2.1. Nutritional and health benefits of beans

Common beans are naturally nutritional energy capsules that can provide a person numerous health benefits (Ugen *et al.*, undated). They are seen as one of the best means of alleviating malnutrition and food insecurity which are prevalent in developing countries (Kamunye, 2016). Several studies have been conducted on the benefits of common beans consumption, being either on nutritional or health benefits.

A study by The Bean Institute (2018) states that dry beans contain between 21 and 25% protein by weight that is much higher than other vegetable protein sources. It further states that dry beans are rich in complex carbohydrates in which comes the majority of calories in the form of starch, resistant starch and a little amount of non-starch polysaccharides. Moreover, the study found beans to be an excellent source of copper, magnesium, manganese and phosphorus and B vitamins. Another study done by Messina (2014) argued that common beans are even richer in fibre than other unrefined plant foods. The results of the study showed that one-half cup of dry beans contains between 5.2 and 7.8 grams of total fibre compared with 1.7-4 grams of total fibre per one-half cup of whole grains. Most types of beans also contain potassium and iron.

Foster-Powell *et al*. (2002) argued that being rich in complex carbohydrates and vegetable protein, beans have a low glycemic index. Thus, they are a perfect food for the management of insulin resistance, hyperlipidemia and diabetes. Messina (2014) identified beans' low glycemic index and high fibre as potential to contributing to the effects of glycaemic control, and beans polyphenol content as potential for protecting against the risk of type 2 diabetes through their antioxidants effects.

According to Winham *et al.* (2016), results from the US National Health and Nutrition Examination Survey I Epidemiology Follow-up Study showed that consuming legume four or more times per week reduced heart disease risk by 22%. Messina (2014) argued that bean consumption is likely to decrease cardiovascular disease risk and other diseases by reducing inflammation. Beans are heart-healthy since they contain plenty of soluble fibre, that can lower

cholesterol and triglyceride levels. Garden-Robinson and Mc Neal (2013) studied the health benefits of common beans and reported that one study showed that a daily consumption of 1/3 cup of cooked beans would lower the risk of nonfatal heart attack by 38 percent.

Another study done by Zhu *et al.* (2012) also found that common beans consumption is associated with lower rates of cardiovascular diseases. They argued that, the cardio-protective activity of common beans consumption is principally due to its effect on cholesterol metabolism. Based on different literature, they found that the net change in total cholesterol for a treatment group with a bean diet compared to control group was 118 mg/ litre and the mean net change in LDL-cholesterol was 80 mg/ litre. Further, for their empirical research they used multivariate ANOVA to analyse the effect of common beans on cholesterol. Their results showed that beans consumption lowered total cholesterol (P= 0.032) and LDL-cholesterol (P= 0.067). Thus, by lowering significantly cholesterol, they are able to reduce the rate of cardiovascular diseases.

Common beans also play a prominent role in lowering the risk of various cancers. Garden-Robinson and McNeal (2013) found that bean consumption is linked to a lower risk of colorectal, breast, stomach, kidney and prostate cancers in human and animal studies. According to Ganesan and Xu (2017), studies have indicated the vital role of common beans in reducing the risk of various cancers including colon, breast and prostate. Their study found that consuming beans two or more times per week decreased the risks of colon cancer up to 47 percent, breast cancer up to 67 percent and prostate cancer up to 22 percent.

A study done by Thompson *et al.* (2012) found that dietary common bean is associated with reduced mammary cancer burden. The authors ran various experiments using a high dietary concentration of bean (60%) to test the effects of beans consumption on this type of cancer and the test was done using regression analysis. The results of the analysis indicated that the mass of mammary carcinoma was reduced at 62.2% ($P < 0.001$). Therefore, mammary cancer burden is reduced markedly by the increase of beans consumption.

Apart from playing a vital role in reducing the risks of chronic diseases, regular common bean intake has many other health benefits. Regular consumption of common beans has proven to be good for obese individuals by lowering serum total cholesterol and low density lipoprotein (Ganesan and Xu, 2017). Zhu et al. (2012) also found that common bean consumption has an anti-obesogenic activity also due to its effects on cholesterol metabolism. The results of their study indicated that common beans reduced the regulatory enzymes involved in fatty acids and

cholesterol biosynthesis. Another study by Garden-Robinson and McNeal (2013) found that bean intake lowers the risk of obesity and overweight for the reason that with beans' fibre and protein content beans consumption may contribute to feelings of short-term satiety. Beans intake also promotes longevity. Researchers found that for every 20 grams in daily legume intake (including bean intake), there is a 7% - 8% decrease in death risk (Messina, 2014).

2.2. Overview of precooked beans

Pre-cooked beans are industrial processed beans that can be reheated in 5-15 minutes before consumption, requiring far less fuel than it would take to cook them from starch (Aseete *et al.*, 2018). To produce precooked beans, activities such as hydration, cooking and sterilisation, and dehydration are done on dry beans (Farmfresh, 2017).

According to Siddiq and Uebersax (2013), beans can be added value by processing them, especially by canning or precooking them, and products such as dehydrated, frozen and extruded beans, flours, and protein concentrates will be produced. Precooked beans are a convenient alternative to consumers in East Africa since in addition to being quickly and easily prepared in comparison to dry beans, they are more affordable than other types of processed bean products such as canned and frozen beans which are only affordable to a small group of wealthy consumers (IDRC, 2014). The idea of introducing precooked beans in East Africa was meant to improve food security through improved diets, raise farmer incomes and conserve the environment in terms of saving fuel, particularly firewood and charcoal (Afedraru, 2015).

2.2.1. Precooked beans in Rwanda

Precooked beans are not yet popular in Rwanda like traditional dry beans though their use among consumers is promising. This may be mainly due to the fact that they are a new product that a large number of the population have no information about (Farmfresh, 2017). They were introduced in Rwanda, in 2009, by Rwanda Agri-business Industries Limited (NAEB, 2012) which was the only processor of processed beans in Rwanda until 2015, the same year it closed down (Farmfresh, 2017). In 2015, another company called Farmfresh was set up. Farmfresh started selling its products in 2016. It is the only company producing precooked beans in Rwanda to date.

According to Farmfresh (2017), two precooked products are produced: precooked High Iron Beans and precooked Mixed Beans. The two products are currently sold in aluminium packets of 700g, but other options for larger sized packaging are being explored. Precooked Mixed Beans are currently sold at Rwf 950 (USD1.1) and precooked High Iron Beans are sold at

Rwf1250 (USD1.45), to regular retailers, including several supermarkets in Kigali. On the other side, the price of dry beans varies between Rwf450 (USD0.52) to Rwf 600 (USD0.7) per Kilogram in the market (HarvestPlus, 2017).

2.3. Economic and environmental benefits of processed beans

Processed beans, whether in the form of canned, frozen, flour or precooked, have been found to have many economic benefits. Different studies have been done reporting economic benefits of processed beans. Those economic benefits involve financial and environmental benefits. A study done by Winham *et al.* (2019) used a general linear model to analyse how canned beans are perceived by consumers in Latin America. The authors found that canned beans were perceived as cost-effective in terms of energy and time savings as they reduce considerably the energy otherwise used to prepare dry beans as well as time used for dry beans preparation. Another study by Zanovec et al. (2011) used descriptive statistic as the methodology to find the economic benefits of canned beans as compared to dry beans consumption. The study found that canned beans have many economic benefits including saving markedly the energy and time used to prepare beans as well as the labour costs involved in preparing dry beans. However, these studies did not look on environmental benefits of canned beans.

Further, studies found that precooked beans reduce considerably the time and fuel otherwise spent to prepare dry beans. According to the study done by Malyon (2014), precooked beans take in average 5 to 15 minutes to be ready for consumption whereas dry beans take as many as three hours to prepare, which takes a lot of energy, being either firewood, charcoal, gas, electricity or paraffin. Therefore, much expenses, labour and time are spent by women to prepare them. The financial benefit of consuming precooked beans consists of the costs and time saved by shifting from cooking dry beans to cooking them. Cooking dry beans is highly time consuming. In fact, there is time spent in hand sorting to remove stones and other foreign matters before cooking dry beans, in washing them, and about three hours of cooking them. The time spent is associated with a great amount of labour, fuel and water used, and these involve a lot of costs to have them.

A study done by Aseete *et al.* (2018) found that the use of precooked bean products had diverse potential financial benefits including; monetary saving from less fuel used, employment opportunities created, and incomes earned by suppliers of the raw materials who are in most cases smallholder women. However, these studies on the economic benefits of precooked beans have been focusing only on individual consumers yet institutional consumers may be big

consumers of beans. Thus, there is a need to evaluate the potential economic benefits of using precooked beans among institutional consumers.

Concerning the environmental benefits, the use of precooked has been associated with the reduced problem of deforestation although not many studies have been done on this endpoint yet. With precooked beans the time required to prepare meals is greatly reduced from three hours to less than 15 minutes, potentially easing the pressure put on forests (Farmfresh, 2017). The study by Aseete et al. (2018) also found that shifting to precooked beans consumption would contribute to environmental conservation through reduced fuel use, hence reduced greenhouse gas emissions. Nevertheless, these studies did not do an empirical research to find out the impact of precooked beans use on deforestation and on natural resources use. Therefore, there is also a need to evaluate the potential environmental benefits of using precooked beans.

2.4. Constraints in consumption of new products innovation among institutions

Precooked beans are new products innovation in the market. Usually new products innovations are expected to possess relative advantage(s) compared to existing products in the same category for them to be preferred by consumers. However, their use is not automatic. Consumers may not use them even when they already know the advantages they provide. Several constraints may hinder the consumption of new innovation products and the knowledge of those constraints would help manufacturers to come up with better marketing strategies. Thus, various studies have been done on the constraints in consumption of processed products.

Oteku *et al.* (2006) conducted a study on "An Assessment of the Factors Influencing the Consumption of Duck Meat in Southern Nigeria" with a case study in Edi state. A structured questionnaire of about 250 questions was administered to 200 respondents. Descriptive statistics were used to assess the consumption constraints. The study found that the consumption of duck meat was constrained by non-availability, lack of sufficient information, inability to slaughter the live duck and some traditional and religious taboos linked with the meat.

Indumathi *et al.* (2007) conducted a study on "the consumers buying behaviour of processed spice products" in Bangalore and Chennai cities in India. The objective of the study was to identify constraints faced in the use of processed spice products. The data for this study were from 200 respondents obtained through simple random sampling procedure. The study found that the main constraints to the use of processed spice products were; high price of the product,

addition of preservatives and decrease in flavour and aroma due to opening and closing of the packets.

Shilpa (2008) studied the consumption pattern of processed horticultural food products in Dharwad district of India. The study assessed constraints in the consumption of processed horticultural food products. The research data were collected from a sample of 180 respondents from both urban, semi-urban and rural areas. The constraints in consumption were analysed by frequencies and percentages. The study found that the major constraint in consumption of processed horticultural food products was that some products were not liked by the majority of the family members when they are purchased. Other constraints were the unawareness about these products and perceived high price.

Ahmad and Anders (2012) conducted a study on the Value of Brand and Convenience Attributes in Highly Processed Food Products. In this study, constraints impeding the consumption of highly processed food products were identified. The study used a subsample of Nielsen Canada's Market Track data panel. Descriptive statistics were used to analyse the constraints to consumption. The study reported branding, inconvenience in terms of hard preparation, package size, product taste and perceived high price to be the major constraints to consumption of highly processed food products.

Wunderlich *et al*. (2014) studied the managerial influence on the diffusion of innovations within intra-organizational networks. Constraints to the use of products innovation were analysed in this study using frequencies and percentages. The study found that the use of products innovation by organizational consumer is constrained by factors such as higher price, limited availability of the product, poor performance, inconvenience and consumers' distrust of sustainability claims.

However, most studies that have been done on constraints impeding the consumption of new products innovation have been focusing on individual consumers, while constraints hindering the use of such products differ from individual consumer to institutional consumer. Therefore, there is a need to conduct empirical studies on constraints impeding institutional consumers' use of new products innovation.

2.5. Institutional buyer behaviour

There are several differences between individual consumer purchase and institutional purchase. A purchase is said to be an institutional purchase when it is made in the name of the company

or institution, regardless of the size (Malaval *et al*., 2014). The buying motives of the institution are significantly different from those of the individual consumer, hence institutional marketing strategies and activities considerably differ from individual consumer marketing strategies and activities (Moller and Wilson, 1995; Malaval *et al.*, 2014). However, a great number of studies have been emphasizing on individual buyer behaviour rather than on institutional buyer behaviour. A few number of studies have been done on the institutional buyer behaviour.

Frederick *et al.* (1996), in their study on a general model for understanding organizational buying behaviour, argued that organizational buying behaviour, either industrial or institutional, is a complex process involving many people in the decision-making process with complex interpersonal interactions and interactions among organizational and individual goals. The process often occurs over a long period of time, requiring information from several sources, and including many inter-organizational relationships. They provided a model encompassing four classes of variables that determine organizational buying behaviour namely; individual, social, organizational and environmental variables. Individual variables include motivation, cognitive structure, personality, learning and perceived roles of individuals in the buying centre. Social variables consist of activities, interactions and sentiments of buying centre members. Organizational variables include organizational technology, structure, goals and tasks, and actors. Environmental variables include physical, economic, political, legal and cultural variables. Although their model is general, it is helpful in understanding the buying behaviour of institutions.

Malaval *et al.* (2014) studied organizational purchase using literature synthesis and case study approaches as the methodology. They explained the buying centre as composed of all people involved in the buying decision process of the organization. They based their study on the Buy-grid model of Robinson and Faris to explain the organizational buying behaviour. This model uses both the buying phases and 3 main buying situations to depict the buying behaviour of organizations. The buying phases include 6 main phases namely; anticipation and recognition of a need, definition of characteristics and quantities necessary, search and qualification of potential sources, collection and analysis of propositions, choice of suppliers and ordering process, and information feedback and performance evaluation. The 3 main buying situations encompass the straight rebuy, the modified rebuy and the new task. This study did not do empirical research to sustain its theoretical findings. However, it provides information useful for marketers to improve their companies' product performance in the market.

Loginova (2011) studied the organizational buying behaviour in business tourism market in Russia. In this study, the general model of organizational buying behaviour proposed by Frederick *et al*. (1995), the model of Kottler (1997) and the model of Vitale *et al.* (2010) were used as the sources of theoretical information. The author discussed the buying centre as the group of individuals having a stake in the buying decision. She proposed psychology and motivation of the organization's members as the essential aspects in that although the organizational buyer decision is based on organizational needs and professional opinions, it is strongly influenced by individual roles, social positions and self-perception. Both primary and secondary data were used. The research was based on a case study to collect information about organizational buying in 3 Russian companies. Based on the information gathered, she concluded that the size of the organization influences the organizational buying process.

Brown *et al.* (2011) studied factors influencing buying centre brand sensitivity to provide an understanding of when brands influence most the organizational buying decisions. The study built on information processing theory to assess those factors. The control variables proposed were individual risk propensity, job level, end consumer demand, purchase involvement, contractual ties, procedural control and cost orientation. A survey was conducted on a sample of 273 organizational buying centre members to obtain data for the study. A confirmatory factor analysis was employed to test the goodness of fit of the data. To analyse the relationships of variables, robust maximum likelihood regression was used. The authors found that brand sensitivity and purchase importance are related in an inverse U-shaped way. This implies that brand sensitivity increases as purchase importance increases but as the purchases become highly important the brand sensitivity decreases. But the results of the study showed that brand sensitivity and purchase complexity stay normally unrelated over the complete purchase.

2.6. Institutional consumer's willingness to use new products innovation

People and institutions worldwide have conducted studies on consumer's willingness to use of new products innovation. Pouratashi (2012) conducted a study on "Factors Influencing Consumers' Willingness to Pay for Agricultural Organic Products (AOP)". This study was done with reviewing and analysing various researches in different countries. The findings of the study revealed that knowledge of AOP, attitude, age and income of consumer, AOP characteristics such as taste, colour, nutritive value, perceived high price and availability were among the factors influencing consumers' decision making about purchase.

Phan *et al.* (2014) studied factors influencing customers' willingness to purchase environmentally friendly products. Data for the study were collected through questionnaire survey from 169 customers. The results of the study indicated that factors such as respondents' knowledge about environmental products, level of education, age and values are not statistically associated with their willingness to purchase environmentally friendly products. However, factors such as respondents' income and value toward environment are statistically associated with their willingness to purchase environmentally friendly products.

Yue *et al*. (2015) investigated factors influencing consumer willingness to buy Genetically Modified (GM) food and nano-food. The study used data from a national survey with US consumers and employed structural equation modelling to explore relationships between potential influences. The results of the study indicated that labelling preferences influence the willingness of consumers to buy nano-food whereas gender and religiosity of consumers influence their willingness to buy GM food.

Hoppe *et al.* (2018) conducted a study on "Factors influencing consumers' willingness to participate in new food product development activities' in Denmark. The data for the study were collected from 1,038 respondents and were analysed by means of hierarchical regression analysis. The results of the study indicated that consumer innovativeness, age of consumer, consumer's perception of price and availability of new food product are the factors influencing consumer's willingness to participate in new food product development activities.

Udomkun et al. (2018) studied the key factors influencing consumers' preference and willingness to pay for meat products in Eastern RDC. This study used a multistage sample survey of 309 respondents to obtain data. Data were analysed using descriptive statistics. The results showed that factors such as perceived high price, low quantity, harmful effects, nutritional value and availability of meat products have a great influence on the willingness of consumers to purchase them.

Briefly, many studies have been discussing factors influencing consumer's willingness to use new products innovation. However, great efforts have been put on individual consumers than on organizational consumers. Therefore, there is a need to conduct studies on factors influencing organizational consumers' willingness to use new products innovation including precooked beans.

2.7. Theoretical framework

The current study was based on the general model of Organizational Buyer Behaviour. This model provides an understanding of organizational buying decision process. The school's buyer behaviour is influenced by 4 classes of variables namely; individual, social, organizational and environmental variables (Frederick *et al.*, 1996). Each class and subclass of variables is broadly classified into Task and Non-task factors.

Environmental variables that have an influence on the school's buying behaviour encompass technological, physical (geographic and ecological), political, economic, legal and cultural factors. Their influence on buying process is through the provision of information as well as opportunities and constraints. These influences are exercised by several entities such as suppliers, customers, government, tender board, trade associations and other social institutions. There are four distinct ways in which environmental variables influence the school buying behaviour; Firstly, physical, economic, technological and cultural factors provide information about suppliers. Secondly, physical, technological and economic factors determine the availability of goods and services. Third, economic and political factors define the general business conditions such as interest rate, economic growth rate and the level of national income. Finally, cultural, social, legal and political factors define norms and values guiding the buying process.

The class of organizational variables are seen as being principally task-related. Organizational factors are classified into four sets of variables, namely tasks, structure, technology and people. Organizational tasks are the work to be performed by the members of the buying centre in the school to solve the buying problem. Those tasks involve among others identifying what is needed based on the budget, assessing the quantity required, getting the suppliers and ensuring the delivery at the right time. Organizational structure is composed of the subsystems of communication, status, authority, rewards and work flow, all performing both task and non-task functions. Buying technology influences what to buy and the school's buying decision process itself. The behaviour of people involved in the school's buying decision process (members of the buying centre) influence the other 3 sets of variables.

Social factors also have a great influence on the school's buying decision process. Social factors determine the interpersonal relationships as well as relationships between the buying centre and suppliers in the buying process. They define task and non-task roles, interactions and sentiments in the buying centre. The buying centre of boarding secondary schools mostly

consists of head master/mistress, cateress, manager and the representative of parents' association. Many members of the buying centre can perform the same role. However, in most of the case it is the caterer who takes the decision of what food products to buy. The interpersonal interactions among the members of the buying centre depend on three facets of role performance, including role expectation, role behaviour and role relationship.

Individual factors have a great influence since only individual can describe and analyse the buying situation, decide and implement. The individual is the centre of the buying process. The school buyer's motivation, personality, perceived role, learning process and cognitive structure are the primary psychological elements that determine his response to the buying situation. However, these elements are affected by interpersonal and organizational influences within which the organizational buyer is involved. The motives of the school buyer are a broad combination of individual and organizational objectives. These motives have both task and non-task dimensions. Task motives implicate the criteria of buying the right quantity from the right source at the right price with delivery at the right time. Non-task motives involve achievement motives and risk reduction motives.

2.8. Conceptual framework

The conceptual framework in the current study is built on the impact of institutional consumers' use of precooked beans on operational costs and wood fuel consumption used in bean preparation. The framework presented in Figure 1 below illustrates factors affecting institutional consumers' willingness to use precooked beans. Caterer's characteristics including age, gender, educational level and experience are one of those factors. Since the caterer is the decision maker, its characteristics would influence its attitude towards precooked beans use. The other factors illustrated in Figure 1 are organizational factors, institutional factors and product characteristics. Organizational factors encompass age, type, geographical location and size of the institution. These factors are also expected to determine whether the school is willing or not to use precooked beans. Institutional factors including type of the market and distance to the market are the other factors influencing the willingness of school to use precooked beans. Lastly, product characteristics including perceived high price and perceived availability of precooked beans are assumed to play a vital role in enhancing or limiting the willingness of schools to use precooked beans as well. Once the institutional consumer is willing to use precooked beans the next step will be the decision to use them. However, this decision encounters many constraints including lack of sufficient information, high price, unavailability

of the product, inconvenient packaging, distrust in sustainability claims, low nutritional value and lack of storage facilities. When the institution decides to use precooked beans, this use will have both economic and environmental effects. Economic effects consist of reduced operational costs and time used in bean preparation whereas environmental effects consist of reduced wood fuel consumption.

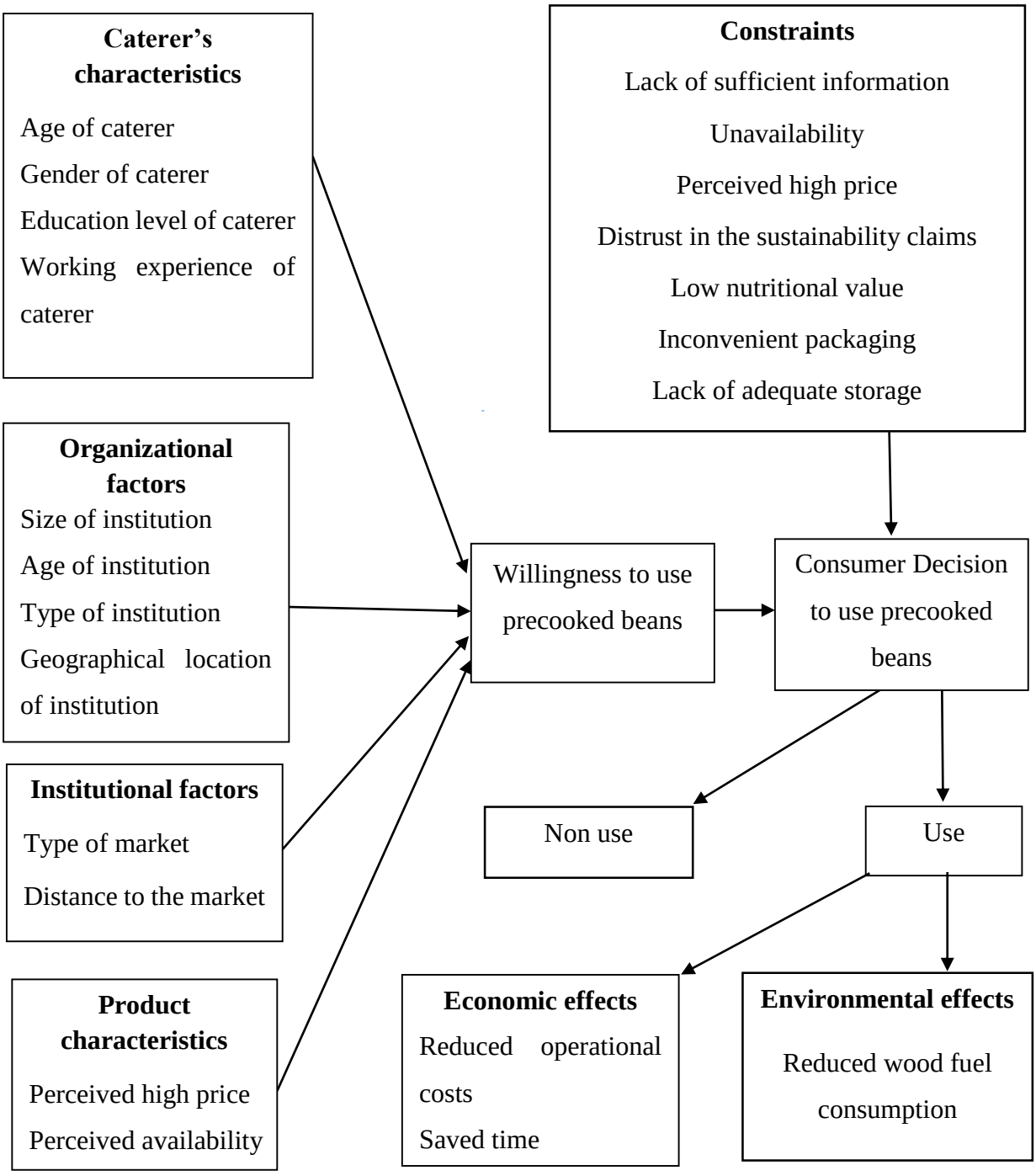

Figure 1: Own conceptual framework

CHAPTER THREE
METHODOLOGY

This chapter presents the area in which the current study has been conducted, how the study was designed, sampling procedure used to obtain respondents for the study and methods of data collection. It also presents how data were analysed, including data management tools used as well as the analytical framework.

3.1. Study area

The study was conducted in the Republic of Rwanda, located in Eastern Africa and belonging to East African community (EAC). The capital city is Kigali and is located near the centre of the country. Rwanda is bordered by Uganda to the North, Burundi to the South, Tanzania to the East and Democratic Republic of Congo to the West. The country is situated between latitudes 1°02′40″ and 2°50′16″South and longitudes 28°51′29″ and 30°53′56″ East (Sirven et al, 1974). The area of Rwanda is estimated at 26,338 km^2, with a population of 11,917,508 in 2016 (World Bank, 2018). Further, Rwanda is the third most densely populated in Africa and the first in EAC (NISR, 2012). Rwanda is divided into 5 provinces namely; Northern, Southern, Eastern, Western provinces and Kigali City.

The study was conducted specifically in the central Rwanda which includes the 3 districts of Kigali and 3 districts from Eastern and Southern provinces nearby (NISR, 2012). Those districts are Bugesera, Gasabo, Kicukiro, Nyarugenge, Kamonyi and Muhanga. The central Rwanda is defined with cooler temperatures averaging 17.5^{o}C to 19^{o}C (Araujo *et al.*, 2016). Its rainfall follows a bimodal cycle even though it is abundant throughout the year (Prioul and Sirven, 1981). The central region is endowed with water resources such as lakes, rivers and marshlands. It is also endowed with soils with high depth (more than 1 metre) and high clay percentage (above 35%) (Muhire et al., 2015). This makes it the most suitable region for growing main food crops in Rwanda, including beans, cassava, maize and sweet potatoes (Muhire et al., 2015). Beans grown in the central region are mostly bush beans (Mulambu *et al.*, 2017).

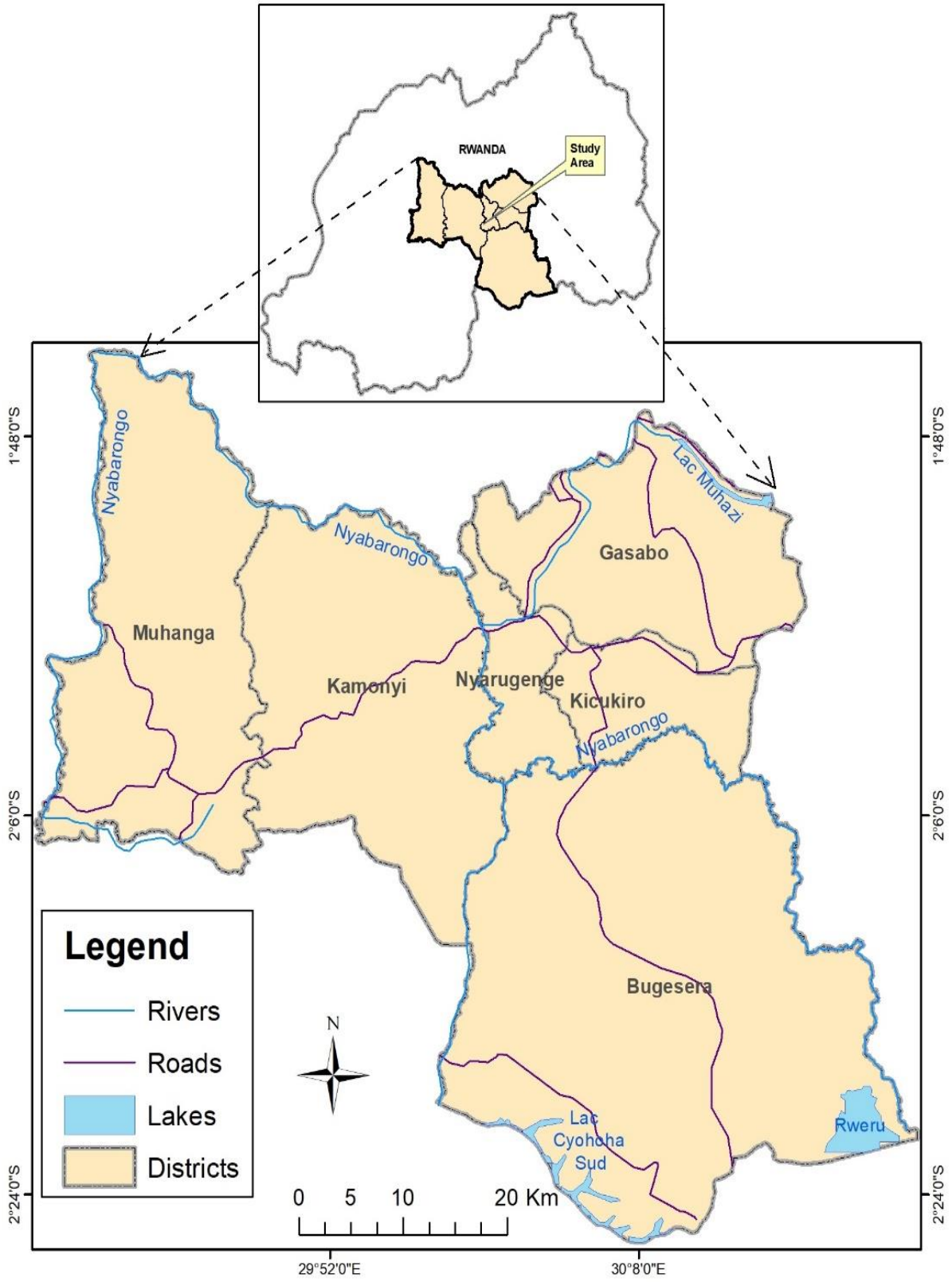

Figure 2: Map of the study area

Source: Egerton University, Geography department (2018)

3.2. Research design

The population of interest for this study comprised of boarding secondary schools in Rwanda. Data for the study was obtained from a sample of 64 boarding secondary schools obtained from a population of 76 boarding secondary schools from the target districts. The respondents were caterers of these schools.

3.3. Sampling procedure and sample size

Population list for boarding secondary schools was obtained from Rwanda Education Board. Multistage sampling technique was used to select the sample of 64 boarding secondary schools. Firstly, the central Rwanda composed of 3 districts of Kigali city and other 3 districts in the neighbourhood of Kigali were selected. Those districts are Gasabo, Kicukiro, Nyarugenge, Kamonyi, Muhanga and Bugesera. The central Rwanda was selected because that is where the concept of precooked beans started. In the second stage, boarding secondary schools in these 6 districts were divided into public schools and private schools. Then, using proportional random sampling a representative sample size was obtained in each category, with computed proportions.

To determine the sample size, the study adopted the sample size formula of Yamane (1967) where at 95% confidence interval, the sample size was found as:

$$n=\frac{N}{1+N(e)^2} \quad \text{………………………………………………………………………….. (1)}$$

Where n is the desired sample size, N is the population size and e is the acceptable margin of error (level of precision= 0.05). Margin of error shows the percentage at which the opinion or behaviour of the sample deviates from the total population. The smaller the margin of error the more the sample is representative to the population at a given confidence interval.

Therefore, the sample size was:

$$n=\frac{76}{1+76(0.05)^2}=\mathbf{64\ boarding\ secondary\ schools}$$

Table 1: Boarding secondary schools' population and sample size for study areas

District	Number of schools	Sample size	
Gasabo	Public schools	7	6
	Private schools	11	9
Kicukiro	Public schools	5	4
	Private schools	9	8
Nyarugenge	Public schools	5	4
	Private schools	1	1
Kamonyi	Public schools	5	4
	Private schools	6	5
Bugesera	Public schools	4	3
	Private schools	7	6
Muhanga	Public schools	8	7
	Private schools	8	7
Total		76	64

3.4. Methods of data collection

Prior to full scale study, pre-testing of the questionnaire was done in 6 boarding secondary schools to check the validity of the questionnaire with the help of 3 enumerators who were trained preceding the preliminary test, and after, corrections were effected. The study used both primary (cross-sectional) and secondary data. Primary data was sourced through a structured questionnaire which was administered to caterers of sampled schools during the period of July 2018. To administer questionnaire in schools, permission was obtained from National Council for Science and Technology. Secondary data was obtained from Farmfresh Food Company and reviews from journals, reports, books and internet.

3.5. Data analysis

Data cleaning and analysis was done using management tools such as SPSS 20 for descriptive statistics, STATA 13 for logistic regression and Ms Excel for partial budget analysis. Analysis was quantitative. It described constraints impeding the use of precooked beans among schools, factors influencing the willingness of schools to use precooked beans and the potential economic and environmental effects of using precooked beans among boarding secondary schools.

3.5.1. Analytical framework

Objective 1: To identify constraints hindering the use of precooked beans among schools in Rwanda.

To analyse this objective, descriptive statistics such as percentages and frequency distribution were used to rank constraints according to their intensity. Data was presented on graphs, bar charts and in tables.

Objective 2: To determine factors influencing the willingness of schools to use precooked beans in Rwanda.

Logistic regression (logit model) was used to analyse factors influencing the willingness of boarding secondary schools to use precooked beans. Logit model was preferred to Linear regression models such as Ordinary Least Squares and Linear Probability models because it is best fitted when the dependent variable is a dichotomous variable. Dichotomous dependent variable violates linearity assumption in normal regression, hence logit model cope with this problem by using a logarithmic transformation of the dependent variable which allows to model a nonlinear dependence in a linear way. Logit model was also preferred to Probit model due to its reliance on log odds that can be transformed into odds ratio, thus makes it easier for interpretation.

Logistic regression of the willingness to use precooked beans was specified as 1 if the school is willing to use precooked beans and 0 if the school is not willing to use precooked beans. The exogenous variables included: age of caterer, gender of caterer, level of education of caterer, working experience of caterer, age of institution, type of institution, geographical location of the institution, size of institution (number of people fed), type of market, distance to the market, perceived high price of precooked beans and perceived availability of precooked beans.

The major purpose of logistic regression was to predict the probability of a school being willing to use precooked beans. As such, according to Greene (2012), the functional form of logit model is written as follows:

$$P = (Y = 1) = \frac{e^{\beta Xi}}{1 + e^{\beta Xi}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

With the cumulative distribution function as follow;

$$F(\beta x) = \frac{1}{1 + e^{\beta Xi}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots .. \quad (3)$$

Where;

Y is the willingness to use precooked beans, Xi are the independent variables and *βs* are the slope parameters associated with independent variables.

Equation (2) can also be written as:

$$Pi = \frac{1}{1+e^{-Zi}} \quad \text{..... (4)}$$

The probability for a given school to be willing to use precooked beans is expressed by equation (4) above, while the probability that a school is not willing to use precooked beans is given by equation (5) below:

$$1 - Pi = \frac{1}{1+e^{Zi}} \quad \text{..... (5)}$$

Therefore, equation (6) can be written as:

$$\frac{Pi}{1-Pi} = \frac{1+e^{Zi}}{1+e^{-Zi}} \quad \text{..... (6)}$$

Where; $\frac{Pi}{1-Pi}$ is the odds ratio in favour of being willing to use precooked beans. This implies that it is the ratio of the probability of being willing to use precooked beans to the probability of not being willing to use precooked beans. Finally, by taking the natural logarithms of equation (6) the equation (7) was obtained as follows:

$$L_i = \ln\left[\frac{Pi}{1-Pi}\right] = Z_i = \beta_0 + \beta_1 X_1 + \beta_n X_n \quad \text{..... (7)}$$

Where P_i is the probability of being willing to use precooked beans and it ranges from 0 to 1, and Z_i is a function of n predictor variables (X_i).

The probability that an institution *n* is willing to use precooked beans can also be modelled as;

$$PBWUse = \beta_0 + \beta_1 Cage + \beta_2 Cgend + \beta_3 Ceduc + \beta_4 CWexp + \beta_5 Isize + \beta_6 Iage + \beta_7 Ityp + \beta_8 Loc + \beta_9 TypmMrkt + \beta_{10} Dist + \beta_{11} PrcvHPce + \beta_{12} PrcvAvail + \varepsilon \quad \text{..... (8)}$$

Where; *PBUse* is the school's willingness to use precooked beans with value 1 for willingness and 0 for non-willingness, β_0 is the intercept, $\beta_{1,\ldots,}\beta_{12}$ are the slope parameters in the model and ε is the error term

Table 2: Variables used in logistic regression

Variable	Description	Measurement	Expected sign
Dependent variable			
PBWUse	Willingness to use precooked beans	1= willing to use, 0 = Unwilling to use	
Independent variables			
Cage	Age of caterer	In years	+/-
Cgend	Gender of caterer	1= male, 0= female	+/-
Ceduc	Education level of caterer	In years	+/-
CWexp	Working experience of caterer	In years	+/-
Isize	Size of institution	Number of people fed	+/-
Iage	Age of institution	In years	+/-
Ityp	Type of institution	1= public, 0=private	+/-
Loc	Geographical location of institution	1= Urban, 0= Rural	+
Dist	Distance to the market	kilometers	+/-
Typmrkt	Type of the market	1= spot market, 0= contract market	+/-
PrcvHPce	Perceived high price of precooked beans	1= Strongly disagree, 2= Disagree, 3= Neutral, 4= Agree, 5= Strongly agree	+/-
PrcvAvail	Perceived Availability of precooked beans	1= Strongly disagree, 2= Disagree, 3= Neutral, 4= Agree, 5= Strongly agree	+/-

Logistic regression model diagnostic Tests

According to Greene (1993), the data in hand of a researcher hardly conform exactly to the theory underlying the model. Thus, diagnostic tests should be done to ensure non-violation of the key assumptions of a given model. Although logistic regression does not make several of the key assumptions of linear regression (Statistic Solutions, undated), some of the assumptions still apply. Therefore, before proceeding with the estimation of multiple linear regression

equation, the degree of correlation among independent variables (multi-collinearity) and the relationship between such variables and the random variables were tested.

Multi-collinearity: in a multiple regression model if there is no linear relationship between the explanatory variables, they are said to be orthogonal. However, following Paul (2015), in most applications of regressions, the explanatory variables are linearly related, and in some situations they are in a nearly perfect linear relationship. In such situations of nearly perfect linear relationship, the inferences based on the regression model can be erroneous and misleading. The author argued that the lack of orthogonality is not a problem itself, the problem comes with the degree of correlation. The problem of multi-collinearity occurs when there is an exact or nearly exact linear relation among two or more of the predictor variables (Hawking and Pendleton, 1983).

To test for multi-collinearity in non-continuous variables the method of examination of correlation matrix was used. This method consists of inspecting the off-diagonal elements r_{ij} in X'X. If the independent variables x_i and x_j are nearly linearly related, then r_{ij} will be approximately unity. According to Kennedy (1985), for these variables, if one of the correlation coefficients has a value of 0.8 or higher in absolute terms, there is a high correlation between the two explanatory variables. This implies that the problem of multi-collinearity exists. The results of this test are presented in Table 3 below.

Table 3: Correlation coefficients of categorical explanatory variables

Variables	Gender	Educational level	Type of institution	location	Type of market	Price	Availability
Gender	1.000						
Educational level	-0.149	1.000					
Type of institution	0.358	-0.362	1.000				
location	-0.146	0.558	-0.457	1.000			
Type of market	-0.160	0.313	-0.390	0.170	1.000		
Price	0.272	-0.523	0.480	-0.382	-0.395	1.000	
Availability	0.120	-0.336	0.284	-0.178	-0.286	0.494	1.000

From the results of Table 3 above, the highest coefficient is 0.558, which means that all coefficients are below 0.80. Therefore, as suggested by Kennedy (1985), there is no presence of multi-collinearity problem among discrete variables.

To test for multi-collinearity in continuous variables, the Variance Inflation Factor (VIF) was calculated as follow:

$$VIFx_i = \left(\frac{1}{1-R_j^2}\right) \qquad (9)$$

Where; x_i is the j^{th} continuous independent variable regressed on the other independent variables. R_j^2 is the coefficient of determination obtained when x_j is regressed on the remaining explanatory variables. If x_j is nearly orthogonal to the remaining explanatory variables, R_j^2 is small and the VIF is approximate to unity, while if x_j is nearly linearly dependent on some subset of the remaining explanatory variables, R_j^2 is close to unity and the VIF is large. For these variables, Gujarati (1995) argued that if the Variance Inflation Factor (VIF) of an input variable goes beyond 10 (this will happen if R^2 exceeds 0.90), that variable is said to be highly collinear. This also implies that there is a problem of multi-collinearity. The results of this test are presented in Table 4 below.

Table 4: Variance Inflation Factor for continuous explanatory variables

Variable	**VIF**	**1/VIF**
Working experience of caterer	3.48	0.287
Age of caterer	2.81	0.356
Age of institution	1.89	0.528
Size of institution	1.53	0.652
Distance to the market	1.04	0.959
Mean VIF	**2.15**	

Note: VIF means Variation Inflation Factor

Table 4 above shows that the highest individual VIF value is 3.48 with a mean VIF of 2.15, which implies that the individual VIF value for all the continuous explanatory variables is less than 10. Therefore, as suggested by Gujarati (1995), there is no presence of multi-collinearity problem among continuous independent variables. Generally, the data was found to have no serious problem of multi-collinearity.

Heteroscedasticity: this is the situation where the variance in the error term, *u*, conditional on the predictor variables, is not the same for all combinations of outcomes of the predictor variables (Wooldridge, 2012). The existence of heteroscedasticity in the model leads the coefficient estimates in discrete choice models to be inconsistent (Hole, 2006). To detect heteroscedasticity in our model, Breusch-Pagan test was conducted. The first step consisted of coming up with hypotheses where the null hypothesis was tested using the chi-square method.

H_0: the error term variances are the same

H_1: the error term variances are not the same

To obtain the chi2 value, estat hettest command was run in Stata. The decision to reject or fail to reject the null hypothesis depended on the value of the chi2; the results were ch2 (1) = 0.01 and the Prob > chi2 = 0.915. This means that the null hypothesis failed to be rejected since the results were not statistically significant. Therefore, as the variance was constant, no heteroscedasticity problem in the model.

Objective 3: To evaluate potential economic and environmental effects of using precooked beans among schools in Rwanda

To evaluate potential economic and environmental effects of shifting from cooking dry beans to cooking precooked beans by schools, a partial budget analysis was used. Partial budget analysis helped to know if this shift will reduce or increase institutional operational costs. According to Tigner (2018), a partial budget helps managers to weigh the financial effects of incremental changes. The partial budget consists of two columns, a subtotal from each column and a net change. In this study, in the first column, all the costs of buying and preparing dry beans were quantified and totalled up. These costs include the purchasing cost of dry beans, transport costs, storage costs, and fuel, water and labour costs. Further, all costs involved in buying and preparing precooked beans were quantified and totalled up as well in the second column. These costs also encompass purchasing cost of precooked beans, transport costs, storage costs, and fuel, labour and water costs. Then, the subtotal of costs involved in dry beans purchase and preparation were calculated as well as the subtotal of all costs involved in precooked beans purchase and preparation. Finally, a net difference was calculated by subtracting the results of column 2 from the results of column 1. Variables included in the partial budget in this study were; Purchasing costs of beans, Transport costs of beans, Transport costs of beans, Fuel costs, Transport costs of fuel, Labour costs and Water costs.

To evaluate the environmental effects of shifting from dry beans to precooked beans consumption by public-feeding institutions, calculations were done based on the literature related to forestry in Rwanda.

CHAPTER FOUR
RESULTS AND DISCUSSION

This chapter presents the results of economic and environmental effects of the use of precooked beans by schools in Rwanda. It is divided into four main sections. The first section provides the discussion of descriptive statistics of factors influencing the willingness of boarding secondary schools to use precooked beans. Constraints hindering the use of precooked beans among schools in Rwanda are presented in the second section. Section three presents the results and discussion on factors influencing the willingness of schools to use precooked beans. The last section provides results and discussion of potential economic and environmental effects of using precooked beans by schools.

4.1. Descriptive statistics of factors influencing the willingness of boarding secondary schools to use precooked beans

4.1.1. Socio-Economic Characteristics of the Caterer

Caterer's socio-economic characteristics were analysed using means, frequency and percentages, and the results are presented in charts.

a. Age of caterer

Results showed that the average age for caterers is 40 years. The majority (81.3%) of respondents were aged between 30 and 50 years. This can be attributed to the fact that working in education sector requires a great level of maturity. This is supported by Kamau (2012) who found that the majority of caterers in boarding secondary schools are within the range of 30 to 50 years. Within this age bracket, also, caterers are physically fit to exercise their duties as required. Walker (2006) found that within organizations the active age of employees is crucial since employees in that age can be optimally used and are potential to improve efficiency. The results also showed that respondents who were aged below 30 years were 7.8% whereas 10.9% were aged above 50 years.

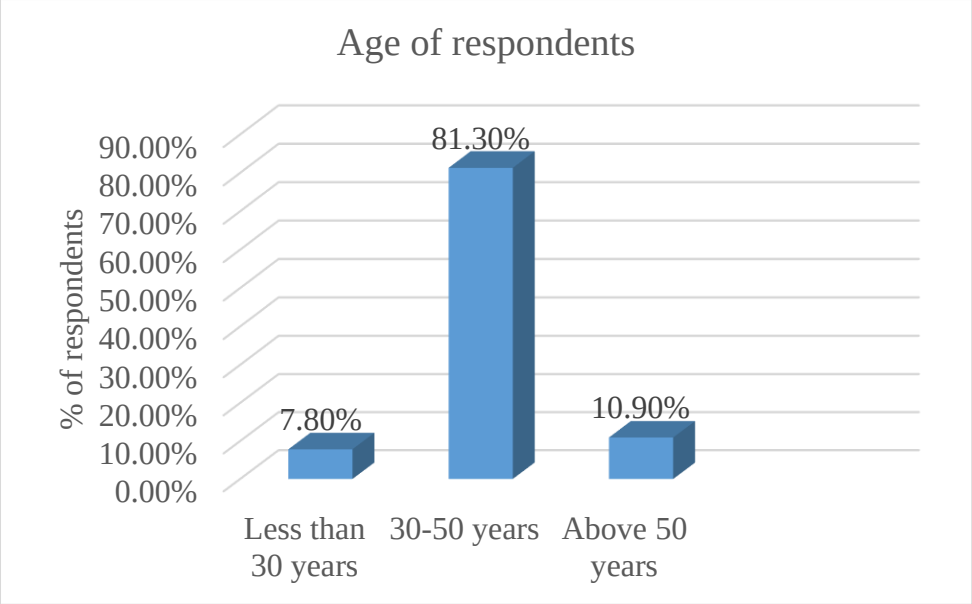

Figure 3: Distribution of caterers by age

b. Gender of caterer

In this target group of schools, a large number of caterers were female. The female caterers represented 62.5% of the respondents while males represented 37.5%. This could be due to the fact that women are more comfortable with the kitchen than men. According to Odhiambo (2011), Cusack (2014) and Orido (2017), women are positioned by the African society as having their place in the kitchen where they exercise control and power over food preparation. In African culture, women are also the ones to plan and shop for their families (Orido, 2017). This could also be the cause for a large percentage of women caterers since it provides them high skills and experience in food purchase as compared to males, which makes them more competitive for this job.

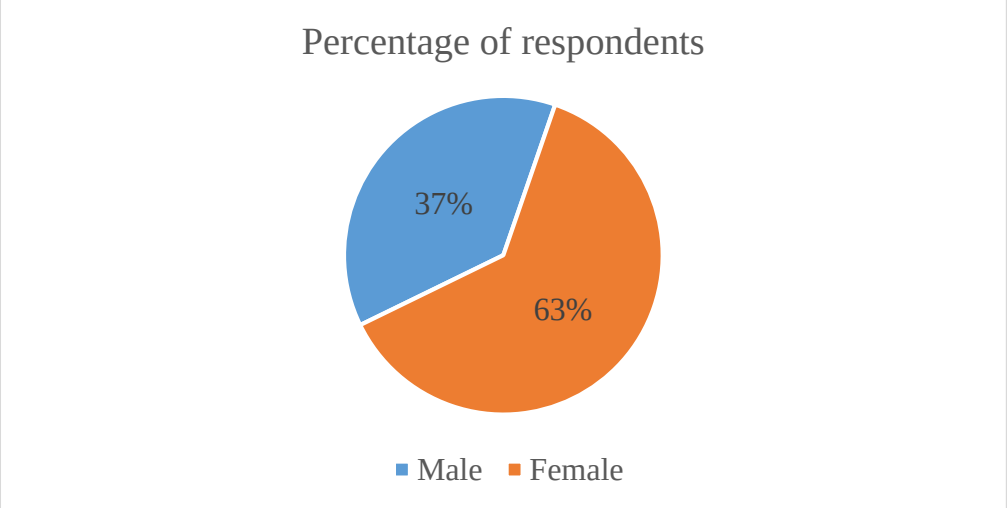

Figure 4: Distribution of caterers by gender

c. Educational level of caterer

About the education level of respondents, the results indicated that the large number (59.4%) of caterers had university education level. Respondents who had a diploma or still in university were 29.7% whereas 10.9% of caterers have only gone up to high school. This is an indicator that most caterers have attained high levels of education which would provide them necessary qualification to identify and deal with challenges they are facing in achieving their duties. Kamau (2012) also found that the majority of caterers in secondary schools had high levels of education to perform optimally their activities. This finding is also in line with the strategy of the Rwandan Ministry of Education consisting of improving the quality of education by improving education level of employees in academic institutions including secondary schools (MINEDUC 2013).

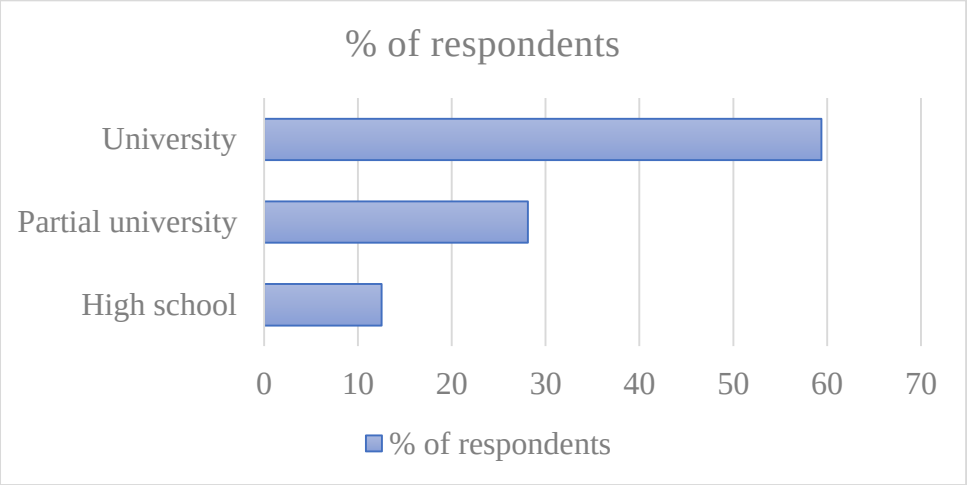

Figure 5: Distribution of caterers by education level

d. Working experience of caterer

The average caterer's working experience was 10 years. The majority of the respondents (64.1%) have 10 or less years of experience in their job of caterer. This is mostly linked to the young age of most caterers in the target group. It may also be attributed to the act of changing of employment generally for the search of more career opportunities (Cline and Kisamore, 2008). This finding is supported by Kagendo (2013) who found that the majority of secondary school caterers have the working experience between 0 and 10 years. Respondents having between 11 and 20 years of working experience were 32.8% while 3.1% have more than 20 years of experience.

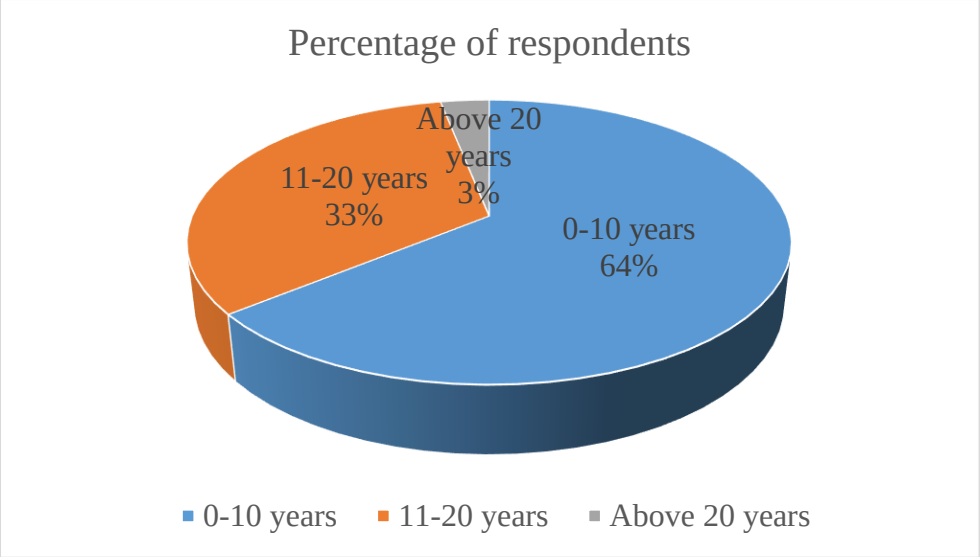

Figure 6: Distribution of caterers by working experience

4.1.2. Organizational Characteristics of schools

Organizational characteristics of surveyed schools were analysed using descriptive statistics such as percentages, mean and standard deviation. Table 5 below presents the percentages and frequency of those characteristics.

Table 5: Distribution of organizational characteristics of surveyed boarding secondary schools

Variable	N	Category	Frequency	Percent
Age of institution	64	Less than 10 years	10	15.6
		10 – 24 years	36	56.3
		Above 24 years	18	28.1
Type of institution	64	Private	36	56.3
		Public	28	43.7
Geographical location of institution	64	Rural	21	32.8
		Urban	43	67.2
Size of institution (number of people to feed)	64	Less than 500 people	42	65.6
		500 – 700 people	13	20.3
		Above 700 people	9	14.1

The results of analysis revealed that 56.3% of surveyed schools were private schools whereas 43.7% were public schools. This large number of private schools may be attributed to the fact that a large number (39 schools) of interviewed schools were sampled from Kigali city and

other districts neighbouring Kigali, where boarding secondary schools are mostly private schools. This may be mainly due to the fact that private investors in education sector prefer investing in urban areas as compared to rural areas (Zhang *et al*., 2015).

Regarding the geographical location of surveyed boarding secondary schools, the results of analysis showed that 67.2% of schools are located in urban areas whereas 32.8% of them are located in rural areas. The majority of schools in the target group are located in urban areas due to the sampled area of the study. In fact, out of the 6 districts of the sampled area 3 districts are the districts of Kigali city, which means that they are in urban area.

Concerning the age of institution in the sampled group of schools, a large number of those schools (56.3%) are aged between 10 and 24 years, 15.6% of them are less than 10 years old and 28.1% are above 24 years old. This large number of schools in the range of 10 and 24 years can be attributed to the goal of the government of Rwanda of building human capital through improving the education sector, after 1994 genocide. According to MINEDUC (2013), before 1994 Genocide, the level of education was generally low in the country, with a small number of schools dominated by public schools. Hence, from the period of 1994 to 2008, the mission of the government, in partnership with private sector, has been to increase the number of schools to achieve its goal of building adequate human capital (MINEDUC, 2013).

The size of the institution was estimated in terms of number of people fed by the school including students and staff members. The majority of those schools (65.6%) were feeding less than 500 people, 20.3% of them were feeding between 500 and 700 people and 14.1% of them were feeding above 700 people. The large number of schools feeding less than 500 people may be attributed to the capacity of the school to take care of its students. Since the large number of schools have been established after 1994 Genocide, as seen previously, their capacity to receive students is still low as compared to the capacity of old schools.

Table 6: Descriptive statistics of organizational factors influencing the willingness to use precooked beans

Variables	**Description**	**Measurement**	**Mean**	SD
Age	Age of institution	Years	21.97	15.056
Size of institution	Number of people fed by the institution	Number	477.58	190.237

Note: SD means Standard Deviation

4.1.3. Institutional factors

Concerning institutional factors, 64.1% of interviewed schools use contract market to purchase food products whereas 35.9% of them use spot market to purchase their food products. This large number of schools using contract market is linked to the new government policy regarding the procurement in schools, particularly in public schools. According to MINEDUC (2014), a new policy has been set stating that the procurement of all products in public schools should be in the hand of tender board to assist in school management.

Results also showed that the distance from the school to the market is less than 1 kilometre for 48.4% of schools. This is mainly because in many cases, schools are purchasing their food products including beans under contract and it's the duty of the supplier to transport purchased products to schools. For 46.9% of schools the distance between the school and the market varies between 1 and 10 kilometres. For 4.7% of schools, that distance goes above 10 kilometres. The average distance from school to the market was 2.855.

4.1.4. Perceived bean characteristics

Perception of a product's characteristics play a vital role in dictating the attitude towards purchasing that product (Darley *et al*., 2010). Perceptions of schools on characteristics of precooked beans are also among factors influencing the willingness of boarding schools to use precooked beans. Therefore, perceived characteristics of precooked beans such as price and availability among others were analysed using frequencies and percentages. The results of the analysis indicated that 46.9% of the respondents perceive precooked beans to be not fairly priced. The results also showed that 45.3% of respondents perceive precooked beans as fairly priced while 7.8% of respondents were neutral. This difference in respondents' price perception may be attributed to the level of income of each school and how much they usually buy dry beans.

In relation to perceived availability of precooked beans, the results of the analysis indicated that the majority of respondents (71.9%) perceive precooked beans as not available in their markets. This can be due to the limited capacity of their producer since the concept of precooked beans is still new and has not yet received enough financial support being either from the government or from private sector. This may also be due to ineffective market structure of precooked beans. The results showed as well that 9.4% of respondents disagreed that precooked beans are unavailable whereas 18.8% of respondents were neutral. The

descriptive statistics of these perceived characteristics including mean scores and standard deviation are presented in Table 7 below.

Table 7: Mean scores of perceived bean characteristics

Variable	Measurement	Mean	SD
Perceived high price	1= Strongly disagree, 2= Disagree, 3= Neutral, 4= Agree, 5= Strongly agree	2.97	1.380
Perceived availability	1= Strongly disagree, 2= Disagree, 3= Neutral, 4= Agree, 5= Strongly agree	4.02	0.934

4.2. Constraints hindering the use of precooked beans in boarding secondary schools

The use of a new product innovation by organizational consumers is a process which encounters different barriers. According to Atkin *et al.* (2017), organizational consumers encounter several barriers in their use of new product or technology, being either internal or external. Barriers vary from one organization to another depending on its size, type and location among other factors (McDade *et al.*, 2010). Several constraints have been assumed to impede the use of precooked beans among boarding schools in Rwanda. To confirm them, this study was conducted in 64 boarding secondary schools and the results showed that 62 schools were not using precooked beans. Moreover, 7 constraints were identified to be the major ones limiting boarding secondary schools to use precooked beans, as shown by the Table 8 below.

Table 8: Distribution of major constraints hindering the use of precooked beans among boarding secondary schools

Constraints	Distribution	
	Frequency	%
Lack of sufficient information about precooked beans	31	50
Unavailability of precooked beans	21	33.9
High price of precooked beans	18	29
Distrust in the sustainability claims of precooked beans industry	10	16.1
Low nutritional value of precooked beans	6	9.6
Inconvenient packaging of precooked beans	3	4.8
Inadequate storage for precooked beans	2	3.2

4.2.1. Lack of sufficient information about precooked beans

Lack of sufficient information about precooked beans has been identified as the main constraint which limited surveyed boarding secondary schools to use precooked beans. According to Shiferaw *et al*. (2015), the key first stage determinants of the use of a new product or technology are awareness and access to information, to weigh options and evaluate relative expected benefits from consuming the new product or using the new technology. A person or an organization is considered to be aware of a product or a technology when his/ its information level on the product or technology surpasses a threshold level (Adegbola and Gardebroek, 2007; Shiferaw *et al*., 2015). Table 8 above shows that the majority (50 percent) of the respondents who were not using precooked beans reported the lack of sufficient information as the primary constraint to their use of precooked beans. Those respondents argued that they could not use a product they do not have sufficient knowledge about its advantages and disadvantages.

4.2.2. Unavailability of precooked beans

Unavailability of precooked beans is the second major constraint mentioned by respondents to impede their use of precooked beans. As shown in Table 8, also 33.9 percent of the respondents who were not using precooked beans mentioned the lack of availability of precooked beans in their market to be among the major barriers to their use of precooked beans. This problem of unavailability of precooked beans in local markets can be attributed to the fact that precooked beans are still a new product. Following to this, their producers may not yet be able to supply it in several market due to their limited capacity or else the structure of precooked beans market may be ineffective. According to Aggarwal *et al.* (1998), in the initial stage of a product's life cycle, its market structure may not be fully developed, causing limited availability and accessibility of it and this creates a barrier to its use. This finding of the study is supported by Goodwin *et al.* (2014) who found that unavailability of a product is one of the main factors that can have a negative effect on its use.

4.2.3. High Price of precooked beans

This is the third main constraint which is limiting boarding secondary schools from using precooked beans according to the results. As shown in Table 8, this constraint was reported by 29 percent of the respondents who were not using precooked beans, as one of their major constraints to the use of precooked beans. They argued that precooked beans are much

expensive as compared to dry beans and that since they are feeding a large number of people they cannot afford to purchase them. This constraint is supported by Campbell (1999); Xia *et al.* (2004); Homburg *et al.* (2005) and Kuester *et al.* (2015) who asserted that perceived price unfairness generates negative emotions that can result in consumers ending the exchange relationships, negative word of mouth or even boycotts.

4.2.4. Distrust in the sustainability claims of precooked beans industry

Distrust in the sustainability claims of precooked beans industry are another constraint which has been hindering the use of precooked beans in boarding secondary schools. Jansson (2011) found that lack of trust in the sustainability of the product is one of the factors that lead to negative attitude toward that product. According to Table 8, 16.1 percent of the respondents that were not using precooked beans indicated that one of the main constraints they had was that they do not trust the sustainability of precooked beans industry. Those respondents claimed that since the first company producing precooked beans had closed down, there is nothing which guarantees that the new company will not also close soon after they have started consuming their beans. Further, they questioned the capacity of precooked beans industry. They said that they do not believe the industry would be able to provide required beans at any time if they were used by all the schools.

4.2.5. Low nutritional value of precooked beans

The nutritional aspect of precooked beans has been also mentioned as a constraint to the use of them in boarding secondary schools. Following Ronteltap *et al.* (2007), the nutritional value plays a crucial role in consumers' acceptance of new innovative food product since consumers are normally concerned about their health. As indicated by findings in Table 8, 9.6 percent of respondents who were not using precooked beans said that they were not using precooked beans because they found them not nutritious in terms of taste and nutrient content as compared to dry beans. Respondents argued that precooked beans do not contain soup which is normally in cooked dry beans and which makes the diet complete for students. Thus, without that soup they cannot serve precooked beans alone with starch. Also, according to their perception, packed food products are taken to be less nutritious and less tasty than fresh food products.

4.2.6. Inconvenient packaging of precooked beans

The inconvenience of precooked beans packaging has also been criticised as being one of the constraints that have hindered the use of precooked beans by the sampled boarding secondary schools. According to Ramirez *et al*. (2014), the inconvenient packaging of a product usually

limits big consumers to use such product. As shown by results given in Table 8, 4.8 percent of respondents who were not using precooked beans indicated that the packaging of precooked beans is not convenient, which is the main reason they do not use these beans. Those respondents claimed that since they cook beans in bulk, unpacking small packages of 400 g each is hard and time-consuming, which makes hard to prepare them.

4.2.7. Inadequate storage for precooked beans

Storage has also appeared to be a constraint to the use of precooked beans among boarding secondary schools although it is the least mentioned. As shown by results given in Table 8, only 3.2 percent of respondents who were not using precooked beans stated the lack of adequate storage to be the major constraint that limited their use of precooked beans. They affirmed that precooked beans require an improved store to ensure the shelf life of these beans, which is different from the store they have for dry beans. This is consistent with the findings of Man (2015) that approved that inadequate storage of a product would have a negative impact on its shelf life, hence would hinder its use.

4.3. Factors influencing the willingness of boarding schools to use precooked beans

To determine factors influencing the willingness of boarding secondary schools to use precooked beans firstly a logistic regression was done and then marginal effects were measured. The results of the analysis are presented in Table 9 below.

Table 9: results of logistic regression and marginal effects of factors influencing willingness to use precooked beans

Variables	Logistic ratio			Marginal effects		
	Coef	**Std Err**	**P > Z**	**Dy/dx**	**Std Err**	**P > Z**
Age of caterer	-0.207	0.165	0.211	-0.058	0.043	0.170
Gender of caterer	-0.483	1.220	0.692	-0.160	0.303	0.599
Education level of caterer	2.719	1.278	0.033	0.786	0.337	0.020
Working experience of caterer	0.122	0.214	0.570	0.042	0.052	0.427
Age of institution	0.012	0.214	0.768	0.001	0.011	0.904
Type of institution	-3.722	1.726	0.031	-0.705	0.220	0.001
Geographical location of institution	-4.106	2.093	0.050	-0.810	0.169	0.000

Table 9: results of logistic regression and marginal effects of factors influencing willingness to use precooked beans (continued)

Size of institution	-0.010	0.005	0.033	-0.003	0.001	0.026
Type of the market	-.0793	1.418	0.576	-.242	0.355	0.495
Distance to the market	-0.083	0.202	0.680	-0.048	0.045	0.283
Perceived high Price of precooked beans	-1.107	0.495	0.005	-0.291	0.131	0.026
Perceived Availability of precooked beans	-9.218	0.699	0.756	-0.025	0.196	0.900
Constant	15.083	7.148	0.035			
Number of obs = 64						
LR chi2 = 61.71						
Prob > chi2 = 0.0000						
Pseudo R2 = 0.6956						
Log likelihood = -13.505						

The dependent variable of the study was the willingness of boarding secondary schools to use precooked beans. It was measured by 1 for schools which are willing to use precooked beans and 0 for those which are not willing to use precooked beans. The results of the study showed that 51.6% of the interviewed schools were willing to use precooked beans. This is a positive feedback showing the potential of precooked beans to be used in schools in the future.

Results of the logistic regression showed that the education level of caterer has a positive influence on the willingness of boarding secondary schools to use precooked beans at 5 percent significance level. The education level of caterer plays a great role in the school's willingness to use precooked beans. The results of marginal effects indicate that high education level (university) of caterer increases its likelihood of willingness to use precooked beans by 78.6 percent. This may be because as one increases his/her level of education he/she becomes more willing to take risks. These findings are supported by Haslet *et al*. (2017) who found that higher education levels have a stimulation effect on the willingness to use new products.

Further, the results of marginal effects confirmed that the type of institution had a negative effect on the willingness of schools to use precooked beans. The effect was significant at 1 percent. As shown in Table 9, being a public school lowers the probability of the school's

willingness to use precooked beans by 70.5 percent. This can be attributed to the difference in school fees paid by a student in these two types of schools. Usually, public school students pay less money compared to students in private schools. This can be a barrier to the use of new products innovation in such schools since those products are expected to be more expensive than the old products. These findings are consistent with the ones of Wang *et al.* (2008) who found that low income influences a positive attitude toward existing products and that as income increases, the attitude toward new products innovations also increases.

It is also apparent from the results that boarding secondary schools that are located in rural areas are less likely to be willing to use precooked beans as shown by the negative and statistically significant coefficient. The results in Table 9 indicate that being located in rural area lowers the likelihood of the school's willingness to use precooked beans by 81 percent. This can be mainly due to the long distance from the school to precooked beans market. This would limit the accessibility of precooked beans, hence impede the willingness to use them. According to Buckmaster (2012), long distance to the market significantly limit the use of new product or technology. These findings can also be attributed to difference in behaviour change time between people in rural areas and those in urban areas. According to Chuzhanova (2016), in rural areas the process of people's behaviour change through innovation adoption tend to be longer than in urban areas.

Furthermore, the results of marginal effects indicate that the size of institution has a negative influence on the willingness of schools to use precooked beans at 5 percent significance level. This implies that as the number of people to be fed by the school increases, the probability of the school's willingness to use precooked beans will decrease. According to the results given in Table 9, a unit increase in the number of people to be fed by the school would reduce the likelihood of the school's willingness to use precooked beans by 0.3 percent. This also can be associated to the resources allocation of the school. Schools which have a large number of people to take care of are expected to use more efficiently their resources to satisfy all the needs than schools with a small number of people. Consequently, this can decrease their willingness to use new products innovation since those products are usually assumed to be more expensive than existing products. These findings are supported by Arts *et al.* (2010) who found that as the number of people to feed influences the likelihood to use new food product innovation.

The perception of boarding secondary schools about the price of precooked beans also plays a vital role in their willingness to use such beans. The results of the study showed that the

perception of schools about the price of precooked beans has a negative influence on the willingness of schools to use these beans at 5 percent significance level. An increase in the perception of school about the high price of precooked beans would reduce the likelihood of the school's willingness to use such beans by 29.1 percent. These findings are consistent with those of Ndubi and Rotich (2015) who also asserted that price has a negative correlation with product use. They are also supported by Lichtenstein *et al*. (2003) who emphasised that the perception of high price reduces the willingness to use a new product since price represents the amount of economic outlay to be given up in exchange for a good or service.

4.4. Economic and environmental effects of using precooked beans among boarding secondary schools

4.4.1. Economic effects

Although the concept of precooked beans was introduced in Rwanda in 2009 (Farmfresh, 2017), its rate of use is still low, and especially very low in institutions such as boarding secondary schools. The results of this study conducted in 64 boarding secondary schools have shown that the main cause of this low rate of use is the lack of sufficient information about precooked beans. One of the key information is to know the economic and environmental benefits that could be brought by using precooked beans among schools.

To evaluate the economic effects of shifting from dry beans to precooked beans consumption among boarding secondary schools a partial budget analysis was used. This analysis consisted of comparing all costs involved in buying and cooking dry beans as well as all the costs involved in purchasing and cooking precooked beans. Firstly, as the study was conducted in 64 boarding secondary schools, the mean of all information related to costs was calculated as shown in Table 10 below.

Table 10 :Summary of information about inputs and costs involved in dry beans and precooked beans consumption

Variables	N	Minimum	Maximum	Mean	Std. Deviation
Intake of dry beans per week (Times)	64	4	7	6.64	.743
Quantity of dry beans cooked per meal (Kg)	64	28	150	63.17	27.489

Table 10: Summary of information about inputs and costs involved in dry beans and precooked beans consumption (continued)

Unit price of dry beans (Rwf/Kg)	64	350	500	433.28	57.571
Total transport costs per term (Rwf)	64	0	45000	10460.94	10999.749
Total price of storing dry beans (Rwf)	64	0	5,000	218.75	820.738
Fuel used for dry beans (m^3)	64	.20	3.00	1.1453	.61410
Fuel availability perception (5 likert-scale)	64	1	5	2.28	1.091
Fuel price perception(5 likert-scale)	64	3	5	4.55	.641
Fuel transport costs perception (5 likert-scale)	64	1	5	3.20	.962
Unit price of fuel (Rwf/m^3)	64	10,000	18,000	14,453.13	1,749.646
Unit price of fuel transport (Rwf/m^3)	64	0	2,500	546.88	843.833
Labour preparing dry beans (number)	64	2	6	3.70	.830
Labour hours per day	64	8	15	12.70	1.519
Hours of sorting dry beans	64	.00	2.00	1.0078	.34810
Hours of cleaning dry beans	64	.00	.34	.2291	.07589
Hours of cooking dry beans	64	3.00	8.00	5.2500	.84045
Labour wage (Rwf/person)	64	25,000	50,000	32,250.00	4,601.587
Water for washing dry beans (m^3)	64	.04	.60	.0906	.06882
Water for cooking dry beans (m^3)	64	.06	.48	.2031	.11008
Unit price of water (Rwf)	64	600	800	695.31	39.560
Size of precooked beans package (Kg)	64	.40	.40	.4000	.00000
Price of precooked beans package (Rwf/package)	64	350	350	350.00	.000
Time used to cook precooked beans (Hrs/meal)	64	.33	.50	.4150	.12021
Fuel used to cook precooked beans (m^3)	64	.10	.20	.1500	.07071
Labour used to cook precooked beans	64	2	2	2.00	.000
Time used to unpack precooked beans (Hrs/meal)	64	.50	.67	.5850	.12021
Water used to cook precooked beans (m^3)	64	.02	.02	.0200	.00000

Table 10 above summarises information about all inputs and costs implicated in the process of buying up to the consumption of dry beans for all 64 schools. It also summarises inputs and costs involved in the consumption of precooked beans for 2 schools which were already using these beans. According to the results, in boarding secondary schools, beans are consumed almost 7 days in a week (6.64 times) and they are cooked once in a day. The quantity of beans

cooked, on average, is 63.17 Kg per meal. This may be due to the fact that beans are a staple food for Rwandans.

Further, the results in Table 11 show a big difference between the price of precooked beans and the price of dry beans. On average 1 kg of dry beans costs RWF433 while 1 kg of precooked beans costs RWF875. This would increase considerably the total costs of precooked beans consumption. However, besides this, dry beans consumption involves other costs that precooked beans consumption does not involve. The results showed that transport costs of dry beans are on average Rwf10,461 per term and storage costs of dry beans per term are estimated to Rwf219 on average. Transport costs are not involved in precooked beans consumption since precooked beans producers assure their transport costs.

In relation to fuel used, firewood was the cooking fuel in all interviewed schools. This may be due to the fact that firewood is the most available and affordable source of energy in the country (MINIRENA, 2017). The results showed that in average a school used 1.145 m^3 of firewood per meal of dry beans while 0.150 m^3 of firewood were used per meal of precooked beans. This implies that the fuel used for cooking dry beans was almost 8 times the fuel used for cooking precooked beans. This little amount of fuel used for precooked beans is due to the fact that precooked beans require only 5 to 15 minutes to be reheated for them to be consumed (Aseete *et al.,* 2018). Thus, this higher amount of fuel used for cooking dry beans leads to higher fuel costs as compared to the fuel costs involved in cooking precooked beans.

Labour costs involved in cooking dry beans were also higher than the ones involved in cooking precooked beans since preparing a meal of dry beans requires, on average, 4 labour and 6 hours whereas preparing the same amount of precooked beans requires, on average, 2 labour and 1 hour. The results also showed that water costs involved in cooking dry beans are far greater than the ones involved in cooking precooked beans. This is because preparing dry beans requires on average 300 litres of water while preparing a meal of precooked beans requires 30 litres of water. The low amount of labour and water usage in cooking precooked beans can also be attributed to the fact that precooked beans require only few minutes to be reheated.

Hence, the information in Table 10 allowed all costs involved in consuming dry beans as well as those involved in consuming precooked beans in a month to be calculated as shown in table 11 below.

Table 11: Inputs and costs involved in dry beans and precooked beans consumption

	Dry beans	**Precooked beans**
Intake of beans per week (Times)	6.64	6.64
Quantity of beans per meal (Kg)	63.17	63.17
Quantity of beans per month (Kg)	1678	1678
Unit price of beans (Rwf/Kg)	433.28	875
Total price of beans (Rwf)	727,044	1,468,250
Total transport costs of beans per term (Rwf)	10,461	0
Total transport costs of beans per month (Rwf)	3487	0
Transport costs of beans per Kilogram (Rwa)	2.07	0
Total beans storing cost per month(Rwf)	3219	2985
Fuel used per beans meal (m^3)	1.15	0.28
Fuel used for beans per month (m^3)	34.5	7.46
Unit price of fuel (Rwf/m^3)	14,453	14,453
Total price of fuel (Rwf)	498,629	107,774
Fuel Transport cost per unit (Rwf/$m^{3)}$	546.88	546.88
Total fuel transport costs per month (Rwf)	18,867	4,078
Labour used for preparation (number)	4	2
Labour hours per day	13	13
Total hours spent on beans preparation	7	1
Monthly wage per person (Rwf/person)	32,250	32,250
Total labour costs for beans preparation (Rwf)	60,949	5,079
Water used for washing per meal (L)	100	0
Water used for cooking per meal (L)	200	30
Total water used per meal (L)	300	30
Total water used per month (L)	7800	880
Unit price of water (Rwf/m^3)	695	695
Total cost of water (Rwf)	5,421	552

Table 11 shows that the price of dry beans per Kilogram at the school gate is Rwf435.35 whereas the price for precooked beans is Rwf875 per Kilogram.

From Table 11 a partial budget of dry beans and precooked beans consumption among boarding secondary schools was prepared as shown in Table 12 below.

Table 12: Partial budget of dry beans and precooked beans consumption by schools per month

Type of cost	Dry beans (Rwf)	Precooked beans (Rwf)
Purchasing cost of beans	727,044	1,468,250
Transport cost of beans	3487	0
Storing cost	3,219	2985
Fuel cost	498,629	107,774
Transport cost of fuel	18,867	4,078
Labour cost	60,949	5,079
Water cost	5,421	369
Subtotal	**1,317,616**	**1,588,535**

Net difference= 1,317,616Rwf –1,588,535Rwf = -270,919Rwf

The partial budget above shows that dry beans consumption in boarding secondary schools remains cheaper than the consumption of precooked beans even though precooked beans consumption would reduce considerably costs involved in the preparation. The difference between the costs of consuming dry beans and the costs of consuming precooked beans is averaged at Rwf270, 919 per month. This implies that a school of about 478 students which cooks on average 63 kilograms of dry beans per meal in 7 days of the week would have to add about Rwf270,919 per month to shift to precooked beans consumption. The main reason for this difference in costs is the fact that the price of precooked beans is higher as compared to the price of dry beans. In fact, the price of precooked beans is Rwf875 per kilogram whereas the price of dry beans is Rwf435 on average at the school gate. This finding is supported by Chandra and Neelankavil (2008) who reported that, in general, the price of new products innovation is greater than the price of same existing products, which may cause their use to be costlier than the use of existing products.

Despite the price of precooked beans being high, the analysis has shown that all other costs involved in cooking precooked beans in boarding schools would be reduced significantly. For a school that cooks 63 kilograms of beans per meal in 7 days of the week, shifting from cooking dry beans to cooking precooked beans would reduce its fuel cost from Rwf498,629 to Rwf107,774 per month on average. The transport cost of this fuel would be reduced from Rwf18,867 to Rwf4,078 accordingly. The same school would also reduce its labour costs from Rwf60,949 to Rwf5,079 per month in average. Furthermore, it would reduce its water costs from Rwf5,421 to Rwf369 per month in average. These costs involved in cooking precooked

beans are far less than those of cooking dry beans mainly due to the slow-cooking nature of dry beans.

The costs of transporting and storing beans would also reduce from Rwf3487 to Rwf0 and Rwf3,219 to Rwf2,985 per month respectively. The cost of transporting precooked beans would be Rwf0 because precooked beans producer supplies its beans to schools with no additional costs (Farmfresh, 2017). Therefore, a reduction in the price of precooked beans would make their use cheaper than the use of dry beans in boarding secondary schools.

a. Sensitivity analysis of net change in price of precooked beans

For total costs of precooked beans to be equal to total costs of dry beans, the purchasing cost of precooked beans should be:

Purchasing cost of precooked beans= 1,468,250Rwf – 270, 919Rwf = **1,197,331Rwf**

Therefore, the break-even price would be;

BEP= 1,197,331Rwf/ 1678Kg = 713.55 = **714Rwf/Kg**

As the price of precooked beans reduces, the net change between the total costs of dry beans and total costs of precooked beans would increase as follow:

Table 13: Sensitivity Analysis of net change in price of precooked beans

Price	Purchasing cost of precooked beans	Net difference
875	1,468,250	-270,919
800	1,342,400	-145,069
750	1,258,500	-61,169
713.55	1,197,331	0

4.4.2. environmental effects

Although precooked beans are less economically profitable than dry beans, their economic benefits can be complemented by their environmental benefits to enhance their use among boarding secondary schools. This study has found precooked beans to be environmentally effective in fuel and water reduction aspects. Indeed, the same school of 478 students, cooking 63 kilograms of beans per meal in 7 days of the week would reduce the fuel used in cooking beans from 34.5 tonnes to 7.46 tonnes of firewood per month on average by using precooked

beans. This makes a difference of 27.04 cubic metre of firewood per month. With about 1,335 secondary schools and 192 Technical and Vocational Education and Training Schools in level 3,4 and 5 (former Technical secondary schools) which are involved in school feeding program (MINEDUC, 2018), 41,290.08 metric tons of wood would be saved on average per month if all those schools would use precooked beans. This implies that 495,480.96 metric tons of wood would be saved per year. This would reduce considerably the imbalance between annual wood supply and annual wood demand, which is the main source of deforestation in the country (MINIRENA, 2017). Table 14 below shows the imbalances between demand and supply of wood in Rwanda in 2009,2010, 2016 and 2017.

Table 14: Wood demand and supply imbalances from 2009,2010,2016 and 2017

Year	**2009**	**2010**	**2016**	**2017**	**Mean**
Supply (1000 $m^{3)}$	3,388	2,539	2,182	1,772	2,470.25
Demand (1000 $m^{3)}$	4,801	5,393	5,552	5,712	5,364.5
Difference (1000 $m^{3)}$	-1,413	-2,854	-3,370	-3,940	2,894.25

Therefore, the use of precooked beans in secondary schools would reduce the average difference between annual wood demand and supply by 17.1%. This implies that since this imbalance between wood demand and supply is the major source of deforestation in the country, the reduction of this imbalance by 17.1% could contribute significantly to the reduction of deforestation. These findings are supported by Natalie *et al.* (2013) who found that high demand for wood either in the form of timber or biofuel are the major source of deforestation and consequently its reduction would have great effects on deforestation and on environment in general.

Concerning water reduction aspect, the shift from consuming dry beans to consuming precooked beans would reduce water used for cooking beans from 7800 litres to 880 litres per month in average. This is for the same school of 478 students on average, that cooks 63 kilograms of beans per meal in 7 days of the week. This is a difference of 6920 litres on average per month in one school. With about 1,335 secondary schools and 192 TVET (former technical secondary schools), in average, 10,567m^3 of water would be saved monthly and 126,804 m^3 of water would be saved annually by using precooked beans. This great amount of water that would be saved by using precooked beans in secondary schools is mainly due to the fact that precooked beans do not require water for washing them or cooking them since they are already

ready for consumption (Aseete *et al.*, 2018). This would contribute to the conservation of water resources, and thus, to the conservation of environment. Moreover, this would ease the problem of clean water shortages that has been mentioned in most of the sampled boarding secondary schools.

CHAPTER FIVE
CONCLUSION AND RECOMMENDATIONS

This section presents summary of the major findings in the study, conclusions drawn, recommendations and area for further research.

5.1. Summary and Conclusion

5.1.1. Summary

Rwanda is concerned with the problem of deforestation resulting mainly from the huge use of wood. In fact, in 2016, wood was still the main source of energy for 80% of the Rwandan population (Uwisengeyimana *et al.*, 2016), being used mainly for cooking purpose. Dry beans being the staple of Rwandan households and institutions they have been reported to contribute significantly to deforestation due to their slow-cooking nature. Thus, the main aim of this study was to promote environment friendly consumption among Rwandan institutional consumers through finding out potential economic and environmental benefits of using precooked beans. To select respondents for the study, the 6 districts of central Rwanda including the 3 districts of Kigali city and 3 districts located in its proximity were selected purposively because this is where the concept of precooked beans started. Accordingly, primary data was collected from 64 boarding secondary schools of which 62 were not using precooked beans and 2 were already using precooked beans. This implies that 96.9 percent of respondents were not using precooked beans.

In order to examine the potential economic and environmental effects of using precooked beans among boarding secondary schools, the study assessed the constraints impeding the use of precooked beans, factors affecting the willingness of schools to use precooked beans, all the costs involved in using precooked beans and all the environmental benefits. Descriptive statistics, logistic regression model and partial budget analysis were used for analysis. During analysis, different software such as SPSS, Stata and Ms Excel were used as management tools for data.

The results of analysis indicated 7 major constraints to the use of precooked beans among boarding secondary schools. The lack of sufficient information about precooked beans was the primary constraint mentioned by the majority (50%) of interviewed boarding secondary schools to hinder the use of precooked beans in schools. The second mostly mentioned constraint was unavailability of precooked beans which was reported by 33.9% of respondents,

followed by perceived high price of precooked beans which was reported by 29% of respondents. Distrust in the sustainability claims of precooked beans industry was stated by 16.1% of respondents, low nutritional value of precooked beans was reported by 9.6% of respondents whereas the inconvenient packaging of precooked beans was reported by 4.8%. The least mentioned constraint to impede the use of precooked beans among boarding secondary schools was the inadequate storage of precooked beans which was mentioned by 3.2% of respondents.

Concerning the factors influencing the willingness of schools to use precooked beans, 12 factors were analysed. Five factors such as education level of caterer, type of institution, geographical location of institution, size of institution and perceived price of precooked beans had a statistically significant influence on the willingness of schools to use precooked beans. The education level of caterer positively influenced the willingness of schools to use precooked beans at a significance level of 5% while the remaining four factors influenced the willingness of schools to use precooked beans negatively. Geographical location and type of institution were statistically significant at 1% whereas size of institution and perceived price were statistically significant at 5%. Other 7 factors namely; age of caterer, gender of caterer, working experience of caterer, age of institution, type of the market, distance to the market and perceived availability of precooked beans had no statistically significant influence on the willingness to use precooked beans.

In relation to the effects of using precooked beans among schools, dry beans consumption was more economically profitable than precooked beans. This implies that shifting from dry beans to precooked beans consumption would increase costs. The increased total costs in precooked beans consumption was mainly due to the high price of precooked beans as compared to the price of dry beans. However, concerning environmental effects of precooked beans use, precooked beans consumption would have considerable environmental benefits. This is explained by the fact that on average 495,480.96 metric tons of wood would be saved if all student-feeding schools in Rwanda were using precooked beans. This is about 17.1% of the imbalance between annual wood demand and supply in the country which would be saved.

5.1.2. Conclusion

Boarding secondary schools faced many constraints that hindered their consumption of precooked beans, but the major constraints were; lack of sufficient information on precooked beans, unavailability of precooked beans, perceived high price of precooked beans, distrust in the sustainability claims of precooked beans industry, low nutritional value of precooked beans, inconvenient packaging of precooked beans and inadequate storage of precooked beans.

The willingness of boarding secondary schools to use precooked beans was influenced by 5 factors namely; the education level of caterer, type of institution, size of institution, geographical location of institution and perceived high price of precooked beans. Among these 5 factors, only the education level of caterer had a positive influence, the other 4 had a negative influence. Therefore, precooked beans producer should consider prior factors in setting its marketing strategies.

Although the use of precooked beans in secondary schools was economically less profitable than the use of dry beans, shifting from dry beans to precooked beans consumption would save a great amount of wood fuel demanded in the country as well as a great quantity of water. Hence, the use of precooked beans in secondary schools would contribute significantly to environmental conservation.

5.2. Recommendations

There is a need for awareness of environmental degradation trend in schools, and the measures to be taken to cope up with this problem. To achieve this, government should set policies that are designed to enlighten schools about the trend in environmental degradation and its damaging effects. Government policy should likewise be set to teach schools the measures to counteract this problem, including how to conserve environment by focusing their food consumption to environmental friendly food consumption.

Further, there is need for the government and institutions involved in public feeding program to recognize the benefits of precooked beans consumption in institutions where beans are consumed in bulk, particularly the environmental benefits. This could motivate the government to subsidize precooked beans in such institutions to an affordable price. This policy may help secondary schools involved in school feeding program to enhance the rates of use of precooked beans. It may also help other institutions feeding people to consider using precooked beans as well. Thus, in addition to helping those institutions to save beans' cooking time and costs, it

would help them to solve the problem of fuel and water availability. Moreover, this may lead to easing pressure put on forests, which in turn would lead to considerable reduction of environmental degradation.

There is also a need for precooked beans producers to be more innovative in their production process in a way to reduce the production cost of precooked beans and improve the nutritious aspect of them. This would reduce the price of precooked beans to an affordable price. Hence, the rates of use of precooked beans would be enhanced either on household or institutional levels, since higher price and low nutritional value have been found to be among the major barriers to the use of precooked beans.

Moreover, precooked beans producers should ensure the optimal awareness of its products. To achieve this, precooked beans should be advertised in various mass media together with different promotions to provide sufficient information. The producers should also consider having big size of precooked beans packages to make it convenient for preparation in large institutions.

Furthermore, environmental protection and conservation entities such as government institutions and non-government organizations should also recognize the environmental benefits of precooked beans consumption, especially of institutional consumption. This may lead those institutions to financially support the precooked beans industry. In turn, the financial support could improve the capacity of the industry to produce sufficient precooked beans and the distribution of precooked beans. Further, it could ensure the sustainability of the industry in general. Thus, the threat of some institutions about the availability of precooked beans as well as the sustainability of the industry would be removed. Therefore, the rates of use of precooked beans in institutions, particularly in schools would be enhanced.

5.2.3. Areas for Further Research

The conclusions drawn in this study were based on the cross sectional data. However, some variables can change over time, hence the effects of the currently significant as well as the non-significant variables should also be checked using time series data. In addition, since this was an ex-ante study a post-ante study is also required in the future to evaluate the economic and environmental effects of precooked beans consumption after they are used in institutions. Further, as the study focused only on schools more research should be done on all institutions to see the large scale implications of precooked beans use. Moreover, research can also be

conducted with more perceived product characteristics since the current study included few of them. Research should also be done about the seasonality of dry beans prices.

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APPENDICES

APPENDIX 1: Questionnaire

Dear respondent,

This questionnaire is prepared to collect data for the study on **Ex-Ante Evaluation of Economic and Environmental Effects of Using Precooked Beans Products by Schools in Rwanda**. This study aims to provide an understanding of the constraints hindering the use of precooked beans among schools, factors influencing the willingness of schools to use precooked beans, and the economic and environmental benefits of using precooked beans. The study is being carried out by a Masters' student at Egerton University. Your most valuable contribution to the questions enclosed will be highly appreciated as this will inform policy towards reduction of fuel wood consumption. You are promised confidentiality with the information you give since it will be used only for purposes of this study.

A. GENERAL INFORMATION

1. Profile

Date	
Questionnaire No	
District	
Sector	
Cell	
Name of Decision maker	
Position	
Telephone No.	
Name of Enumerator	

B. CATERER'S CHARACTERISTICS

Age of Caterer	…….years
Gender of caterer	1= Male 0= Female
Education level of caterer	1= High School 2= Partial university 3= University
Work experience of caterer	……years

C. SOCIO-ECONOMIC FACTORS

1. When did the institution start operating?	
2. What is the type of the institution?	1= Public 0= Private
3. Where is the institution located?	1= Urban 0=Rural
4. How many students does the institution have?	……
5. What is the level of income of the institution per year? (in Rwf)	

D. INSTITUTIONAL FACTORS

1. Are beans a key meal of the institution	1= Yes, 0= No
2. What type of beans do you purchase in your organization?	1=Dry beans 2=Precooked beans
3. Who is involved in the bean procurement process?	……..
4. Are there any procurement policies dictating the process to be followed in procuring beans? If Yes, who establishes and who enforces them/	1=Yes 0= No
5. Are you aware of precooked beans?	1= Yes; 0=No If 0, skip to
6. Where did you get the information about their existence?	1= Radio 2= TV; 3= Internet 4= Producer 5= Friends and relatives 6= Other, *Specify*, ……..
7. Was this source sufficient?	1= yes 0= no If 0, skip to
8. Where did you get the information? *Encircle the right answer(s)*	1= Radio 2= TV; 3= Internet 4= Producer 5= Friends and relatives 6= Other, *Specify*, ……..
9. In which type of market do you get your purchases?	1=Spot market 2= contract market 3= Others, *Specify*, …….

10. Do you pay for reinforcing contract?	1=Yes 0=No If 0, skip to 11
11. How much do you pay for reinforcing contract? (in Rwf)	……
12. How much do you pay for loading beans after sale? (in Rwf)	……
13. How much do you pay for transporting dry beans from the market to the institution? (in Rwf)	…….....
14. How much do you pay for unloading dry beans? (in Rwf)	……
15. How much do you pay for storing dry beans in your organization? (in Rwf)	……
16. What is the distance from the institution to the market? (in Kilometers)	...…….

E. ENVIRONMENTAL FACTORS

1. Is there any government policy dictating schools' procurement of food?	1=Yes 0=No
2. If yes, does the policy apply for private schools? (only for private schools)	1=Yes 0=No
3. How much do you know about environmental effects of cooking dry beans?	…….
4. Is there any civil society which has an influence on your procurement process?	1=Yes 0=No
5. If yes, which one?	1= religious entity 2= NGO 3= Parents Association 4= Other, *Specify*……..

F. PERCEIVED CHARACTERISTICS OF PRECOOKED BEANS

On a scale of 1 to 5, please rate how much you agree with the following statements showing precooked beans perception:1= Strongly disagree, 2= Disagree, 3= Neutral, 4= Agree, 5= Strongly agree

Factor	Statement	Rate
1. Price	• I am willing to pay Rwf350 per package of precooked beans	…….
	• I am able to pay Rwf350 per package of precooked beans	…….
2. Availability	• Precooked beans are not available in local markets	…….

	• Precooked beans' market is far from the institution	……

G. WILLINGNESS TO USE PRECOOKED BEANS

1. Is the school using precooked beans?	1= Yes 0= No *If 1, skip to question 4*
2. Why is it not using them?	1. No information about precooked beans 2. Negotiating contact with new supplier is costly 3. Precooked beans are expensive 4. Precooked beans are not available 5. Precooked beans packaging is not convenient 6. No trust in precooked beans sustainability claims 7. Precooked beans are of poor quality 8. Precooked beans cooking process is complicated 9. Precooked beans are not energy efficient 10. Precooked beans are not time saving 11. Other, *specify* …….
3. Is the school willing to use precooked beans in the future?	1= Yes 0= No *If 0, skip to question 5*
4. What motivates its willingness to use precooked beans?	1. Precooked beans are cost-saving 2. Precooked beans are ease to use 3. Precooked beans are nutritious 4. Precooked beans are of good quality 5. Precooked beans are energy efficient 6. Precooked beans can solve the problem of wood fuel availability 7. Precooked beans can solve the problem of water shortages 8. Other, specify ……. *Skip to the next section*
5. Why is it not willing to use precooked beans?	1. Precooked beans are costly 2. Negotiating contact with new supplier is costly 3. Precooked beans market is far from school 4. Precooked beans are not nutritious 5. Precooked beans are of poor quality 6. Precooked beans cooking process is complex 7. Precooked beans packaging is not convenient 8. Precooked beans production is not sustainable 9. Precooked beans are not energy efficient 10. Other, *specify* …….

H. QUANTITIES AND COSTS OF DRY BEANS AND INPUTS USED FOR COOKING PER DAY

1. Dry beans	1.1.How many days of the week do you cook beans?	……
	1.2.How many times do you cook beans in a day?	……
	1.3.What is the quantity of dry beans do you cook per meal? (in Kg)	…….
	1.4.What is the unit price? (in Rwf)	……
	1.5. What is the frequency of buying dry beans?	1= daily 2= weekly 3= monthly 4= 0ther,
2. Fuel	2.1.Which type of fuel are you using to prepare dry beans?	1. Firewood 2. Charcoal 3. Gas 4. Electricity
	2.2. What is the amount of fuel do you use to prepare each meal?	……..
	2.3.What is the amount of fuel do you use to prepare dry beans per meal? (cubic meter)	……...
	2.4.What is the purchase cost per unit? (in Rwf)	……..
	2.5. How much do you pay for transport of fuel per unit? (not applicable for electricity)	…….
	2.6. How much do you pay to load fuel per unit? (not applicable for electricity)	…….
	2.7. How much do you pay to unload fuel per unit? (not applicable for electricity)	…….
3. Labour	3.1.How many people are involved in preparing beans?	……..
	3.2. How many hours do they work per day?	…….
	3.3.For how many hours do they prepare bean meal?	……..
	3.4.What is the wage of one person per month? (in Rwf)	……..
4. Water	4.1.What is the quantity of water used to wash dry beans per day? (in cubic meter)	……..
	4.2. What is the quantity of water used for cooking dry beans per day? (in cubic meter)	……..
	4.3.What is the cost per unit? (in Rwf)	…….

5. Time	5.1.How much time does it take you to sort dry beans?	…….
	5.2. How much time does it take you to clean dry beans?	…….
	5.3.How much time does it take you to cook dry beans?	…….

I. CHALLENGES INVOLVED IN COOKING DRY BEANS

1. Wood fuel	1.1.What type of wood fuel markets are available to the institution?	1= formal 2= informal 3= both
	1.2. In which type of market do you purchase wood fuel?	1= formal 2= informal 3= both
	1.3. Is wood fuel easily available in the market?	:1= Strongly disagree, 2= Disagree, 3= Neutral, 4= Agree, 5= Strongly agree
	1.4.Is wood fuel highly priced?	1= Strongly disagree, 2= Disagree, 3= Neutral, 4= Agree, 5= Strongly agree
	1.5. Is wood fuel involving high transport costs?	1= Strongly disagree, 2= Disagree, 3= Neutral, 4= Agree, 5= Strongly agree
2. Water	2.1.Is clean water available on daily basis?	1=Yes, 0=No
	2.2. If No, how many times in average in a week do you access clean water?	…….times
	2.3.Does the price of water vary according to the quantity used?	1=Yes, 0= No
	2.4.If yes, does this represent a big challenge to clean water consumption in your institution?	1= Strongly disagree, 2= Disagree, 3= Neutral, 4= Agree, 5= Strongly agree

APPENDIX 2: Production process of precooked beans

Once dry beans have been received and inspected by Farmfresh production facility in Kabuga, the production process of precooked beans takes place in the following stages:

i. Conditioning

This stage is taken to prepare dry beans as raw materials. It consists of:

- removing stones, wood and other foreign matters from beans by a de-stoning machine;
- inspecting and sorting beans manually to make sure no foreign matter is remaining in the raw materials.

ii. Washing

Since beans from the market are dusty, this stage consists of washing them twice to make sure they are clean enough for consumption. This process takes basically between 10 to 15 minutes.

iii. Soaking

In this stage, beans are soaked basically for 8 to 12 hours in plastic boxes on the counters of the factory, to allow water uptake.

iv. Filling and sealing

In this stage, soaked beans are packed in aluminium pouches. 400g of soaked beans are put in each pouch and 300g of brine solution is added in them to reach 700g net weight. Pouches are then vacuum sealed to remove the air. The vacuum machine can seal 2 pouches at a time.

v. Cooking, sterilising and cooling

In this stage, sealed pouches are put in the autoclave that cooks, sterilises and cools beans. Beans are cooked with steam for 45 minutes at a temperature from 0 to 121˚C and a pressure from 0 to 0.25Mpa. The autoclave can cook up to 180 pouches at a time. The sterilisation occurs at a temperature from 121 to 130˚C and a pressure of 0.25Mpa and it lasts basically 18 minutes. The cooling occurs at a temperature from 130 to 45˚C and a pressure of 0.25Mpa and it lasts basically 10 minutes.

APPENDIX 3: results of logistic regression of factors influencing willingness to use precooked beans

Variables	**Coef**	**Std Err**	**Z**	**P > Z**	**95% CI**	
Age of caterer	-0.207	0.165	-1.25	0.211	-0.530	0.117
Gender of caterer	-0.483	1.220	-0.40	0.692	-2.875	1.908
Education level of caterer	2.719	1.278	2.13	0.033	0.215	5.224
Working experience of caterer	0.122	0.214	0.57	0.570	-0.298	0.541
Age of institution	0.012	0.214	0.30	0.768	-0.071	0.096
Type of institution	-3.722	1.726	-2.16	0.031	-7.104	-.339
Geographical location	-4.106	2.093	-1.96	0.050	-8.208	-0.004
Size of institution	-0.010	0.005	-2.13	0.033	-0.019	-0.001
Type of market	-.0793	1.418	-0.56	0.576	-3.572	1.986
Distance to the market	-0.083	0.202	-0.41	0.680	-0.480	0.313
Price	-1.107	0.495	-2.24	0.005	-2.078	-0.137
Availability	-9.218	0.699	-0.31	0.756	-1.587	1.1152
Constant	15.083	7.148	2.11	0.035	1.073	29.094
Number of obs = 64						
LR chi2 = 61.71						
Prob > chi2 = 0.0000						
Pseudo R2 = 0.6956						
Log likelihood = -13.505						

APPENDIX 4: Descriptive statistics of Socio-economic characteristics of the Caterer

Variables	N	Minimum	Maximum	Mean	Std. Deviation
Age of Caterer	64	27	59	39.94	7.551
Work experience of caterer	64	2	24	9.61	5.898