CONSUMER ACCEPTANCE AND WILLINGNESS TO PAY FOR SHELF LIFE EXTENDED FRESH CASSAVA ROOTS IN UGANDA: CASE OF KAMPALA DISTRICT

BY

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DECLARATION

I, Kwagala Innocent, hereby declare to the best of my knowledge and understanding that the work contained in this thesis is original and has never been submitted; in part or wholly to Makerere University or any other institution of higher learning for the award of a degree. Any information from other sources is duly acknowledged.

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DEDICATION

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LIST OF ACRONYMS

CE	Choice experiment
CGAIR	Consortium of international Agricultural Research Centre
CV	Contingent valuation
CVM	Contingent valuation method
DBDC	Double bounded dichotomous choice
FAO	Food and agriculture organisation
FAOSTAT	Food and Agriculture Organisation of the United Nations Statistics
GDP	Gross domestic product
HRH	High relative humidity
IIRR	International institute of rural reconstruction
IITA	International institute of tropical agriculture
NARO	National agricultural research organisation
NPA	National planning authority
PHL	Post- harvest loss
PPD	Post-harvest physiological deterioration
SBDC	Single bounded dichotomous choice
UBOS	Uganda Bureau of statistics
UGX	Uganda shillings
US	United states
WTP	Willingness to pay

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ABSTRACT

Post-harvest losses along the fresh cassava roots value chain result in a reduction in the amount of food available for consumption and income losses to farmers and traders. New modern technologies such as waxing have proved efficient in extending the shelf life of fresh cassava roots to up to two weeks and one week under high relative humidity (HRH) storage. This study examined factors that influence different segments of consumers (supermarket and open market shoppers) willingness to pay (WTP) for fresh cassava roots with extended shelf life in Uganda. The main objective of the study was to determine factors that influence consumers' WTP for fresh cassava with extended shelf life and to determine the level of acceptance. To achieve the objective, the contingent valuation method using a probit probability function and a double-bound dichotomous choice format was used. A total of 400 respondents; 250 from eight open markets and 150 from five supermarkets were interviewed. Sensory evaluation results were mixed but taste for waxed and HRH storage fresh cassava roots was positive and significant in both consumer segments. The results showed that supermarket shoppers were WTP a premium of 60.71% for a kilogram of waxed fresh cassava roots and 28.57% for a kg of HRH storage fresh cassava roots. Comparatively, open market respondents were premiums of 21.43% for a kilogram of waxed and 17.86% for a kg of HRH storage fresh cassava roots. No factor had a significant influence on supermarket respondents WTP for fresh cassava with extended shelf life. However, for open market respondents, initial bid/price had a negative and significant ($p < 0.01$) influence on WTP for both waxed and HRH storage fresh cassava products, years of schooling had a positive and significant ($p < 0.01$) influence on WTP for waxed cassava while distance to the market had a positive and significant ($p < 0.01$) influence on WTP for HRH storage fresh cassava roots. The market potential from the double bounded dichotomous choice elicitation method among supermarket shoppers was estimated to be between US$45.8 million/year and US$ 48.7 million/year for waxed cassava and US$ 27.8 million/year and US$28.0million/year for HRH storage fresh cassava while for open market shoppers, estimated to be between US$31.2 million/year and US$24.0 million/year for waxed cassava and US $18.3million/year and US$21.8million/year for HRH storage cassava.

The results of this study provide important information about market opportunities for fresh cassava roots. The results also have policy implementation and recommendations regarding investing in technologies for extending the shelf life of fresh cassava roots.

Key words: Bivariate probit model, Shelf life, Contingent valuation, Willingness to pay

CHAPTER ONE

INTRODUCTION

1.0 Background

1.1 Significance of the Agriculture Sector in Uganda

Agriculture is the main driver of economic growth and poverty reduction in Uganda. The sector contributes at least 23.5% of the national GDP (Uganda Bureau of Statistics, 2017) and about 40% of the export earnings (Economic Policy Research Centre, 2017). The agricultural sector also employs about 36% of the total labour force compared to 12% in construction, 23% in trade and 29% in services other than trade (UBOS, 2018). Despite its significance, production and productivity of Uganda's agriculture sector remains lower than the rate targeted by the government. Over the period of 2010-2014, annual growth rate of the agricultural sector was about only 2.2%, lower than the average annual GDP growth rate of 5.2% and the average annual population growth rate of 3% and also far short of the 6% growth target for the agricultural sector set by African Governments (Ministry of Agriculture Animal Industry and Fisheries, 2016). Over the same period, there was a 6.12% increase in area planted for root crops (sweet potatoes, Irish potatoes, and cassava), while production of the same decreased by 2.3% and yields also decreased significantly to 8%.

In developing countries, post-harvest loss (PHL) is one of the major causes of low agricultural performance. Post-harvest losses result into a reduction in the amount of food available for consumption and income losses to farmers and traders. This translates into reduced food security and stifles poverty reduction efforts (Goletti & Wolff, 1999). In developing countries, food loss within the value chain causes at least a 15% reduction in income (Rockefeller, 2015). In sub-Saharan Africa, farmers lose up to 30% of their crops to post-harvest losses (Frattini, 2016). Post-harvest loss is a leading cause of food insecurity for millions of farm families.

In Uganda, cassava is one of the crops that suffer a lot of post-harvest losses and measures to reduce these losses offer an important pathway for availing more food, reducing poverty and enhancing nutrition. The Second Uganda National Development Plan (NPA, 2015) identifies post-harvest handling as a critical gap in the agricultural sector in Uganda and asserts that plugging this gap has far reaching effects on wealth and job creation in Uganda.

1.2 Significance of Cassava in Uganda

Cassava is an important food and cash crop enterprise in many agrarian economies particularly in the Sub-Saharan Africa (Abass et al., 2013; Nweke, Haggblade & Ballard, 2004; Naziri et al., 2014). Annual per capita consumption of cassava is above 80kg per capita in Africa compared to the global percapita consumption of 17kg (Aerni, 2005). About 60% of farmer households in Uganda grow cassava and at least 90% of households consume the crop in different forms (East African Agricultural Productivity Programme, 2011), which include fresh cassava tubers, dried chips, boiled fresh roots, roasted chips and flour. Cassava is also used for animal feed and raw material in manufacturing (starch) and food processing (Mbwika et al., 2001). Among root and tuber crops, cassava production in Uganda in 2016 was estimated at 2.71 million tons compared to 171,271 tons of potatoes and 1.91 million tons of sweet potatoes (UBOS, 2017). The Eastern and Northern regions are the leading producers of cassava in Uganda, accounting for 37% and 34% of national cassava production respectively (Uganda Census for Agriculture, 2010). The Western and Central regions account for 15% and 14% of national output, respectively. Cassava production in Uganda is dominated by smallholders who cultivate between 0.4 and 0.8 hectares of land (Rubaihayo & Keya, 2013).

Cassava provides above11% of the total caloric needs of the Ugandan population and is the second most important source stable food in the country after bananas (Steve & Reno, 2010). However, cassava productivity remains low and erratic in Uganda and declining from 2.81 million tons in 2012 to 2.71 million tons in 2016 (UBOS, 2017). Low productivity of cassava is attributed to several technical and economic factors including poor postharvest handling and processing techniques (Kilimo Trust, 2012); resulting into high post-harvest losses of the crop, poor quality cassava and cassava products which fetch low prices on the market (National Planning Authority, 2015).

1.3 Status of Cassava Postharvest losses in Uganda

Fresh cassava is highly perishable, presenting a serious challenge to farmers, traders and consumers of cassava in Uganda. The fresh tuber undergoes rapid postharvest physiological deterioration (PPD) within 2-3 days of harvest (Booth, 1973; Pace et al., 1989; James & Opara, 2015). Available statistics show that about 29% of cassava in Africa is lost after harvesting (FAO, 2000), which is high relative to other regions for example 10% in Latin America, 8% for the Caribbean and 2% in Thailand (Naziri et al., 2014). According to Tibagonzeka et al.,

(2018) post harvest losses in the districts of Kamuli, Apac and Nakasongola in Uganda were estimated at 17% for sweet potatoes and 19% for cassava with the highest losses recorded during storage. The study highlights the need need for adaptive studies to develop and promote post harvest reduction technologies.

1.4 Strategies to reduce Cassava post-harvest losses

Strategies for increasing the shelf life of cassava roots to a minimum of two weeks could have a substantial effect on cassava utilization and address an estimated 90% of the deterioration constraints faced along the cassava value chain (Rudi et al., 2011). Most farmers and consumers in Uganda currently use the traditional methods of reducing cassava PHL. The most common one is leaving cassava roots in the soil after maturity until roots can be harvested, processed, marketed and consumed. Many farmers leave the tubers in the field for up to three years (Kilimo Trust, 2012). The technique is however not efficient because it requires large areas of land leaving less land available for further agricultural production (Wenham, 1995; Revi, Aked & Balagopalan, 1996).

Researchers and scientists have recently generated and promoted new modern technologies such as waxing and use of polythene bags for prolonging the shelf life of cassava tubers after harvesting. For example cassava storage in polythene bags under high relative humidity is widely used in South America and extends shelf life to about 4 weeks while waxing has been used in Latin American countries such as Brazil, Colombia and Costa Rica and extends shelf life up to 2 months (Revi, Aked & Balagopalan, 1996; Aristizabal & Sánchez, 2007). These technologies offer a great opportunity for reducing PHL along the cassava value chain in Uganda.

In light of the above, the International Institute for Tropical Agriculture (IITA), in collaboration with several partners (NARO & IIRR) in Uganda, is piloting waxing and high relative humidity storage technologies for extending the shelf-life of fresh cassava through the EU-IFAD funded project ‘Extending Utilization of Roots, Tubers and Bananas and Reducing their Postharvest Losses’ implemented by the CGIAR Research Programme on Roots, Tubers and Bananas (RTB). The technologies are being piloted with pilot plants in Kyenjojo and Kabarole Districts. The pilot plants are owned by a farmers’ association and a trader respectively.

Fresh cassava root waxing involves: (i) cleaning, streaming and sorting into uniform size suitable good for food grade wax treatment; (ii) immersing the crates containing the roots in water followed by washing with soft brush until they are clean; (iii) the roots are allowed to dry in normal air temperature, so that the wax coating treatment functions better; (iv) melting the wax to boiling point and then immersing the trays with the cassava roots, for few seconds; and (v) marketing of the treated waxed-coated cassava roots.

High relative humidity storage of fresh cassava roots entails: (i) cleaning, and sorting into uniform sized roots; (ii) immersing the crates containing the roots in water followed by washing with soft brush until they are clean; (iii) the roots are allowed to dry in normal air temperature; (iv) dip roots in water and 4% bleach (Sodium hypochlorite); and (v) pack the roots in air tight polyethylene bags

1.6 Problem Statement

High PHLs remain a major cause of low yields in many major staple crop enterprises including cassava in Uganda. The International Institute of Tropical Agriculture in partnership with NARO and IIRR are piloting technologies to extend shelf life of cassava in Uganda. The technologies include waxing and use of high relative humidity. Preliminary evaluations at NARO show that technologies increase the shelf life of fresh cassava roots from 2-3 days to up to 3 weeks and 1 month for high relative humidity and waxing technologies respectively. These technologies exhibit potential benefits to farmers, traders and consumers of cassava. However, the ultimate success of shelf life extended cassava products will depend on consumers' judgement and acceptance of the products. This thesis aims to give a first insight into the potential demand for extended shelf life cassava in Uganda, in terms of consumer preferences and willingness to pay (WTP) for the product.

Whereas some studies have investigated acceptance and WTP in various other aspects of cassava products (for example; Erih et al., (2015) on consumers' willingness to pay for cassava flour inclusion in bread; Pato (2013) consumer acceptance and willingness to pay for induced quality attributes in processed cassava leaves products and Oparinde et al., (2014) on WTP for bio fortified yellow cassava), there is limited rigour literature on the consumer acceptance and WTP for cassava with extended shelf life. This study will contribute to literature in this realm by identifying factors that influence consumers WTP for shelf life extended cassava.

1.7 Objective of the study

The main objective of the study was to determine the factors that influence consumers' willingness to pay (WTP) for cassava roots with shelf life extended by waxing and high relative humidity technologies in Uganda.

1.7.1 Specific objectives

1. To understand consumers perceptions about attributes of fresh cassava roots with shelf life extended by waxing and high relative humidity storage technologies.
2. To estimate the price that consumers are willing to pay for fresh cassava roots with shelf life extended by waxing and high relative humidity storage technologies.
3. To determine the factors that influence consumers' willingness-to-pay for fresh cassava roots with shelf life extended by waxing and high relative humidity storage technologies
4. To estimate the market potential for fresh cassava roots with shelf life extended by waxing and high relative humidity storage technologies

1.7.2 Hypotheses

1. Conventional fresh cassava tastes better than shelf life extended fresh cassava roots
2. Consumers are willing to pay higher price (premium) for shelf life extended cassava roots
3. Market outlet has positive influence on consumers' WTP for cassava with extended shelf life

1.8 Significance of the research study

According to the Second National Development Plan (NDPII) 2015/16 – 2019/20 identifies investing in post-harvest handling techniques as one of the ways to maximise profits from agricultural value chains. However before investing in these technologies, there is need to understand consumer perceptions towards shelf life extended products. Results of the study will provide potential investors with quantitative data possible market potential which helps them to make informed decisions about the economic viability of the proposed new technological investment.

Breidert *et al.,* (2006) identifies knowledge about a product's willingness-to-pay on behalf of its (potential) customers as a critical factor in pricing decisions or new product development. The study will quantify the price consumers are WTP for fresh cassava with extended shelf life. This information will help companies and other fresh cassava roots value chain to pursue a pricing strategy that is suitably customized to their marketing environment and also leverage on the possibility of increasing profitability of the products offered.

The study segments consumers into supermarket and open market consumers. Data from the study will also assist in understanding both the behaviour of the different segments. Market segmentation allows businesses to focus on their consumers' behaviours and purchasing patterns (Martin, 2011). If done effectively, market segmentation allows an organization to achieve its highest return on investment. The research will expand on the body of knowledge regarding WTP and factors influencing WTP for cassava with extended shelf life.

CHAPTER TWO

LITERATURE REVIEW

Willingness to pay is defined as the maximum price a buyer is willing to pay for a given quantity of goods and services or to avoid something that is undesired. (Tanrivermis, 1998;Smith & Nagle, 2002; MarianiI & Pêgo-Fernandes, 2014). The most important issue for project designers and planners is to ensure finacial sustainability of a project which involves predicting what users will be able and willing to pay for a good or service (Wedgwood & Sansom, 2003). As a result, a significant literature has been developed around survey methods for estimating individuals' willingness-to-pay (WTP) in the absence of revealed market variation. These methods are now widely used for both developing optimal pricing strategies and also in the forecasting of responses to price changes and for modelling demand functions. This chapter explores key relevant literature on the methods for measuring WTP,and empirical studies on indviduals' WTP.

2.1 Methods for measuring willingness to pay (WTP)

At the highest level, the literature classifies the different methods for estimating WTP into revealed and stated preference methods (Breidert, 2005). Revealed preference are also refereed to as observations while preference data derived from surveys is also referred to as stated preference. According to Competition Commission (2010), willingness to pay studies have been largely based on stated preference data, mainly because revealed preference (actual choices) data are unavailable or markets do not currently exist. Therefore, this study focuses on stated preference approaches. According to Breidert (2005), surveys/state preference for estimating WTP can either be direct or indirect. In direct surveys respondents are asked to state how much they would be willing to pay for some product while for indirect surveys, some sort of rating or ranking procedure for different products is applied. Conjoint analysis is an indirect surveying method. When considering stated preference methods, the main categories are the contingent valuation methods,conjoint analysis and discrete choice experiments (Competition Commission,2010).

2.1.1 Conjoint analysis

Conjoint analysis is used to study the factors that influence consumers' product purchasing preference (Kuhfeld, 2010). According to Kuhfeld (2010), products possess attributes such as price, colour, ingredients, guarantee, environmental impact and predicted reliability. The overall preference evaluations are used to make inference of the relative contributions of the different attribute levels of the product (Breidert et al., 2006).

According to Rao (2013), the specification of the function depends upon the types of attributes chosen for the study. The attributes of a product can be divided broadly into two classes: categorical and quantitative. A nominal scale using either brand names or verbal descriptions such as high, medium or low describes a categorical attribute; where the levels of the attribute are described by words. A quantitative attribute is measured either on interval scale or ratio scale and numbers to describe the levels of such attribute. Breidert et al., (2006) argues that with conjoint analysis price is incorporated into the conjoint designs as an additional attribute in order to provide WTP estimates. This however leads to three types of problems associated with the inclusion of price attributes in conjoint experiments which include; by treating price as an attribute in a conjoint study, part-worth utilities are estimated for the presented price levels. Yet by definition price does not have a utility, rather it reflects an exchange rate between different utility scales, implying that the price of goods do not influence the goods' utility.
Additional problems associated with conjoint analysis include the occurrence of interactions between price and other attributes which are likely to occur that violate the additive-compensatory model. Also, traditional conjoint analysis does not incorporate a decision rule (Breidert et al., 2006).

2.1.2 Choice Experiments

This method involves presenting to individuals a number of scenarios or profiles each representing a commodity in terms of its underlying characteristics or attributes. Respondents are asked to evaluate the presented alternatives and to choose their preferred one (Breidert et al., 2006). When using choice experiments (CE) to value the products' price is often included as one of the attributes of each alternative so that preferences towards the other attributes can be measured in terms of dollars, that is; WTP (Morey et al., 2000). CE avoids both part-whole bias and yea-saying problems common with CMV. However CE does not always take into account all the attributes in the experimental design and it also ignores the interaction between the attributes. In comparison, CVM and CE provide different merits to the policy researcher; CVM is best suited to valuing the overall policy package or product while CE is best at valuing the individual characteristics that make up the policy or product (Hanley et al., 1998). CE is therefore not appropriate for this study since its focus is not at individual characterestics of the product.

2.1.3 Contingent Valuation Method

The contingent valuation method (CVM) method involves survey data, for which a random sample of individuals are asked to answer a questionnaire containing a hypothetical market transaction with the purpose of eliciting their WTP. From an economic point of view, WTP is the variable of interest. The type of data obtained depends on the elicitation format. This often consists of presenting the individual under survey with one or several prices that she can either accept to pay or not, thus leading to interval data on WTP (Fernandez et al., 2001). Contingent valuation is mostly used because of its ability to estimate willingness to pay for a non-market good by creating a hypothetical market for that good. Estimation method depends on how the information on WTP is elicited. There are different types of elicitation techniques in CV. These include open-ended questions, bidding games, payment cards, closed-ended single-bound dichotomous choice questions, and closed-ended double-bound dichotomous choice questions (Umberger et al., 2002).

The National Oceanic and Atmospheric Administration (NOAA) panel recommends the use of a dichotomous choice format in CV surveys (Flachaire & Hollard, 2007). Dichotomous choice contingent valuation questions have gained popularity over the last several years. This is due to their purported advantages in avoiding many of the biases known to be inherent in other formats used in the CV method. Several types of biases are minimized by adopting dichotomous choice valuation questions (Cameron & Quiggin, 1994). The closed-ended dichotomous choice techniques have become a credible approach in CV studies (Haab & McConnell, 2002). The coefficient estimates from the double-bounded model are asymptotically more efficient than those from the single-bounded model and it also yields tighter confidence interval (Hanemann et al., 1991).

Willingness to pay can be estimated either by ordered probit or by a bivariate probit model. The bivariate probit model allows for the possibility of different distributions of WTP across the initial and follow-up question while the interval data model assumes the same distribution of WTP during initial question and the follow-up question. The bivariate probit model also relaxes the restrictive assumptions of the interval data model and solves the problem of potential bias caused by these assumptions. In addition, the Probit allows for non-zero correlation, while the logistic distribution does not (Cameron & Quiggin 1994). Haab &

McConnell (2002) state that in CV analysis the design of questionnaires and survey procedure is crucial. It is worth stating the obvious: no amount of careful data handling and econometric analysis can overcome a poorly designed questionnaire. This study will therefore use CVM.

2.2 Empirical studies on consumer sensory evaluation and willingness-to-pay for agricultural products

Erih et al., (2015) investigated consumers' willingness to pay for inclusion of cassava flour in bread in Lagos State, Nigeria. The contingent valuation method was adopted to estimate both the mean willingness to pay of consumers and the factors that affect their willingness to pay and these were analysed using the bivariate probit model. The factors that influenced consumers' willingness to pay for composite cassava wheat bread were the respondent's age, gender, respondents' awareness, marital status, position in the household and the proportion of income spent on bread.

Zhang et al., (2012) studied consumers' WTP for traceable pork, milk and cooking oil, and its determinants using data from Nanjing, China with major emphasis on effects of consumer knowledge. Data used in this study was collected by a consumer survey using a single-bounded dichotomous choice contingent valuation method (CVM) to elicit WTP through dichotomous choice. Mean WTP and factors that affect WTP were obtained using binary logit model. The study revealed that Nanjing consumers are willing to pay a significant positive price premium for food traceability despite premium variations across products. It further revealed that consumers' WTP for food traceability was positively affected by consumer knowledge about food traceability and awareness of food quality and safety-related certifications.

Peters, Nwankwo, &Bokelmann (2013) investigated consumers' responsiveness to an increase in prices of the indigenous chicken products and how much they are willing to pay for them in the market in Kenya. Results from the study revealed that consumers were willing to pay 23.26% per kg more for indigenous chicken meat and 41.53% for eggs. Socioeconomic factors like age, income, education and family size significantly determined consumers' willingness to pay. Other important factors included the indigenous chicken meat substitutes' prices, attributes like taste/flavour and the product's form on purchase. The yolk colour and size of eggs determined the consumers' willingness to pay. Preference for indigenous chicken products were found to be high. In a related study by Michel, Anders, & Wismer (2011) on chicken consumers in Edmonton to assess the importance of the chicken part, production method, processing method, storage method, the presence of added flavor, and cooking method on consumer preferences for different value-added chicken product attributes. Results showed that half of all participants on average were WTP 30% more for a value-added chicken product over the price of a conventional product. Overall, young consumers, individuals who shopped at farmers' markets and those who prefered free-range or organic products were more likely to pay a premium for value-added chicken products. As expected, consumers' WTP was affected negatively by product price. Furthermore, according to the study by Balogh *et al.,* (2016) on consumer preferences for an archetypal traditional food product, results indicated that traditional food products can command a substantial premium, albeit contingent on effective quality certification, authentic product composition and effective choice of retail outlet.

Cerda *et al.,* (2012) investigated consumer preferences and willingness to pay for organic agricultural products in Chile. The study applied contingent valuation method using a logistic probability function and a single-bound dichotomous choice format to assess consumer willingness to pay for organic apples and to determine the main attributes that consumers look for when purchasing apples. The study revealed that consumers were willingness to pay an additional 130 Chilean Pesos per kilogram for organic apples and had greater preference for apples produced organically than by conventional methods. Owusu and Anifori (2013) analysed the determinants of consumer willingness to pay a premium for organic water melon and lettuce using a bivariate Tobit model. Their findings showed that in addition to socioeconomic characteristics, product freshness and cleanness had positive effects on consumer willingness to pay a premium for organic watermelon compared to conventional watermelon. Whereas product size exhibited negative influence on consumer willingness to pay premium for organic lettuce, less insect damage to vegetables increased WTP. Muhammad *et al.,* (2015) studied consumers' willingness to pay for organic food in UAE. A regression model was used to identify the major determinants of consumers WTP. The results showed that majority of consumers were willing to pay more for the organic food products. The age, nationality, education, household size and income were deciding factors for consumers willing to pay higher price for organic food.

According to the study by Carpio & Isengildina-Massa (2008) to evaluate South Carolina consumers' willingness to pay for locally grown products using contingent valuation with double bounded elicitation approach. Results indicated that consumers were willing to pay an average premium of 27% for local produce and 23% for local animal products. It also revealed that South Carolina producers can add value to their locally grown products by labeling and identifying them.

2.3 Conceptual framework.

Based on theories reviewed from the literatures on willingness to pay, an idea on consumer's acceptance and willingness to pay for fresh cassava with extended shelf life can be conceptualised. Consumer's decision whether to buy a product or not is directly influenced by; socio-economic factors, attitude or intention, purchase behaviour, product characteristics, knowledge and awareness.

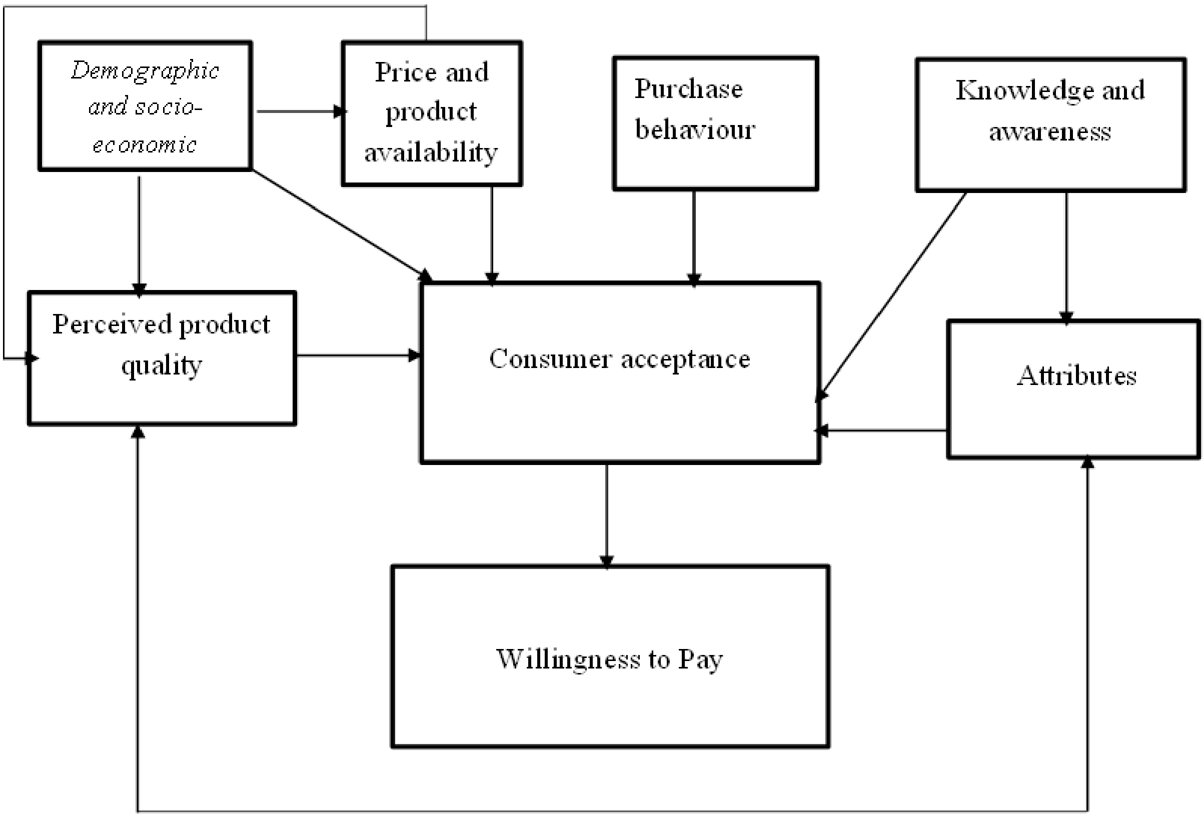

Figure 1: Framework Reflecting Consumer's WTP for food products (Adopted from Aryal *et.al*, (2009) and Bonti-Ankomah & Yiridoe (2006))

Consumer theory is mainly concerned with how a rational consumer makes consumption decisions. The consumer's choice sets are assumed to be defined by certain prices and the consumer's income or wealth. In this case a consumer chooses a vector of goods $x = (x_1 \ldots\ldots x_n$ to maximize their utility subject to a budget constraint that says she cannot spend more than her total wealth (w) $\max u(x) s.t. p.x \geq w$ (Levin & Milgrom, 2004).

In general WTP is the amount of income or money that makes the respondent indifferent between the status quo (the existing situations) and proposed contingent valuation scenario (Haab & McConnell., 2002). Hanemann (1984) recommends deriving WTP from the indirect utility function. The indirect utility function of respondent j is formulated as follows:

$V_{ij} = V\left(Y_{j,} Q_{j,} M, P\right)$Where, $V(.)$ is the indirect utility function, $Y_{j,}$ is the respondents' income, $Q_{j,}$ is the product, M is the covariates or characteristics of consumer that might affect his or her WTP and P is an exogenous price. For the status quo, original product $i = 0$, the indirect utility function of the consumer is given by $V^{oj} = V\left(Y^j, Q^0, M, P\right)$. If the consumer is willing to pay some money C $(C^j > 0)$ for the new product, the indirect utility function of the individual consumer is given by $V^{1j} = V\ (Y^j - C^j, Q^1, M, P)$. The compensation variation is given by a mathematical equation below:

$V\left(Y^j, Q^0, M, P\right)$ - $V\ (Y^j - C^j, Q^1, M, P)$. Where $V(.)$ the indirect utility function, Y is the income of the consumer, Q^0 is the level in the original status of the product, and Q^1 is the improved state of product. $Q^1 > Q^0$. And M is the covariate of the consumer behaviour that might affect their WTP and P is a vector of exogenous prices and C is the compensation variation; that is the WTP bid of the consumer.

CHAPTER THREE

METHODOLOGY

This chapter describes the methods and materials that were employed in the study. The first part presents a description of the study area, sample size and sampling techniques. The second part describes taste sample preparation, bid design and preliminary survey. The third part comprises of the data and data collection process. Lastly a presentation of a review of the analytical methods and the underlying economic theory.

3.1 Study area

The study was conducted in Kampala city of Uganda. Kampala is bordered by Mukono district in the East and Wakiso district in the South, North and West. The study sample included consumers who shop from open markets and supermarkets in Kampala. The district was selected for this study because of its high population and also being the main destination market for most of the fresh cassava in Uganda. According to the provisional results of the 2014 national census, the district has an estimated population of 1,516,210 (UBOS, 2014). The World Bank (2015) report also asserts that Kampala is among cities with high population growth rates and if current patterns of growth continue, it will become a mega-city with a population of more than 10 million people within the next 20 years. It was therefore important to understand consumers WTP and potential demand of fresh cassava with extended shelf life.

3.1.2 Sample size and Sampling

Given that Kampala has a population of 1,516,210 (UBOS, 2014), the sample size was estimated from the specification (Israel, 1992) below.

$$n = \frac{N}{[1 + N(e^2)]} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. (1)$$

$n =$ sample size to be estimated, $N =$ population size and e is the margin error

$$n = \frac{1516210}{[1 + 1516210(0.05)^{2}} = 399.89$$

This figure was rounded to 400 respondents.

The study used a two stage sampling technique. In the first stage, main open markets and supermarkets were purposively selected. In the second stage, respondents from each category were sampled systematically (for every 5^{th} respondent) from both open markets and supermarkets.

For consumers that shop from open market, eight local markets in Kampala (Nakawa, Nakasero, Kasubbi, Busega, Owino, Kalerwe, Kawempe and Bugolobi) were selected. The selection of open markets and supermarkets was purposive basing on size[1] and location[2]. Thirty two respondents were systematically selected from each open market. A total of 256 respondents were interviewed but 250 were considered for this study. For consumers that shop from supermarkets, five local supermarkets were selected (Nakumatt - Bugolobi, Mega standard - Central town, Tuskeys - Bwaise, Kenjoy - Entebbe road and Quality supermarket – Nalya) were selected. Thirty respondents were systematically selected from each supermarket totalling up to 150 respondents.

3.1.3 Taste sample preparation and sensory evaluation

Fresh cassava was harvested and treated for both shelf life extending technologies; waxing and high relative humidity (HRH) storage at Kawanda Agricultural Research Institute. But before fresh cassava roots were harvested for shelf life extension treatment, they would first be pruned seven days before harvesting. Pruning treatment (all leaves and stems are cut away except for about 30-cm-high stems and the stems and roots are left for 2 weeks or more before harvest delays occurrence of PPD (Tanaka, et al., 1984).

Each of the samples of waxed, HRH storage and fresh cassava were prepared, packaged in aluminium foil and transported in cooler boxes. To eliminate bias resulting from differences in varieties, one variety[3] would be used to prepare all the three test samples. Both waxed and HRH storage samples of cassava would be prepared three days after treatment when PPD starts to set in if they were not treated while fresh cassava would be prepared before three days to make sure that PPD has not started affecting tubers. The three samples were then coded (702 686 and 973) to eliminate bias from respondents. According to Mason & Nottingham (2002) a three-digit code, chosen at random should assigned to each product and used to identify the

[1] Priority was given to bigger and larger open markets and supermarkets

[2] With regard to location, markets on major roads leading into and out of Kampala were selected including those in the city centre

[3] The varieties used in the study are NAROCAS1 and Nyaraboke

product sample to the panellist. Use of the alphabet or single or double digit numbers as codes is discouraged, because some letters and numbers can have special meaning to panellists

Respondents were sat down in an isolated tasting booth/tent and were asked to evaluate the different cassava samples in terms of the colour, aroma, taste, flavour, appearance and mouth feel. After taste for every attribute, respondents rinsed their mouth with bottled water to avoid bias or confusing the attributes.

3.2 Bid design and preliminary survey

An important issue in the implementation of the CV survey and especially the DBDC is the choice of initial and follow up bid vectors (Cameron & Quiggin, 1994). To obtain a preliminary guess about the WTP distribution, a pilot study with open-ended questions that directly asked the individuals the maximum amount they are willing to pay for fresh cassava roots with extended shelf life was conducted. A total of 30 respondents from 3 open markets and 15 from 2 supermarkets were interviewed. Apart from providing information about the distribution of WTP, the pilot study results also gave an indication about the covariates that significantly affect WTP and helped to validate the survey questionnaire. To fit the observed data points to an underlying probability distribution, a non-parametric kernel density estimation was used.

For observations greater than 7,500 UGX the bid values are associated with a probability density value that is close to zero. In view of this, three starting bids of 1500, 3000 and 6000 UGX were randomly allotted to 150 supermarket respondents and 250 open market respondents as initial bid values for the double bounded dichotomous choice format and distributed proportionally to the formal survey questionnaire. If the respondent agreed to pay the offered bid, the follow up bid was doubled and in case of a no response, the respondent was offered a bid that was half of its initial value. For instance, when offered a bid of UGX 1500, a follow up bid of UGX 3000 was offered if the response was yes and in case of a no response a bid offer of UGX 750 was given to the respondent. Thus, the range of bid vectors in the follow up were; UGX 750, UGX 1500, UGX 3000, UGX 6000 and UGX 12000, spanned the relevant left tail of the kernel density where most of the observations were concentrated

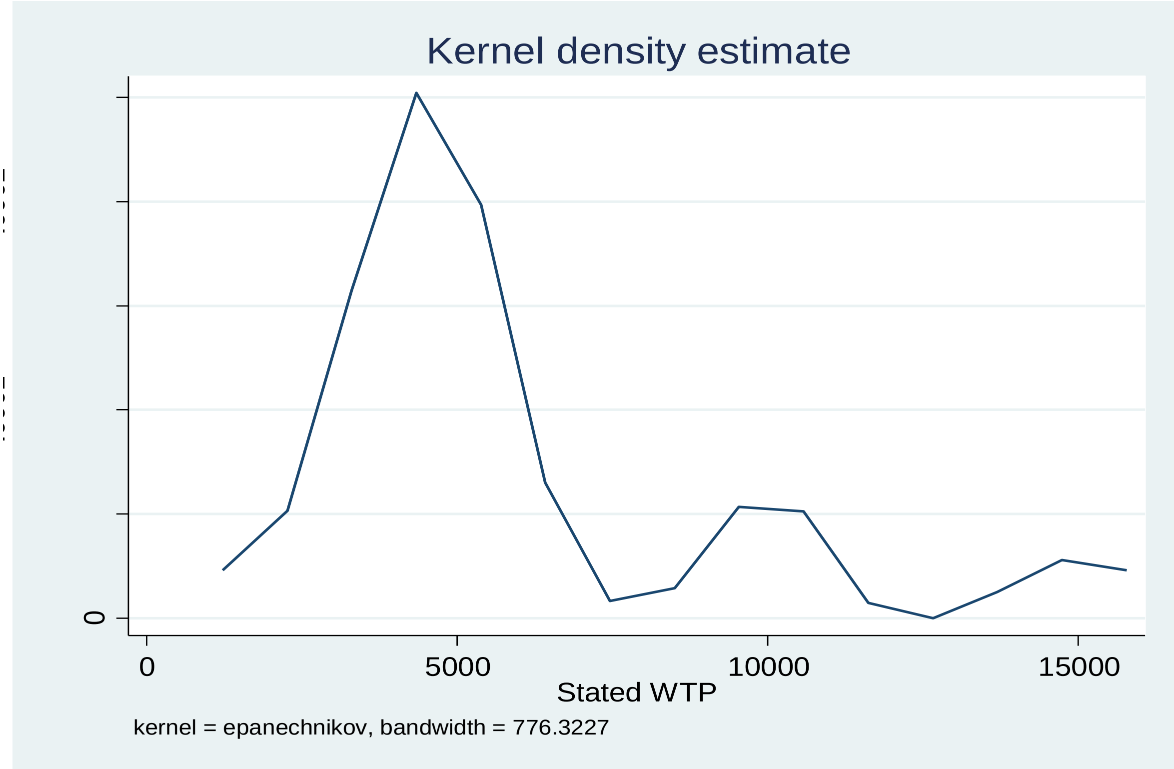

Figure 2: Kernel Density Estimates of Stated WTP from the Pilot Study

Also from the pilot survey, it was observed that most cassava is sold in heaps averaging around 3kg sold at about UGX 3,000. To replicate this in the main survey, heaps of untreated fresh cassava, waxed and high relative humidity storage samples were weighed and 3kg of each presented to consumers while eliciting their willingness to pay.

3.3 Data and data collection

A cross- sectional survey was carried out using a pre-tested questionnaire. Five trained research enumerators were used in data collection and one research supervisor was in charge of supervision to help in quality control and assurance. Data on consumer's socioeconomic attributes, preferences and WTP and factors that influenced their WTP was collected through face-to-face interviews. The NOAA Panel on Contingent valuation recommends use of face to face interviews (Arrow, et al., 1993).

3.4 Analytical Methods

Data on different segments of consumers' socio economic characteristics, WTP prices and factors that affect WTP was summarized, coded, and descriptive statistics (Cross tabulations, frequencies, means, standard deviations, and t-tests) were generated using STATA, SPSS and MS excel.

3.4.1 Identifying consumers' perceptions about the attributes of shelf life extended fresh cassava roots

Attributes which included colour, aroma, taste, flavour, mouth feel and appearance were evaluated. Three experimental samples (waxed cassava, HRH storage cassava and conventional/normal fresh cassava roots) were steamed, packed and coded to eliminate name bias before being presented to respondents. Evaluation of the attributes was be based on a nine-point hedonic scale (1 = Dislike extremely, 2 = Dislike very much, 3 = Dislike moderately, 4 = Dislike slightly, 5 = Neither like nor dislike, 6 = Like slightly, 7 = Like moderately, 8 = Like very much, 9 = Like extremely). Data on fresh cassava roots attributes' was obtained from the rank values assigned. Frequencies and unpaired t-test comparisons were used to establish the level of significance.

Table 1: Fresh cassava attributes and the corresponding weights

Attribute	**Measurement**
Colour	1 = Dislike extremely, 2 = Dislike very much, 3 = Dislike moderately, 4 = Dislike slightly, 5 = Neither like nor dislike, 6 = Like slightly, 7 = Like moderately, 8 = Like very much, 9 = Like extremely
Taste	1 = Dislike extremely, 2 = Dislike very much, 3 = Dislike moderately, 4 = Dislike slightly, 5 = Neither like nor dislike, 6 = Like slightly, 7 = Like moderately, 8 = Like very much, 9 = Like extremely
Aroma	1 = Dislike extremely, 2 = Dislike very much, 3 = Dislike moderately, 4 = Dislike slightly, 5 = Neither like nor dislike, 6 = Like slightly, 7 = Like moderately, 8 = Like very much, 9 = Like extremely
Flavour	1 = Dislike extremely, 2 = Dislike very much, 3 = Dislike moderately, 4 = Dislike slightly, 5 = Neither like nor dislike, 6 = Like slightly, 7 = Like moderately, 8 = Like very much, 9 = Like extremely
Mouth feel	1 = Dislike extremely, 2 = Dislike very much, 3 = Dislike moderately, 4 = Dislike slightly, 5 = Neither like nor dislike, 6 = Like slightly, 7 = Like moderately, 8 = Like very much, 9 = Like extremely
Appearance	1 = Dislike extremely, 2 = Dislike very much, 3 = Dislike moderately, 4 = Dislike slightly, 5 = Neither like nor dislike, 6 = Like slightly, 7 = Like moderately, 8 = Like very much, 9 = Like extremely

3.4.2 Estimation of Mean Willingness-to-Pay

The estimation of WTP was done using CVM. To obtain WTP estimates that are more cogent with the recent CV studies (Calia & Strazzera, 1998), the Double Bounded Dichotomous Choice (DBDC) approach was used. Here, respondents were presented with a “follow up” question in addition to the “yes-no” options of the Single Bounded Dichotomous Choice (SBDC). According to Haab and McConnell (2002), DBDC questions expand the information base of the WTP estimates and provide more efficient assessment than SBDC due to a number of reasons; (1) the number of responses is increased so that a given function is fitted with more data points, (2) the sequential bid offers for yes-no and no-yes responses yields clear bounds on WTP and for the no-no and yes-yes combinations. Efficiency gain comes from the fact that they truncate the distributions where the respondent’s WTP are likely to reside (Haab & McConnell., 2002).

Let’s assume that "P^0" was the pre-specified initial bid offered,"P^1" was a bid value less than the pre-specified initial bid ($P^1<P^0$) and "P^2 " was a bid value higher than a pre-specified initial bid ($P^2>P^0$). The double bounded dichotomous format question starts with the pre-specified initial bid "P^0". The lower level "P^1" and the higher level "P^2" depend on the response obtained from the pre-specified initial bid. That means the respondent consumer who answered “yes” for the pre-specified initial bid, he or she received a higher bid "P^2"; for the consumer who answered “no” for the pre-specified initial bid, he or she received a lower bid value"P^1". Finally, we had “yes-yes”, “no-yes”, “no-no”, and “yes-no” categories of outcomes. According to Haab and McConnell (2002), the bounds on WTP are:

$P^0 \leq WTP \geq P^2$ For yes-yes response

$P^0 \leq WTP < P^2$ For yes-no response

$P^0 > WTP \leq P^1$ For no, yes response

$P^0 > WTP < P^1$ For no, no response

The most general empirical or econometric model for the double-bounded data comes from the formulation (Haab & McConnell, 2002).

$$WTP_{ij} = \mu_{ij} + \varepsilon_{ij} \quad (2)$$

Where WTP_{ij} denotes the ith respondent’s willingness to pay, and j = 1, 2 represents the first and second respondent’s answers; μ_1 and $\mu_2$are the mean for the first and second responses; ε_{ij} unobservable random component.

Based on Haab and McConnell (2002) the probability of observing each of the possible two bid response sequences (yes-no, yes-yes, no-yes, no-no) that respondent i answers the first and second bid can be represented as follows.

Pr (yes,yes) $= \Pr\left(WTP_{1i} \geq P^0, WTP_{2i} \geq P^2\right) = \Pr\left(\mu_1 + \varepsilon_{1i} \geq P^0, \mu_2 + \varepsilon_{2i} \geq P^2\right) \ldots \ldots (3)$

Pr (yes,no) $=\Pr\left(WTP_{1i} \geq P^0, WTP_{2i} < P^2\right) = \Pr\left(\mu_1 + \varepsilon_{1i} \geq P^0, \mu_2 + \varepsilon_{2i} < P^2\right) \ldots \ldots (4)$

Pr (no,yes) $= \Pr\left(WTP_{1i} < P^0, WTP_{2i} \geq P^1\right) = \Pr\left(\mu_1 + \varepsilon_{1i} < P^0, \mu_2 + \varepsilon_{2i} \geq P^1\right) \ldots \ldots (5)$

Pr (no,no) $= \Pr\left(WTP_{1i} < P^0, WTP_{2i} < P^1\right) = \Pr\left(\mu_1 + å_{1i} < P^0, \mu_2 + \varepsilon_{2i} < P^1\right) \ldots \ldots (6)$

If errors were assumed to be normally distributed with mean 0 and respective variances of σ_1^1 and σ_2^2, then WTP_{1i} and WTP_{2i} have a bivariate normal distribution with mean μ_1 and μ_2, variances σ_1^1 and σ_2^2 and correlation coefficient ρ, the model is called the bivariate model. Given the binary choice responses to each WTP question, the normally distributed model is called bivariate probit model (Haab & McConnell, 2002).

The bivariate discrete probit model estimated correlation coefficient of the error term are assumed to follow the normal distribution with a normal distinguishable from zero, the system of equation could be estimated as Seemingly Unrelated Bivariate Probit Regression model (SUBPRM) that takes into account independent Probit (Cameron & Quiggin, 1994). Therefore, for this study SUBPRM was used to estimate the mean WTP of the respondent's from the double bounded format.

According to Greene (2003), the general specification for a two-equation model would be;

$Y_1^* = X_1\beta_1 + \varepsilon_1 \ldots \ldots \ldots (7)$

$Y_2^* = X_2\beta_2 + \varepsilon_1 \ldots \ldots \ldots (8)$

$E[\varepsilon_1|X_1X_2] = E[\varepsilon_2|X_1X_2] = 0 \ldots \ldots \ldots (9)$

$Var[\varepsilon_1|X_1X_2] = Var[\varepsilon_2|X_1X_2] = 1 \ldots \ldots \ldots (10)$

$Var[\varepsilon_1|X_1X_2] = \rho \ldots \ldots \ldots (11)$

Where, Y_1^* = i^{th} respondent unobservable true WTP at the time of the first bid offered.

$WTP = 1 \; if \; Y_1^* \geq X_1 or \; 0 \; otherwise$

$Y_2^* = i^{th}$ respondent's point estimate at the time of the second bids offered;

$WTP = 1 \; if \; Y_2^* \geq X_2 or \; 0 \; otherwise$

X_1 and X_2 were the first and second bids offered to the sample respondents; and ε_1 and ε_2 are error terms for the first and second equation; β_1 and β_2 are coefficients of the initial and second bid.

Empirically this was determined as follows;

$$Y_1^* = \beta_0 + \beta_1 initailbid + \varepsilon_1 \dots \dots (12)$$

$$Y_2^* = \beta_0 + \beta_2 secondbid + \varepsilon_1 \dots \dots (13)$$

After running the regression of the dependent variable WTP on the constant and the bid values, the mean WTP from the bivariate Probit model was calculated using the formula specified by Haab and McConnell (2002) as follows:

$$WTP = -\frac{\alpha}{\beta} \dots \dots (14)$$

Where α denoted the coefficient for the constant term or the intercept of the model and β was the slope coefficient of bid values that was offered to the respondents.

3.4.3 Empirical factors that influence consumer WTP

In this study, the aim was to determine socioeconomic and demographic factors affecting the decision of the consumer to purchase shelf life extended or conventional fresh cassava. The yes/no responses by respondents are used to fit binary response models. When the dependent variable in a regression model is binary (0, 1), the analysis could be conducted using either linear probability model, Logit, or Probit model (Greene, 2002). Linear probability model cannot be used because it may generate predicted values less than 0 or greater than 1, which violates the basic principles of probability and the coefficient of determination (R2) is likely to be much lower than one (Greene, 2002; Gujarati, 2004). For this reason, it is questionable to use R2 as a measure of model fitness. This provides the means for estimating the probability of WTP using a Logit or Probit model, depending on the assumption on the distribution of the error term (ε) and computational convenience.

Therefore, probit model was used to identify the factors that affect WTP.The probit model takes the following form (Cameron and Quiggin, 1994).

$$Y_i^* = \beta_0 + \beta' X_i + \varepsilon_i \dots \dots (15)$$

$$Y_i = 1 \; if \; Y_i^* \geq P_i or Y_i = 0 \; if \; Y_i^* < P_i$$

Where:β is a vector of unknown parameters of the model, X_i is a vector of explanatory variables (total income, age, education level, family size, gender, awareness of shelf life extended cassava, marital status, access to credit, perception of respondents towards shelf life extended cassava, and initial bid), Y_i^* = Unobservable consumers' actual WTP for cassava with extended shelf life. Y_i = Discrete response of the respondents for the WTP, P_i= offered initial bid assigned arbitrarily to the i^th^ respondent random component and ε = error term N (0,σ).

Empirically factors affecting WTP were estimated as follows;

$$Y_i^* = \beta_0 + \beta_1 X_1 \dots \dots + \beta_n X_n + \varepsilon_i \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots .. (16)$$

Where;

Y_i^*= Unobservable consumer WTP for fresh cassava with extended shelf life

β_0= constant

$\beta_1 - \beta_n$= vector of coefficients

$X_1 - X_n$= vector of explanatory variables

P_i = offered initial bids assigned arbitrary to the i[th] respondent

ε_i = Unobservable random component.

Table 2: Showing Variables hypothesized to affect consumers' WTP for shelf life extended fresh cassava roots

Variable	Description	Apriori signs
X_1	Income (Monthly income of the household)	+
X_2	Age (Number of years of the respondent)	+/-
X_3	Education (Number of years spent in school)	+
X_4	Family size (Number of member in the household)	-
X_5	Gender (1=Male,0= otherwise)	-
X_6	Marital status(1= married,0 = otherwise)	+
X_7	Access to credit (1=acess,0= otherwise)	+
X_8	Awareness (1= aware,0= not ware)	+
X_9	Initial bid (price of fresh cassava)	-
X_{10}	Market outlet (1=open market,0 =otherwise)	+
X_{11}	Size of the root (1=small,0= otherwise)	+/-
X_{12}	Frequency of purchase (1=daily,0= otherwise)	+/-
X_{13}	Frequency of purchase (1=weekly,0= otherwise)	+/-
X_{14}	Frequency of purchase (1= weekly,0= otherwise)	+/-
X_{15}	Quantity bought (1=1-3 heaps,0=otherwise)	-
X_{16}	Rank of cassava ((1= primary,0 otherwise)	+

Respondents' monthly income was hypothesized to have a positive influence on consumer WTP. Increase in income increase the amount of disposable income leading to increase in the quantity purchase. Various previous studies have shown that income has a positive influence on consumer WTP (Muhammad *et al.,* 2015; Cerda *et al.,* 2012; Zhang *et al.,* 2012). Age was expected to have a positive influence on WTP. Since Uganda has a large proportion of the population being young who are either unemployed or working in the low paid jobs, they find it hard to afford purchasing basic commodities compared to older population which most likely has high income, education and more resources. Also a studies by Muhammad *et al.,* (2015); Carpio & Isengildina-Massa (2008) found positive relationship between age and WTP. Previous studies have shown positive influence of education on consumer WTP (Muhammad *et al.,* 2015; Shen, 2012). Goktolga & Esengun (2009) in their study revealed a negative relationship between household size and consumer WTP. As the family size increases, household expenditure also increases and little attention is paid to buying more quantities of food in the household. This study therefore hypothesized household size as having negative effect on consumer WTP. Being male is expected to have negative influence on WTP due to the fact that most of household consumption decisions are made by females. Study by (Liu & Chen, 2015) revealed that being male had a negative influence on consumer WTP. Being maried means an increase in the number of people in the household thus requring more food. Therefore being married is hypothesized to increase WTP as revealed in the study by Haghjou *et al.,* (2013) were married consumers had a positive willingness to pay for organic food products.

Access to credit is hypothesized to have positive influence on consumer WTP. However it's not clear whether this credit is used for consumption or investment. Zhang *et al.,* (2012) revealed significant positive influence between product information and consumer WTP. Product awareness is expected to have positive influence on consumer WTP as it provides more information on the benefits of the product in question. Consistent with most WTP consumer studies (Utoni, 2016; Liu & Chen, 2015), price or intial bid was hypothesized to have a negative influence on WTP in a sense that as price increases, quantity purchased decreases. Purchasing from open market is hypothesized to have positive influence on WTP. However it's also hypothesized to have negative influence on WTP for supermarket shoppers. Liu & Chen (2015) in their study on consumer willingness to pay for traceable food revealed a positive and significant influence of purchasing from market on consumer WTP.

Size fresh cassava roots was hypothesized to have negative effect on WTP. Large and big sized roots are bulky and difficult to transport compared to small root sizes. Study by Owusu and Anifori (2013) on the determinants of consumer willingness to pay a premium for organic water melon and lettuce revealed a negative and significant relationship between size and consumer WTP. Angulo, Gil, & Tamburo (2008) in their study on consumer WTP for labelled,revealed a negative and significant effect of purchasing frequency on WTP. However Amato *et al.,* (2017) investigated consumers' perception and willingness to pay for "Non-Added Sulphite" wines through experimental auctions and revealed a positive relationship between purchasing frequency and WTP. Frequency of purchase is therefore hypothesized to have either positve or negative influence on consumer WTP. With regard to the rank of cassava or cassava being the main/primary source of food, its hypothesized to have a positive effect on WTP.

3.4.4 Estimating market potential of fresh cassava with extended shelf life

Estimating market potential is a very important in determining whether the market is large enough to support the new technology (Wolfe, 2006). Once the estimated market potential has been calculated, it is then possible to determine if the market is large enough to sustain the proposed business or sustain an additional competitor in the marketplace. The estimated market potential sets an upper boundary on the market size and can be expressed in either units and/or sales. However, to have a valid analysis of aggregation of benefits, the different biases of the sample design during contingent valuation study have to be minimized, and protest zero responses should be excluded from the data (Mitchell & Carson, 1989). Hence, attention was paid to minimize all the biases in this study that is; an appropriate sampling technique to select sample respondents was used in addition to the questionnaire being administered through a face-to-face interview that helped to get a high-response rate. Based on the NOAA panel guide following (NOAA, 1993), protests zero respondents are excluded from the aggregation.

According to Wolfe (2006), market potential for a business requires specific information on the number of people or potential buyers, an average selling price, and an estimate of consumption or usage for a specific period of time. Once this information has been collected, the following formula can be applied to estimate the market potential.

Estimated market Potential $(MP) = N * P * Q \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots .. (17)$

Where; MP = market potential, N = number of possible buyers, P = average selling price and Q = average annual consumption.

CHAPTER FOUR

RESULTS AND DISCUSSION

This section consists of five parts and presents results from descriptive and econometric data analyses. The first part -includes statistics of all the variables of interest. The second part discusses findings of sensory evaluation. The third part estimates the amount different segments of consumers are willing to pay for the different shelf life extended products of fresh cassava. The fourth part presents econometric results of the factors influencing consumers' WTP for the shelf life extended fresh cassava products. The fifth part estimated the market potential of the new products of fresh cassava roots with extended shelf life.

4.1 Socio-economic characteristics of surveyed consumers

The results indicate that consumers in the two market categories are comparable in some attributes except for age, marital status, household size, education level and years of schooling, distance to market, and rank of cassava in the household, daily purchase of cassava and preferred root size (Table 3).

Results revealed that most consumers in open markets were married and were generally older than consumers who purchase from supermarkets. The low concentration of younger consumers in open market could be due to the fact that most supermarket consumers are not married with smaller household sizes resulting in less demand for food. This implies that their food demands can be meet by purchasing food items from supermarkets at relatively higher prices. The older and married open market consumers have large household sizes, and their food demands can be met by purchasing from open market where food is sold at relatively lower prices. With regards to education, most of supermarket consumers (99%) had attained formal education compared to 94% from open markets. Similarly, supermarket consumers had spent more years in school than open market consumers (Table 3). Consumers' level of education affects the way purchasing decisions are made. Open market consumers travel more distance to reach the market compared to supermarket consumers. This could be attributed to high concentration of mini supermarkets or grocery stores in the study area. Majority of open market consumers ranked cassava as their primary source of food and made daily cassava purchases more often than supermarket respondents. This could be a result of high household sizes and low monthly household incomes. For supermarket consumers, cassava was not ranked as a primary source of food in the household resulting in less daily purchases probably because fresh cassava is not available in most supermarkets in Uganda. Our results also revealed that supermarket consumers prefer small root sizes than open market consumers because small sized roots are portable and easy to transport.

Table 3: Mean of respondents socio-economic characteristics

Respondent characteristics	Open market(n=250)	Supermarket (n=150)	t-statistic
Male (1=male,0= female)	0.61 (0.49)	0.57 (0.50)	0.81
Age (years)	35.72 (10.77)	31.13 (7.27)	4.63***
Marital status (1= married,0= other)	0.68 (0.47)	0.56 (0.50)	1.96**
Household size	4.58 (2.68)	3.75 (2.42)	3.11***
Education level (1=formal,0=non-formal)	0.94 (0.23)	0.99 (0.82)	-2.53***
Years of schooling (years)	9.45 (3.92)	13.77 (3.40)	-11.21***
Occupation (1=employed,0=otherwise)	0.97 (0.17)	0.95 (0.21)	0.98
Distance to the market/supermarket (km)	3.25 (3.67)	1.63 (1.18)	5.23***
Monthly income (UGX)	465000.0 (622888.50)	479152.50 (406764.20)	-0.25
Rank of cassava in HH (1= primary,0 otherwise)	0.40 (0.49)	0.13 (0.34)	5.94***
Credit access (1=acess,0=otherwise)	0.67 (1.33)	0.79 (0.41)	-1.03
Currently buy cassava (1=open market,0 =otherwise	0.90 (0.31)	0.85 (0.36)	1.27
Frequency of purchase (1=daily,0=otherwise)	0.16 (0.37)	0.10 (0.30)	1.79*
frequency of purchase (1=weekly,0= otherwise)	0.68 (0.45)	0.72 (0.45)	-0.84
Frequency of purchase (1=monthy,0=otherwise)	0.15 (0.36)	0.15 (0.36)	-0.04
Quantity purchased (1=1-3 heaps,0=otherwise)	0.95 (0.21)	0.97 (0.16)	-1.05
Preferred root size (1=small,0= otherwise)	0.23 (0.42)	0.36 (0.48)	-2.88***
waxed cassava awareness (1= aware,0=0therwise)	0.03 (0.18)	0.04 (0.20)	-0.42
HRH cassava awareness (1= aware,0=0therwise)	0.02 (0.15)	0.04 (0.20)	-0.91

Source: Survey July-October 2016, ***, **,* significant at 1%, 5% and 10%, respectively. Numbers in parenthesis are standard deviation of the mean

4.2.1 Consumer awareness of shelf life extended fresh cassava

Results of the study showed that only 4% of supermarket consumers were aware of shelf life extended cassava products, whilst 3% and 2% of open market consumers were aware of waxed and HRH storage fresh cassava products, respectively. Consumers' awareness about a given product improves their loyalty towards a product. This has been indicated in previous studies where significant positive relationships between awareness and product loyalty are needed in order to implment effective product awareness to enhance consumers' product loyalty to the company's products (Dhurup et al., 2014).

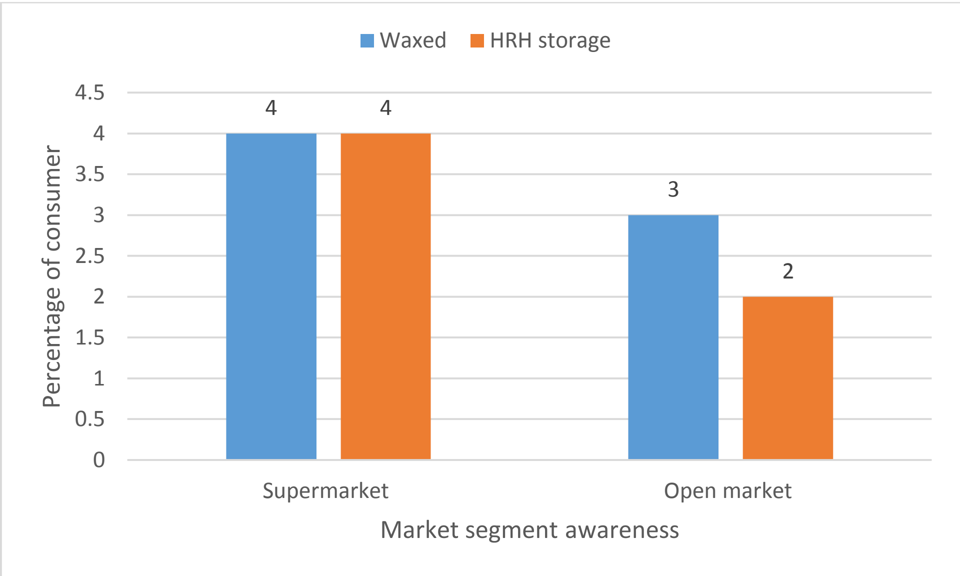

Figure 3: Consumer awareness of shelf life extended fresh cassava

4.2.2 Quantity and purchasing frequency of fresh cassava

Majority of consumers purchased between 1-3 heaps (supermarkets 78.7% and open market 77.6%) of cassava followed by those that purchase less than a heap (18.1%), and only 1.1% of respondents purchased more than 12 heaps.

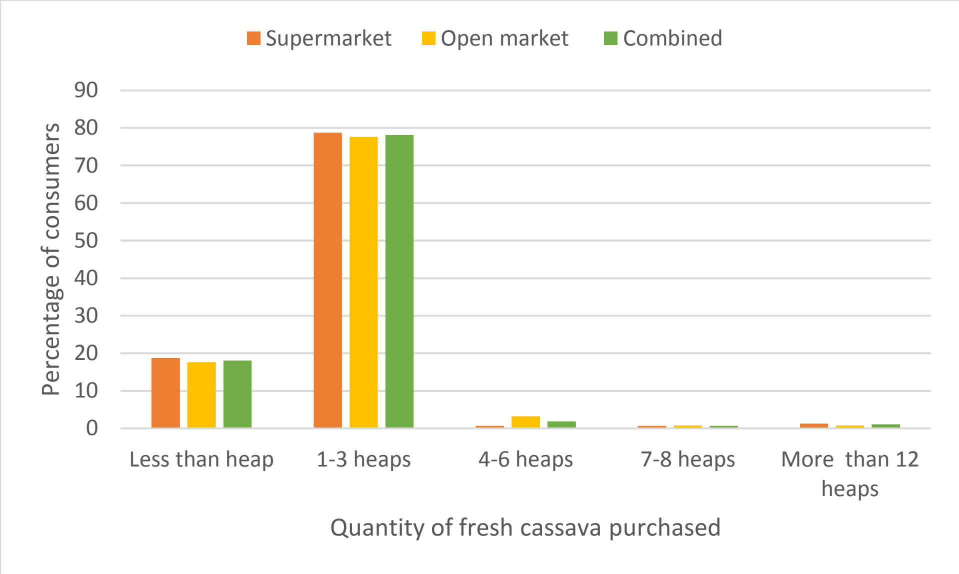

Figure 4: Quantity of fresh cassava purchased

With respect to how often respondents purchased fresh cassava, most of respondents (70.0%) purchased fresh cassava on a weekly basis, followed by those that purchased cassava monthly (15.3%). Few respondents purchased fresh cassava on a daily basis (8.2%).

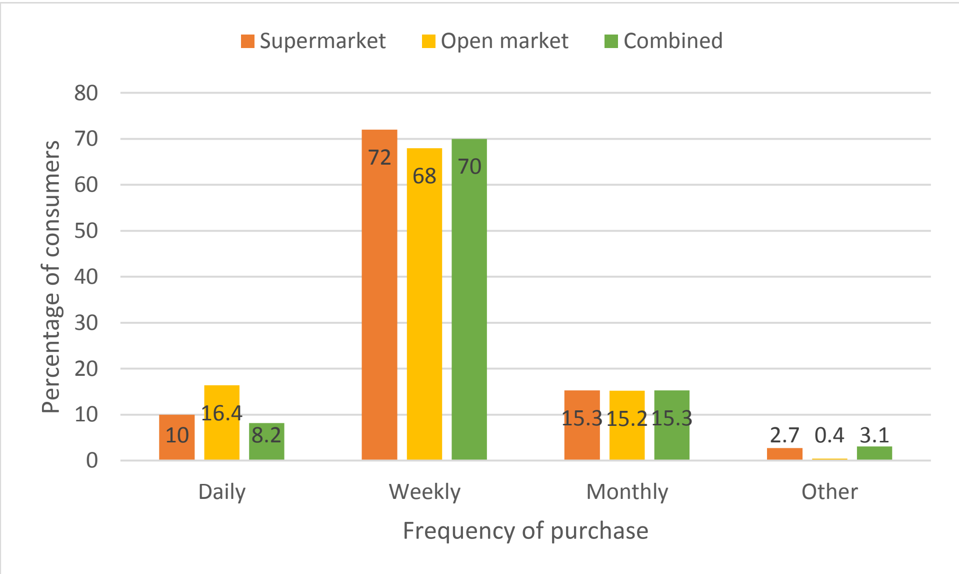

Figure 5: Fresh cassava purchasing frequency

4.3 Consumer sensory evaluation of shelf life extended fresh cassava

Sensory properties of the product are the main parameters used by customers for choosing appropriate food products. The study focus was to show the effect of shelf life extension on the sensory properties of fresh cassava. Respondents were offered taste samples of waxed cassava, conventional/normal cassava and HRH storage cassava. The evaluation of sensory properties was based on a 9-point hedonic scale. The untrained panellists evaluated overall acceptance of sensory properties of colour, aroma, taste, flavour, appearance and mouth feel for the three fresh cassava products. The degree of difference between the taste samples was analysed using a paired t-test to determine the level of significance (Table 7).

The attribute colour of waxed cassava has the highest score among both segments of consumers followed by HRH storage and lastly normal cassava. Further analyses revealed that there is a positive and significant difference between colour of waxed and normal fresh cassava products among supermarket consumers ($p < 0.01$). The findings of this study contradict the findings by Data *et al.*, (1984), which revealed the quality attribute of colour from pruned cassava plants was better than that of unpruned cassava plants. Waxed cassava aroma had the highest score in both consumers segments followed aroma of HRH storage except for open market consumers were aroma of normal fresh cassava was higher than that of HRH storage. There was also a positive and significant difference between the colour of waxed and normal cassava among supermarket consumers ($p < 0.01$), contrary the negative and significant difference between the HRH storage and normal cassava colour among open market consumers.

For taste, waxed cassava had the highest score, followed by HRH storage and lastly normal cassava among both supermarket and open market consumers. There was a positive and significant difference for both consumer segments ($p < 0.01$) among the taste of waxed and normal cassava and HRH storage and normal cassava. Implying that both waxed and HRH storage fresh cassava tastes better than normal cassava. The reason for the better taste of waxed and high relative humidity storage fresh cassava roots could be the fact that before fresh cassava is harvested for shelf life extension treatment, it must be pruned at least seven days before harvesting. According to Oirschot *et al.,* (2000) and Sánchez *et al.,* (2013) analysis of the cassava roots revealed a relationship between the combined sugar and starch contents and the pruning interval duration, and that sugar and starch contents were inversely related to each other. The sugar content increased with the interval period of pruning, probably as a result of starch hydrolysis. Other properties such as the contents of dry matter, cyanogen, scopoletin, amylose and reducing sugars and the starch pasting properties were not affected by pruning interval. It was then concluded that the sugar content, that is; the sugar/starch ratio of cassava roots is positively related to their resistance to post-harvest physiological deterioration.

According to the analysis by Data *et al.,* (1984), the ratings for quality attributes in terms of texture, flavour and general acceptability were lower in roots harvested from unpruned than pruned cassava plants, while the reverse was true in colour and appearance. Study findings show that flavour of waxed cassava has the highest score among both supermarket open market consumers followed by normal cassava and lastly HRH storage fresh cassava. Further analysis reveal a positive and significant difference ($p < 0.01$ and $p < 0.1$) between the flavour of waxed and normal fresh cassava among super market and open market consumers respectively. Conversely, there is a negative and significant difference ($p < 0.1$) between the flavour of HRH storage and normal fresh cassava among open market consumers. Sensory results from analysis of appearance are mixed. Appearance of waxed and HRH storage scored higher than normal cassava among supermarket consumers while normal cassava has higher score than both waxed and HRH storage cassava among open market consumers. Further analysis reveal a positive and significant difference ($p < 0.05$) between the appearance of waxed and normal cassava among supermarket respondents. Mouth feel of waxed cassava among supermarket consumers' scored higher than normal cassava while normal cassava scored higher than HRH storage among supermarket consumers and also higher than waxed and HRH storage cassava among open market consumers. Statistical analysis results show a positive and significant difference ($p < 0.01$) between the mouth feel of waxed and normal cassava among supermarket consumers.

Statistical analysis of the sensory attributes for both segments of consumers reveal that the hypothesis of conventional fresh cassava tastes better than waxed and HRH storage fresh cassava roots is rejected. This is due to the fact that the t-test on the difference in the mean scores between taste of waxed and normal cassava and between HRH storage and normal cassava is positive and significant ($p < 0.01$)

Table 4: Mean scores for waxed, HRH storage and conventional fresh cassava products

Attribute	Supermarket respondents						Open market respondents					
	waxed	Normal	t-value	HRH	Normal	t-value	Waxed	Normal	t-value	HRH	Normal	t-value
Colour	6.95 (0.11)	6.31 (0.13)	3.69***	6.39 (0.15)	6.31 (0.13)	0.41	6.38 (0.11)	6.32 (0.11)	0.33	6.19 (0.11)	6.32 (0.11)	-0.83
Aroma	6.84 (0.12)	6.09 (0.14)	4.12***	6.15 (0.14)	6.09 (0.14)	0.34	6.48 (0.12)	6.30 (0.12)	1.05	5.94 (0.13)	6.30 (0.12)	-1.99*
Taste	7.16 (0.14)	5.72 (0.18)	6.34***	6.71 (0.16)	5.72 (0.18)	4.12***	6.75 (0.12)	5.87 (0.14)	4.89***	6.47 (0.13)	5.87 (0.14)	3.17***
Flavour	6.87 (0.13)	6.07 (0.14)	4.19***	5.97 (0.15)	6.07 (0.14)	-0.49	6.50 (0.12)	6.23 (0.12)	1.62*	5.93 (0.12)	6.23 (0.12)	-1.85*
Appearance	6.71 (0.17)	6.23 (0.15)	2.15**	6.37 (0.15)	6.23 (0.15)	0.67	6.17 (0.14)	6.31 (0.11)	-0.80	6.11 (0.12)	6.31 (0.11)	-1.28
Mouth feel	7.06 (0.13)	6.25 (0.15)	4.02***	6.22 (0.15)	6.25 (0.15)	-0.16	6.44 (0.13)	6.46 (0.12)	-0.12	6.10 (0.13)	6.46 (0.12)	-2.02**

Source: Survey July-October 2016, ***, **,* significant at 1%, 5% and 10%. Numbers in parenthesis are standard error of the mean

4.3 Consumers' WTP for shelf life extended fresh cassava

Majority of interviewed respondents answered yes to the first contingent valuation question except for the highest start bid of UGX 6000 where less than half of the respondents answered yes (Table 11). Contingent evaluation data indicated that individuals were sensitive to the bid amount; as the bid amount went up, the proportion of individuals that gave a positive answer went down whilst as the bid amount went down, the proportion of positive answers went up. The same trend was observed for both supermarket and open markets respondents for discrete bid offers for both waxed and high relative humidity storage fresh cassava. These results are consistent with previous studies (Lopez-Feldman, 2012; Seck, 2016) which suggests a decrease in the WTP when a higher bid is introduced. According to Carson (2000), when using a binary discrete choice question, data should be tested to ascertain its applicability. One of the tests as suggested by Carson (2000) is the economic maxim: the higher the cost/price, the lower the demand. From the results of the study, the findings conform to this test (Table 11).

Table 5: Respondents' distribution of discrete responses to bid offers on conditional WTP

Initial bid (UGX)	First response for supermarket		First response for open markets	
	Waxed (Yes)	HRH (Yes)	Waxed (Yes)	HRH (Yes)
1500	49 (89.1%)	45 (81.8%)	88 (89.8%)	66 (76.7%)
3000	34 (72.3%)	26 (55.3%)	41 (56.2%)	26 (30.9%)
6000	23 (47.9%)	10 (20.8%)	35 (44.3%)	14 (17.5)

Note: Prices are in local currency (Uganda shillings, UGX). As of October 2016, the exchange rate was about US$1 = UGX 3600 and Figures in parentheses are percentages of respondents

4.3.1 Estimated consumer WTP for shelf life extended fresh cassava

From the pilot survey, the cost of 3kg of conventional fresh cassava roots was UGX 3,000, implying that the price of a kg was UGX 1,000. The mean WTP for 3kg of waxed and HRH storage cassava by supermarket and open market respondents from the double bounded dichotomous contingent valuation was analysed using the seemingly unrelated bivariate probit regression model (SUBPRM). The coefficient of the initial and follow-up bid values was negative and significantly less than 1 and 5% significant probability level, except for the coefficient of the second bid for HRH storage cassava that was negative and insignificant for both supermarket and open market respondents (Table 12). The implication of this negative relationship indicates that, as the value of the initial and second price increased, respondents' WTP for fresh cassava with extended shelf life decreases. In the bivariate probit model, the correlation coefficient rho (ρ) is less than one which confirms that the random component of WTP for the first and the second question is not perfectly correlated. Also, because the second equation parameters are likely to contain more noise in terms of anchoring bias where the respondents are assumed to take while forming WTP for the second question, estimated parameter of the first-response equation is used to obtain mean WTP.

Table 6: Respondents WTP coefficients for 3kg of waxed and HRH storage fresh cassava products

Variable	Supermarket (n=150)		Open market (n=250)	
	Waxed	HRH	waxed	HRH
Bid1 (First bid)	-0.00029*** (0.00006)	-0.00044*** (0.00007)	-0.00030*** (0.00005)	-0.00040*** (0.00005)
Constant	1.41090*** (0.2418)	1.72827*** (0.27779)	1.09591*** (0.17447)	1.29873*** (0.18982)
Bid2 (second bid)	-0.00013** (0.00006)	-0.00003 (0.00007)	-0.00023*** (0.00009)	-0.00003 (0.00005)
Constant	0.77347*** (0.28630)	0.14067 (0.2765)	0.88609*** (0.31057)	-0.11356 (0.20174)
rho	-0.42641 (0.19763)	-0.20636 (0.23153)	-0.49212 (0.15251)	-0.42385 (0.17332)
Log likelihood	-166.66158	-174.76368	-273.93996	-300.44422
Wald chi2(2)	30.66000	39.02000	46.83000	63.12000
Prob > chi2	0.00000	0.00000	0.00000	0.00000
Likelihood-ratio test of rho	0.00000	0.00000	0.00000	0.00000
chi2(1)	3.68300	0.70860	7.17200	4.735000
Prob > chi2	0.05500	0.39990	0.00740	0.029600

Source: Survey July-October 2016, *, **,* significant at 1%, 5% and 10%. As of October 2016, the exchange rate was about US$1 = UGX 3600 and Figures in parentheses are percentages of respondents**

The mean WTP is calculated $as;\ WTP = -\frac{\alpha}{\beta}$ (Haab and McConnell, 2002). Supermarket consumers' mean WTP for 3kg of fresh cassava with shelf life extended by waxing technology from the double bounded Probit is estimated to be US$ 1.35 and US$1.09 for HRH storage fresh cassava while for open market consumers' the mean WTP for waxed cassava is estimated to be US$ 1.02 and US$0.90 for HRH storage cassava (Table 12). Since the price of 3kg of conventional cassava is US$0.83, the corresponding price of a kg is US$ 0.28. The resulting premiums are among supermarket consumers are US$ 0.17 (60.71%) for waxed cassava and US$0.08 (28.57%) for HRH storage, while for open market consumers, the premiums are US$0.06 (21.43%) for waxed and US$0.05 (17.86%) for HRH storage fresh cassava. Results show that both segments of respondents are WTP a premium for the shelf life extended fresh cassava products. This is probably because respondents appreciate the value added to fresh cassava via shelf life extension. Most studies have shown positive consumer WTP for improved quality and enhanced storage of agricultural commodities. Nicholson, & Meloy, (2016) studied whether shelf life influences product attractiveness, willingness to purchase, and willingness to pay for organic and conventional milk, whilst controlling for the effect of the milk production system. Other studies, consistent with our findings, indicated that consumers value the length of shelf life only after being prompted and were willing to pay a premium; Zhang *et al.,* (2010) analysed effect of Ethylene treatments as an effective method for shortening post-harvest ripening periods for winter Anjou pears and allow market availability throughout the year. Our results also indicated that treatment-induced quality losses significantly affect consumers' willingness to pay (WTP). Mean WTP for each treatment reveals that consumers prefer pears with a six-day ethylene treatment and were willing to pay a premium of $0.25/pound compared to the market price. Wayua *et al.,* (2009) studied consumers WTP for enhanced milk sensory characteristics and assurances; the results suggested that even poor consumers are willing to pay for enhanced sensory characteristics and assurances if these can be communicated in a trusted manner.

Supermarket respondents are WTP, a higher premium for both waxed and HRH storage fresh cassava products than open market respondents (Table 12). Findings of this study where supermarkets respondents' show higher WTP than their counterparts in open markets align with the findings of by Batte *et al.,* (2004), which revealed that specialty grocery shoppers had a greater willingness to pay for organic products than the traditional grocery shoppers. From the results, both supermarket and open market respondents are WTP a premium for waxed and high relative humidity storage fresh cassava and hence *the hypothesis that supermarket and open market respondents are willing to pay a premium for waxed and high relative humidity storage fresh cassava roots cannot be rejected.*

4.4 Factors influencing consumers' WTP for shelf life extended fresh cassava

The econometric analysis was done to determine the effect of socio-economic factors on consumers' willingness to pay for fresh cassava with extended shelf life (waxed and high relative humidity fresh cassava). The estimates for the probit model showed that initial bid/price reduce the probability of open market consumers' WTP for both waxed and HRH storage fresh cassava, while years of schooling and distance to market increase the open market consumers WTP for waxed and HRH storage fresh cassava respectively (Table 13). None of the factors had an effect on supermarket consumers' WTP for both waxed and HRH storage fresh cassava products.

The initial bid/ price among open market consumers is negative and significant for both waxed and HRH storage fresh cassava. This implies that for every unit change in price, the probability of WTP reduces by 0.016% for waxed cassava and 0.019% for HRH storage cassava holding other factors constant. Same findings were obtained by Utoni (2016) and Liu & Chen (2015), which showed a negative and significant relationship between price and consumer WTP. With regards to supermarket consumers, initial price had no significant effect on their WTP. This is probably due to the fact that supermarket consumers have higher incomes and therefore less sensitive to price changes compared to open market consumers who are mostly low income earners and more sensitive price to price changes. Lower-income shoppers have more elastic demand for agricultural products (Jones et al., 1994). Price elasticity differences between higher and lower-income shoppers, showed that lower-income shoppers had a price elasticity of demand (-1.55) twice that of higher-income shoppers (-0.59).

Years of schooling has a positive and significant effect on open market respondents WTP for waxed cassava. The marginal effects indicate that, an additional year in school increases the probability of open market consumers' WTP for waxed cassava by 3.25%, keeping the other variables constant. Several previous studies have also shown positive and significant effect of education on consumer WTP (Muhammad *et al.,* 2015; Shen, 2012; Hicks *et al.,* 2009).

Distance to the supermarket has a positive and significant effect on open market consumers' WTP for high relative humidity storage fresh cassava roots. The marginal effects indicate that, for every kilometre away from the open market, the probability of willingness to pay for the increases by 3.48%, keeping the other variables constant. The reason for increase in WTP with increase in distance for open market respondents stems from the fact that once consumers' have travelled long distance to the market with is costly in terms of transport, they cannot afford to go back home minus the product because its more expensive for them to keep coming to the market. However, result of the current study contradict with the findings by Grebitus el al., 2013, which revealed that average consumer WTP for food was falling with increase in distance traveled.

Analysis of the factors that affect WTP for waxed and high relative humidity storage fresh cassava roots with extended shelf life for both segments of respondents, *results reveal that the hypothesis of market outlet having a significant ($p < 0.01$, $p < 0.05$ & $p < 0.1$) influence on WTP for both waxed and high relative humidity storage fresh cassava roots is rejected.*

Table 7: Probit model estimates of factors affecting WTP for fresh cassava roots with extended shelf life

Variable	**Supermarket respondents**		**Open market respondents**	
	waxed cassava	HRH storage	waxed cassava	HRH storage
	marginal effect	marginal effect	marginal effect	marginal effect
bid1	-0.0001183 (0.00072)	-0.000222 (0.0004)	-0.0001568*** (0.00002)	-0.0001896*** (0.00003)
Gender (1=Male,0= Female	0.0987463 (0.58388)	0.2427461 (0.38854)	0.0476172 (0.07553)	0.0283123 (0.07894)
Age	-0.0064757 (0.04007)	-0.004367 (0.01143)	-0.0022672 (0.00369)	0.0002665 (0.00394)
marital (1= Married, 0 = Not married)	0.1323921 (0.77026)	0.1567915 (0.28332)	0.0349421 (0.08205)	0.0958907 (0.08208)
HHno (Number of people in the household)	-0.0198701 (0.12234)	-0.0236015 (0.04757)	-0.0076075 (0.01356)	-0.0086813 (0.01484)
Yrschool (Years spent in school)	-0.0147682 (0.09101)	-0.0145783 (0.03104)	0.0324574*** (0.01019)	0.0162943 (0.0103)
Occupation (1= employed, 0= not	-0.1073516 (0.84324)	-0.2301479 (0.75799)	-0.1254718 (0.20056)	-0.1360942 (0.94008)
dist (distance to the supermarket/market)	-0.0028899 (0.04)	-0.0026243 (0.04452)	0.0145298 (0.00965)	0.0347768*** (0.01299)
income	2.41e-09 (0.00000)	1.81e-07 (0.00000)	2.49e-09 (0.00000)	1.55e-08 (0.00000)
rank2 (1=main food,0=compliment)	0.0988371 (0.72483)	0.1335082 (0.35524)	0 .0371323 (0.07644)	-0.016533 (0.07886)
awareness (1=aware,0=not ware)	0.2487224 (2.57473)	0.2327261 (0.77873)	0.072811 (0.18611)	0.2268923 (0.21509)
OUTLET (1= open market 0= otherwise	-0.1685145 (1.34525)	-0.2844092 (0.88039)	0.0143038 (0.13567)	0.0689501 (0.1442)
credit_2 (1=Have access,0= no access)	0.232069 (0.95365)	0.2849751 (0.26227)	0.0058958 (0.02972)	0.0091643 (0.03693)

daily purchase (1= purchase daily,0= otherwise)	-0.8512741 (11.573)	-0.7716991 (7.5946)	0.7411858 (7.75319)	0.8093263 (8.66495)
Weekly purchase (1= purchase weekly,0=otherwise)	-0.7349483 (31.61)	-0.7449044 (14.223)	0.9398401 (5.67182)	0.9332573 (7.80568)
Monthly_PURCH (1= purchase monthly,0= otherwise)	-0.8870287 (15.16)	-0.8190609 (9.99071)	0.7296504 (7.35069)	0.7979486 (8.31888)
quantity_purchased (1=less or equal to 3 heaps,0=more than 3 heaps)	-0.0692909 (0.54467)	-0.0621646 (0.31345)	0.1317691 (0.18789)	0.1032787 (0.20458)
ROOTSIZE (1=small size,0= medium size)	0.1342009 (0.88761)	0.206534 (0.44663)	0.0041637 (0.08572)	0.001806 (0.08838)

Source: July-October 2016, ***, **,* significant at 1%, 5% and 10%

4.5 Market potential for shelf life extended fresh cassava

The current study estimated the aggregate market potential of shelf life extended fresh cassava using total WTP obtained from the sample respondents and total population of the study area (Table 14). The estimated market potential among supermarket consumers is higher than that of open market consumers for both waxed and HRH storage fresh cassava products.

The number of potential buyers for shelf life extended fresh cassava roots is estimated basing on the population estimates for Kampala district and according to the 2014 population census, Kampala is estimated to have a population of 1,516,210 (UBOS,2014). Considering that 69.8% and 60.7% of supermarket respondents are willing to pay the first and second bids, respectively for waxed fresh cassava roots, the estimated number of potential buyers of waxed fresh cassava roots in Kampala is 1,058,315 and 920,340 for the first and second bids, respectively. With regards to high relative humidity storage fresh cassava roots among supermarket respondents, 52.6% and 44.3% of respondents are willing to pay first and second bids, respectively. The estimate number of potential buyers of high relative humidity storage fresh cassava roots is 797,526 and 671,681 for initial and second bids, respectively. For open market consumers, 63.4% are WTP first bid and 46.2% second bid for waxed fresh cassava roots. The corresponding estimate of potential buyers is 961,277 and 700,489 for the first and second bids, respectively. For high relative humidity storage fresh cassava roots, 42.7% and 41.7% of respondents are willing to pay first and seconds bids. The estimate number of potential buyers of high relative humidity storage fresh cassava was 647,422 and 632,260 consumers, respectively.

Based on the empirical mean WTP estimates, and information on the number of potential buyers and average annual purchasing, the market potentials of the shelf life extended fresh cassava root products were computed (Wolfe, 2006).

Table 8: Showing estimated market potential for the different fresh cassava products

Variable	Supermarket respondents				Open market respondents			
	waxed cassava		HRH storage		waxed cassava		HRH storage	
	Bid 1	Bid 2	Bid 1	Bid 2	Bid 1	Bid 2	Bid1	Bid 2
Number of potential buyers	1,058,315.0	920,340.0	797,526.0	671,681.0	961,277.0	700,489.0	632,260.0	647,422.0
Empirical mean WTP price per kg (UGX)	1,621.7	1,983.3	1,309.3	1,563.0	1,217.7	1,284.2	1,082.3	1,261.8
Frequency of purchase (kg) per year[4]	96.0	96.0	96.0	96.0	96.0	96.0	96.0	96.0
Estimated Market potential (billion UGX)	164.8	175.2	100.2	100.8	112.4	86.4	65.7	78.4
Estimated Market Potential (million US$)[5]	**45.8**	**48.7**	**27.8**	**28.0**	**31.2**	**24.0**	**18.3**	**21.8**

Note: 1 US Dollar ($) = 3,600 Ugandan shillings (UGX) in 2016, Source: Author's calculations

For supermarket consumers, the total market size for waxed fresh cassava roots from the double bounded formats is estimated at between US$45.8 million/year for initial bid and US$ 48.7 million/year for the follow up bid while for HRH storage fresh cassava, the estimated market size is between US$ 27.8 million/year and US$ 28.0 million/year for the initial and second bids respectively. With open market consumers, the estimated total market potential for waxed is between US$31.2 million/year and US$ 24.0 million/year. For HRH storage fresh cassava the market size is estimated at between US$ 18.3 million/year and US$21.8

[4] Most of the respondents purchase 1-3 kg of fresh cassava weekly. An average of 2 kg weekly was used in calculating the quantity of purchase in a year per respondent.

million/year). The results indicate existence of market potential for shelf life extended fresh cassava and present an opportunity for investment.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND POLICY RECOMMENDATIONS

5.1 Summary and conclusions

High post-harvest losses are still and remain a major challenge along the food value chains in Uganda and fresh cassava roots in particular. Strategies to reduce these losses present potential benefits to farmers, traders and consumers. However success of these shelf life extended products in the market entirely depends on consumer acceptance and WTP. The thesis investigated consumer acceptance and WTP for shelf life extended fresh cassava roots products in Uganda. The study was conducted in the central district of Kampala and target consumers were segmented into open market and supermarket consumers. A cross sectional survey was conducted in eight (8) main open markets and five (5) supermarkets. Primary data was collected using a pre-tested questionnaire. Descriptive statistics were used to analyze consumers socio-economic characteristics, a 9-point hedonic scale used in the consumer sensory evaluation, a double bounded dichotomous choice elicitation method was adopted in eliciting WTP which was a later determined using seemingly unrelated bivariate probit model and factors influencing WTP were determined using a probit model.

Finding on consumers socio-economic characteristics indicate that supermarket and open market consumers are comparable in some aspects except for age, marital status, household size, education level and years of schooling, distance to market, and rank of cassava in the household, daily purchase of cassava and preferred root size. Open market consumers were older than supermarket consumers with an average age of 35.72 years compared to 31.13 for supermarket consumers. Sixty eight percent (68%) of open market consumers were married while only 56% of supermarket consumers were married. Open market consumers had larger household size with an average of 5 members compared to an average of 4 members for supermarket consumers. Supermarket consumers had an average of 13.77 years in school which is higher than 9.45 years in school for open market consumers. Also open market consumers travelled more distance (3.25km) to reach the market compared to 1.63km travelled by supermarket consumers to reach the supermarket. Most open market consumers were using fresh cassava as their primary food while only 13% of supermarket consumers ranked fresh cassava as their primary source of food. Furthermore, 16% of open mat consumers purchased fresh cassava daily compared to only 10% of supermarket consumers. For supermarket consumers, 36% preferred smaller sized cassava roots while 23 of open market consumer showed preference for small sized roots.

Results of the sensory evaluation are mixed. For supermarket consumers, there is a positive and significant difference between waxed and normal cassava in all the attributes (colour, aroma, taste, flavor, appearance and mouth) while only taste shows a positive and significant difference between HRH storage and normal cassava. With open market consumers there is no significant difference between the attributes of waxed and normal cassava with exception of taste and flavor that exhibit positive and significant difference. For HRH storage, aroma, flour and mouth feel show negative and significant difference between HRH storage and normal cassava while taste shows positive and significant difference.

Willingness to pay results show supermarket consumers are WTP premium of 60.71% for waxed and 28.57% for HRH storage fresh cassava products while open market consumers are WTP premiums of 21.43% and 17.86% for waxed and HRH storage fresh cassava products respectively. Concerning factors affecting WTP for shelf life extended fresh cassava roots products, none of the factors has a significant influence on supermarkets consumers' WTP for both waxed and HRH storage fresh cassava roots. For open market consumers, initial bid (price) has a negative and significant while years of schooling and distance to the market show a positive and significant influence on WTP for waxed and HRH storage fresh cassava products respectively.

The estimated market potential for supermarket consumers is between US $45.8 million/year and US $48.7 million/year for waxed cassava and US$27.8million/year and US $28.0 million/year for HRH storage fresh cassava. For open market consumers, the market potential estimate is between US $ 31.2 million/year and US $ 24.0 million/year for waxed, and US $ 18.3 million/year and US $21.8 million/year for HRH storage fresh cassava roots .

In conclusion, identifies the great preference of waxed and HRH storage fresh cassava products by both supermarket and open consumers especially because of their taste attribute. The preference is further augmented by both consumer segments' WTP premium for both waxed and HRH storage fresh cassava roots. Premiums for supermarket consumers and waxed cassava are higher than premiums for open consumers and HRH storage cassava roots respectively. Market potential exists for both waxed and HRH storage cassava in both market segments. Market potential for supermarket consumers and waxed cassava is however higher than the market potential for open market consumers and HRH storage fresh cassava roots respectively. Existence of market potential highlights the need for investment into fresh cassava roots shelf life extension technologies.

5.3 Recommendations

Policy measures like creating more awareness need to be put in place by governments, non-governmental organizations and other stakeholders to promote consumption of shelf life extended fresh cassava and investments into fresh cassava shelf life extension technologies.

Promote adoption of waxing and high relative humidity fresh cassava shelf life extension technologies through sensitisation of cassava value chain actors. This will enable to increase their margins from the premiums that consumers are WTP.

The strong positive relationship between years of schooling and willingness to pay for fresh cassava roots with extended shelf life underpins that need to set policies for improving the education levels of the population. For example increasing government scholarships especially for the underprivileged students

Need to promote production of cassava through providing quality inputs, to leverage on the existing market potential for fresh cassava with extended shelf life

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APPENDICES

Appendix 1: Supermarket respondents' distribution of discrete bid offers for waxed cassava

Initial bid	First response		Second bid	Second response	
	Yes	**No**		**Yes**	**no**
1500	49 (89.1%)	6 (10.9%)	750	6 (100%)	-
			3000	30 (61.2%)	19 (38.8%)
3000	34 (72.3%)	13 (27.7%)	1500	9 (69.2)	4 (30.8)
			6000	10 (29.4%)	24 (70.6%)
6000	23 (47.9%)	25 (50.1%)	3000	24 (96%)	1 (4.0%)
			12000	02 (8.7%)	21 (91.3%)
Mean %	**69.8**			**60.7**	

Appendix A - Supermarket respondents' distribution of discrete bid offers for high relative humidity storage cassava

Initial bid	First response			Second response	
	Yes	**No**	**Second bid**	**Yes**	**no**
1500	45 (81.8%)	10 (18.2%)	750	8 (80.0%)	2 (20.0%)
			3000	15 (33.3%)	30 (66.7%)
3000	26 (55.3%)	21 (44.7%)	1500	14 (66.7)	07 (33.3%)
			6000	05 (19.2%)	21 (80.8%)
6000	10 (20.8%)	38 (79.2%)	3000	14 (36.8%)	24 (63.2%)
			12000	03 (30.0%)	07 (70.0%)

Appendix B - Open markets respondents' distribution of discrete bid offers for waxed cassava

Initial bid	First response			Second response	
	Yes	**No**	**Second bid**	**Yes**	**no**
1500	88 (89.8%)	10 (10.2%)	750	07 (70.0%)	03 (30.0%)
			3000	39 (44.3%)	49 (55.7%)
3000	41 (56.2%)	32 (43.8%)	1500	25 (78.1%)	07 (21.9%)
			6000	04 (9.8%)	37 (90.2%)
6000	35 (44.3%)	44 (55.7%)	3000	33 (75.0%)	11 (25%)

			12000	-	35 (100.0%)
Mean %	**63.4**			**46.2**	

Appendix 2 - Open market respondents' distribution of discrete bid offers for HRH storage cassava

Initial bid	**First response**			**Second response**	
	Yes	**No**	**Second bid**	**Yes**	**no**
1500	66 (76.7%)	20 (23.3%)	750	16 (80.0%)	04 (20.0%)
			3000	18 (27.3%)	48 (72.7%)
3000	26 (30.9%)	58 (69.1%)	1500	36 (62.1%)	22 (37.9%)
			6000	02 (7.7%)	24 (92.3%)
6000	14 (17.5%)	66 (82.5%)	3000	38 (57.6%)	28 (42.4%)
			12000	03 (21.4%)	11 (78.6%)
Mean %	**41.7**			**42.7**	

Appendix 3 - Estimated market potential

Variable	**Supermarket respondents**				**Open market respondents**			
	waxed cassava		HRH storage		waxed cassava		HRH storage	
	Bid 1	Bid 2	Bid 1	Bid 2	Bid 1	Bid 2	Bid1	Bid 2
Number of potential buyers	1,058,315	920,340	797,526	671,681	961,277	700,489	632,260	647,422
Empirical mean WTP price per kg (UGX)	1,629.4	1,939.5	1,310.5	1,661.9	1,233.8	1,309.3	1,073.9	1,149.3
frequency of purchase (kg) per year	96	96	96	96	96	96	96	96
Estimated Market potential (UGX)	165,544,172,256	171,359,945,280	100,335,151,008	107,161,598,774.4	113,858,262,009.6	88,046,423,779.2	65,182,465,344	71,431,882,041.6
Estimated Market Potential (US$)[6]	45,984,492.3	47,599,984.8	27,870,875.3	29,767,110.8	31,627,295.0	24,457,339.9	18,106,240.4	19,842,189.5