FARMERS' WILLINGNESS TO PAY FOR IMPROVED CASSAVA CUTTINGS ATTRIBUTES IN RUGOMBO DISTRICT, BURUNDI

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EXTENDED ABSTRACT

Despite cassava being both a staple food, a major source of calories, and the third most important crop after beans and bananas in Burundi, its seeds system is characterized by informal sectors and the unavailability of clean and healthy planting materials. These challenges, together with the traditional poor farming practices have attributed to low cassava productivity. Therefore, the study aimed at assessing farmers' Willingness to Pay (WTP) for improved cassava cuttings attributes in Burundi, specifically the study assessed: i) farmers' preferences for improved cassava cuttings attribute; ii) WTP for attributes of improved cassava cuttings and; iii) factors influencing farmers' preferences and WTP for improved cassava cuttings attributes. Primary data were collected in Rugombo district, Cibitoke Province in Burundi where cassava is intensively grown. The study area is also among the regions most affected by Cassava Mosaic Disease (CMD) and Cassava Brown Streak Virus (CBSV). A systematic sampling approach was used to select 352 respondents for this study from the list of cassava farmers. The Focus Group Discussion (FGD), semi-structured questionnaire, and Best-Worst Scaling (BWS) questions were used to get cassava cutting attributes prioritized by farmers in the study area. The mixed logit model was used to assess preferences, WTP, factors influencing farmers' preferences and WTP for improved cassava cuttings attributes. Results from FGD, semi-structured questionnaire, and BWS method show that farmers prioritized most resistance to diseases when compared to other cassava cuttings attributes which include roots yield, taste, maturity time and input price. Results from CE indicate that respondents have strong preferences for higher yield and they were willing to pay more for that attribute (BIF 70) compared to other attributes like resistance to diseases (BIF 36), sweet taste (BIF 35), and early maturity times (BIF 18). Further, the study found that preferences and WTP for improved cassava cuttings attributes are influenced by education level, land ownership status (both owned and rented land), increase in the size of cassava land, high experience in producing cassava, project beneficiaries, and distance to the market. The study recommends to the Ministry of Agriculture and other development partners involved in cassava cuttings multiplication to avail and consider the preferred attributes in their interventions and actions.

Keywords: Improved Cassava Cuttings Attributes, Willingness to Pay, Best-Worst Scaling, Choice Experiment, Burundi.

DECLARATION

I, Henriette Ndayisaba, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my original work done within the period of registration and that it has neither been submitted nor concurrently being submitted in any other institution.

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I remain solely responsible for any error in the content or design inherent in this dissertation.

DEDICATION

This dissertation is dedicated to my wonderful and supportive family especially my mother Niyonzima Gaudence and Priest Aime Irakoze who took care of my son Ndayisabe Best Ibrahim Schneider when I was away from home.

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LIST OF ABBREVIATIONS

%	Percentage

ACFS	Assessment of Crops and Food Supplies
AERC	African Economic Research Consortium
BIF	Burundi International Franc
BWS	Best-Worst Scaling
CBSV	Cassava Brown Streak Virus
CE	Choice Experiment
CIAT	International Center for Tropical Agriculture
CMD	Cassava Mosaic Diseases
CVM	Contingent Valuation Method
DCE	Discrete Choice Experiment
ENAB	Enquête National Agricole du Burundi (Burundi National Agricultural Survey)
FAO	Food and Agriculture Organization
FGD	Focus Group Discussion
g	Gram
Ha	Hectare
IFAD	International Fund for Agriculture Development
IITA	International Institute of Tropical Agriculture
ISABU	Institut des Sciences Agronomiques du Burundi (Institute of Agronomic Sciences of Burundi)
Kcal	kilocalorie
Kg	Kilograms
Km	Kilometer
m	Meter
m^2	Meter square

MWTP	Mean Willingness to Pay
MXL	Mixed Logit Model
PRODEMA	Projet de productivité et de développement des Marches Agricoles (Agricultural Markets Productivity and Development Project)
RERAA	Rapport d'Evaluation des Récoltes, des Approvisionnements Alimentaires (Crop and Food Supply Assessment Report)
RTB	Roots, Tubes, and Banana
TZS	Tanzanian Shillings
USD	United States Dollar
WTP	Willingness to Pay

CHAPTER ONE

1.0 GENERAL INTRODUCTION

1.1 Background Information

The agriculture sector is the backbone of the economy in developing countries. It is the primary source of income for more than 80% of the poor population, and it plays a crucial role in reducing poverty and improving food security (Bouwmeester *et al*., 2012). Vegetative propagated crops such as roots, tube and banana (RTB) are central of the agriculture production systems, and consumption choices throughout much of sub-Saharan Africa (Wossen *et al*., 2020). For example, cassava was considered as the food of the poor households in Africa (Howeler *et al*., 2013); yet, it is the staple food of over 800 million in the tropics, including 500 million in Africa (Vernier *et al*., 2018). In sub-Saharan Africa, cassava is one of the major food crops and ranks second as a staple food after maize, and the third most important crop after beans and bananas in Burundi (Assanvo *et al*., 2017).

Cassava is easily grown with a low level of inputs (water and fertilizer), drought-resistant (Barratt *et al*., 2006), and a high energy food providing 159kcal of dietary energy per 100g of an edible portion (Aloys and Ming, 2006). Cassava is in addition rich in vitamin B1, vitamin B2, vitamin B3, vitamin B6, vitamin C, folate, magnesium, manganese, potassium, and copper (Lancaster and Brooks, 1983).

In addition, cassava also has traces of vitamin B5, vitamin A, vitamin E, vitamin K, calcium, iron, selenium, zinc, and phosphorus (Li *et al*., 2017), making it an important nutritional food to combat food insecurity (Vernier *et al*., 2018). Moreover, cassava is used in human food and as feed for cattle and raw material (starch, ethanol) in various agroindustry (Howeler *et al*., 2013). Therefore, there is an opportunity for Burundi to tap into the potentiality of cassava for improved livelihoods of the local farmers.

Despite its importance, cassava production as other RTB is also constrained by pests and diseases, high costs of pesticides, and low-quality planting material (Okonya *et al*., 2019). This essentially leads to low cassava production, thereby impacting highly on food security (Howeler *et al*., 2013). As a way of mitigating such a situation, the government of Burundi, together with its key partners (International Institute of Tropical Agriculture: IITA, International Fund for Agriculture Development: IFAD), have been fighting food insecurity through the multiplication and distribution of resistant cassava cuttings. However, the Assessment of Crops and Food Supplies done in Burundi in 2018 (ACFS) recognized that the outcome of these interventions has often not met the expectations and interests of many farmers. It is assumed that these efforts can only be impactful if the seeds' system becomes sustainable, meaning that all small-scale farmers have to get access to a suitable variety and quantity of seeds in their communities. The 2018 ACFS also revealed that the use and availability of improved cassava cuttings were very limited, with only two provinces in 18 having 80800 cassava cuttings grown. This low rate of adoption resulted in low productivity (ACFS, 2018).

As a solution to the limited availability of improved seeds, David (2003) argued that there should be a regular potential demand for new seeds to be introduced into the local seeds' system. However, farmers do not traditionally buy cuttings; they rely mainly on their stocks or obtain them from other farmers. Cassava is also considered as a public good given its vegetative propagation, which creates little incentives as a business opportunity for private seed suppliers (David, 2003). The question then is whether farmers can buy cassava cuttings, and if so, how much they will be willing to pay for those cuttings? Given the situation that the product has no market value, hence it is believed that when the product reaches the market there will be hope for sustainability. Therefore, there is a need to assess farmers'WTP for cassava cuttings to establish a sustainable seeds system for cassava.

1.2 Problem Statement and Justification

Despite cassava being both a staple food and a major source of calories, its seeds system is characterized by the dominance of the informal sector and the unavailability of clean and healthy cassava cuttings (Almekinders *et al.*, 2019). Together with the traditional poor farming practices, these challenges have led to low cassava productivity (Aloys and Ming, 2006). Crop diseases compound the problem further, recent statistics indicate that cassava production has declined by 50% to 100% from 2015 to 2019 due to Cassava Mosaic Disease (CMD) and Cassava Brown Streak Virus (CBSV) diseases (PRODEMA, 2019). Okonya *et al.* (2019) reported that plant diseases and scarcity of resilient plant material, lead to food insecurity problems in the country. Response to these problems through decentralized farmers' group approach for free cuttings delivery has not been sustainable. There is, therefore, a need to tackle the problem via a seeds system applying market rules in the hope of sustainability.

A study done by Walker and Alwang (2015) on a project quantifying the adoption of improved genotype in food crop and dryland regions shows that the adoption of seed variety differs among different crops, regions, and countries. Due to this, a study in assessing the adoption of cassava cuttings is very crucial in Burundi. Another study done by Almekinders *et al.* (2019) when looking why intervention in the seeds system of roots, tubers and banana crops do not reach their full potential shows that the economic sustainability in seed system intervention cannot be guaranteed because the actual demand of farmers for seeds is unclear. Therefore, more information is required to influence decision-making by the farmers about the replacement of their degenerated seeds.

There is a pool of literature that has focused on the adoption of cassava and other products. For example, a study done by Wossen *et al.* (2017) on the adoption of cassava variety in Nigeria shows that farmers prefer attributes such as quality of flour, higher yield, big roots, and earlier maturity time. Other studies conducted in Tanzania and Ghana assessed WTP for cassava seeds among farmers (Baidoo and Amoatey, 2012 and Maggidi, 2019) results show that WTP for cassava seeds is influenced by age, cassava land size, cassava varieties, livestock and family labour, access to information on proposed agricultural services, market access, distance to the market, land ownership matters, source of income and farmers income. However, these studies did not show cassava attributes preferred by farmers when they decide to grow cassava. The studies done on the commercialization of certified cassava seeds as well as conservation of cassava varieties in Uganda show that a higher quality of planting material, traditional knowledge on variety, storability in the ground, and cooking quality are among factors that influence adoption (Nakabonge *et al.*, 2018 and Awio *et al*., 2019).

Meanwhile, in Burundi, different studies have also been done to increase cassava production. For example, studies done by Bigirimana *et al*. (2011) and Bowmeester *et al.* (2012) recognized the existence of diseases and pests, while Okonya *et al*. (2019) show the quantity of cassava loss due to diseases and pests. Aloys and Ming (2006) on the other hand demonstrate that cassava should be processed industrially, not traditionally, while Lambri *et al*. (2013) suggested different improved processing methods to reduce the cyanide content of cassava roots. Thus, on the other hand, the thesis contributes to the body of literature on farmers’preferences and WTP for cassava cuttings attributes by using a choice experiment. It is essential to note that, understanding farmers’ preferences enable policymakers to know farmers’ needs and respond by coming up with relevant technologies and the required amount. Information on WTP will also shed light on the maximum amount of money farmers can pay for the cassava cuttings and design appropriate marketing strategies to improve adoption.

1.3 Study Objectives

1.3.1 Overall objective

The overall objective was to assess farmers’ willingness to pay (WTP) for improved cassava cuttings in the Rugombo district.

1.3.2 Specific objectives

To achieve the main objective, the study specifically assessed:

i. Farmers’ preferences for cassava cuttings’ attributes

ii. Farmers’ WTP for cassava cuttings’ attributes.

iii. Factors influencing farmers’ preferences and WTP for the cassava cuttings’ attributes.

1.4 Research Questions

i. Which cassava cuttings attributes are preferred by farmers when they decide to grow cassava?

ii. What is the WTP for improved cassava cutting attributes preferred by farmers?

iii. Is there existence of preference heterogeneity for cassava cuttings attributes and what are its determinants?

1.5 Conceptual Framework

WTP for a given product is a function of, among other things, product attributes, socio-economic characteristics, farm characteristics, and institutional characteristics. The conceptual framework of this study envisaged a series of cassava attributes that farmers can choose when they decide to plant cassava (e.g. disease-resistant, drought-resistant, roots yield, sensory-taste, roots size, starch content, maturity time, inputs price, hardness, softness, inputs needed, leaves yield, architecture, the color of the cassava). Using a rapid reconnaissance, a list of five cassava cuttings attributes was preferred by cassava farmers in the study area, these are roots yield, resistance to diseases, taste, maturity time, and inputs price. These attributes were then used in the WTP assessment. Based on our knowledge on the topic and insights from empirical review, factors that influence preferences and WTP for cassava cuttings attributes are socio-economics characteristics, farm characteristics, and institutional factors. These factors could be (i) age of the farmer, (ii) education level, (iii) land ownership status, (iv) cassava land size, (v) experience in producing cassava, (vi) project beneficiaries status, and (vii) distance to the market (Ulimwengu and Sanyal, 2011; Baidoo and Amoatey, 2012; Bentley *et al*., 2017; Acheampong *et al*., 2018; Awio *et al*., 2019; Maggidi, 2019; Kgosikoma *et al*., 2020 and Kimathi *et al*., 2021).

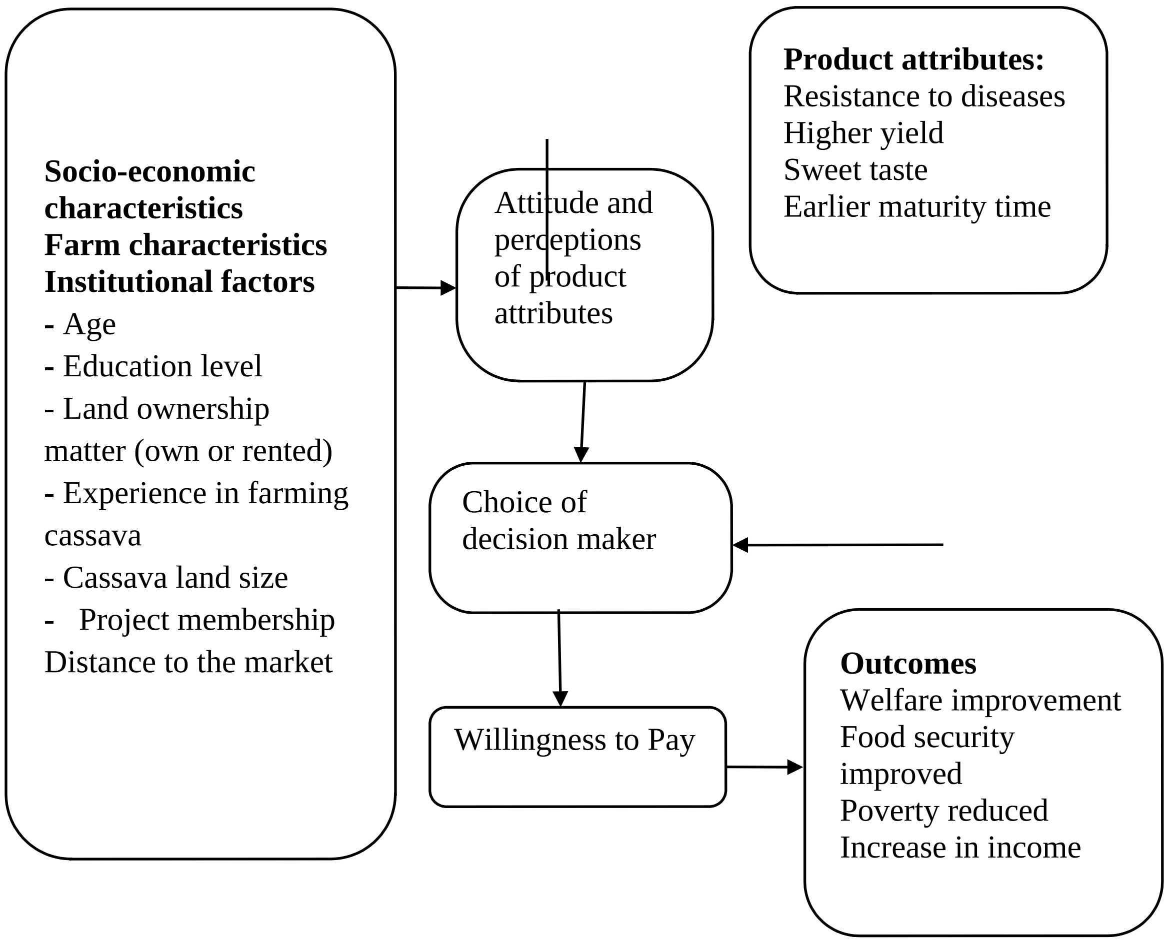

Figure 1.1: Conceptual framework of the study

Source: Author, 2022

1.6 Study Area

The study was carried out in the Rugombo District located in Cibitoke province (Northwest Burundi). Rugombo district is located in Imbo natural region and borders two countries, Rwanda and the Democratic Republic of Congo, respectively, to the north and the east. It is a region with low rainfall, a tropical climate with a dry season of at least 3 to 5 consecutive months depending on the altitude; the average precipitation is 900 mm. It is an area that experiences a great diversity of food and industrial crops. The value of the soil maintains high fertility, but the development of which requires stringent anti-erosion measures. Rugombo district was chosen for two reasons. First, it is located in Cibitoke, one of the real granaries of food security in Burundi. For example, it contributed 32% of the national cassava production in 2003. Second, CIBIOKE is among the provinces most affected by CMD and CBSV diseases. It is the one that has recorded an insufficiency or a shortage of cassava cuttings since the 2018B season (RERAA, 2018).

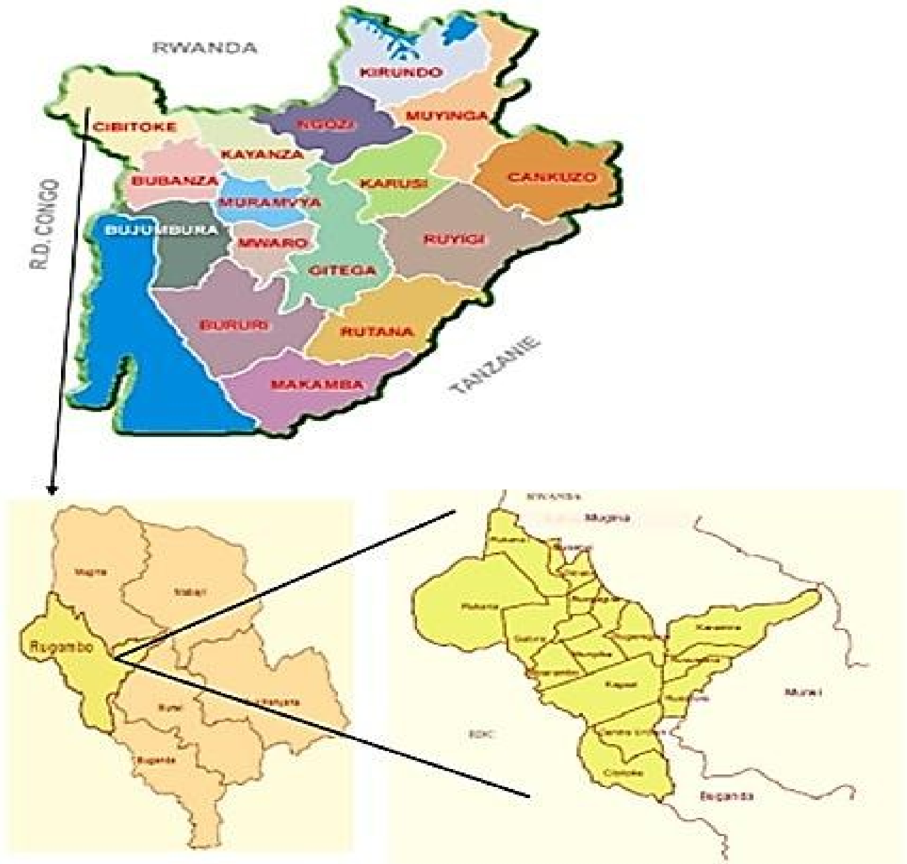

Figure 1.2: Map of Rugombo district, Cibitoke province in Burundi

Source: Monograph of Rugombo district, 2006

1.7 Data and Research Design

This study employed cross-sectional data collected in Rugombo district. A structured questionnaire was used to gather information necessary to address the three specific objectives of this study.

Specifically, the information collected ranged from the farmers' socio-economic characteristics, farm characteristics and institutional factors to farmers' willingness to pay for the cassava cuttings attributes. Other information was regarding farmers' preferences and attitudes to improved cassava attributes in question. Moreover, additional information was collected from secondary sources such as official databases, journal articles, and reports. This design was chosen because it allows collecting data at a single point in time, It is relatively cheap and less time-consuming. It allows data collection from a large pool of subjects and compares the difference between groups (Kraemer *et al.*, 2000).

1.8 Sample Size and Sampling Procedure

The target population in the study area was cassava farmers, heard of households, both those who received cassava cutting for free from the project (project beneficiaries) and those who did not get cassava cuttings from the project (non-project beneficiaries). A systematic sampling approach has been used: firstly, the Rugombo commune was purposively selected as the study area. The area was chosen because it is one of the regions where cassava is intensively cultivated. It is also a region that has been seriously affected by CMD and CBSV diseases. Most crucial, it is a region where the International Institute of Tropical Agriculture (IITA) and the Institute of Agronomic Sciences (ISABU) would experiment with new improved cassava cuttings. Secondly, stratification of the targeted population was done. After a list of 4132 cassava farmers was obtained from ISABU, the reseacher applied the formula by Krejcie and Morgan (1970) to determine the sample size as follows:

$$n=\frac{N*x^2*p*q}{d^2*(N-1)+(x^2*p*q)} \quad \ldots\ldots\ldots\ldots (6)$$

Where n = sample size, $x^2$is the table value of chi-square for 1 degree of freedom at the desired confidence level (at 95% confidence level, x^2= 3.8416 ≈ 3.84), N = total number of cassava farmers, p = population proportion considered to be 0.5 to provide maximum sample size, q = (1-p) = 0.5 and d = degree of accuracy expressed as a proportion

(d = 0.05).

Applying the formula, the sample size for the study is set at 351≈ 352 cassava farmers. The area of study is constituted of 14 wards, i.e. strata where the production of cassava is popular. The researcher, therefore, could proceed with the stratification of the sample. The weight of each stratum was obtained by dividing the strata population and total population. Thus, the numbers of farmers to be interviewed for each stratum (weighted wards sample size) was obtained by multiplying the weight by the total sample size (352). Thirdly the reseacher proceeded with random sampling by randomly picking each 12th farmer from the list of each ward (total population for each stratum divided by weighted wards sample size).

Table 1.1: Sampling procedure

True Wards	Total population	Weight	Weighted wards Sample Size	Sampling interval per ward
Ruvumera	235	0.056873	20	12
Kagazi 2	553	0.133833	47	12
Kagazi 3	426	0.103098	36	12
Cibitoke	330	0.079864	28	12
Rukana	568	0.137464	48	12
Musenyi	291	0.070426	25	12
Gabiro	83	0.020087	7	12
Samu	158	0.038238	13	12
Gicaca	109	0.026379	10	12
Kiramira 1	253	0.061229	21	12
Kiramira 2	226	0.054695	19	12
Rusoro	386	0.093417	33	12
Munyika	228	0.055179	19	12
Mparambo	286	0.069216	24	12
	4132	1	352	

1.9 Organization of Dissertation

This work is organized into publishable manuscripts format consisting of four chapters. First, the introduction presents the general context, the scope, the objectives, the research questions, the contribution of the study, conceptual framework, study area, sampling, and sampling procedure. Chapter two presents the first manuscript, which focuses on attributes of improved cassava cuttings prioritized by farmers in the study area. This paper will be published in the *Journal of Agribusiness in Developing and Emerging Economies.* Chapter three focuses on WTP for improved cassava cuttings attributes in Rugombo district, Burundi. This paper is submitted to *Eastern and Southern Africa Journal of Agricultural Economics and Development.* Finally conclusions of the majors’findings and recommendations are presented in chapter four.

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CHAPTER TWO

2.0 Farmers’ attributes prioritization for improved cassava cuttings in Rugombo district, Burundi

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2.1 Abstract

Purpose- The paper aims to explore farmers’ prioritization for cassava cutting attributes in Rugombo district. Specifically, the study assessed: (i) cassava varieties that are grown by farmers in the study area, and (ii) cassava cutting attributes prioritized by farmers when they decide to grow cassava.

Design/methodology/approach -Primary data were collected in Rugombo district, Cibitoke province in Burundi where cassava is intensively grown. A systematic sampling approach was used to select 352 respondents for this study from the list of cassava farmers. A semi-structured questionnaire was used to get cassava varieties grown by farmers, while the Focus Group Discussion (FGD), semi-structured questionnaire, and Best-Worst Scaling (BWS) questions were used for cassava cuttings attributes prioritized by farmers in the study area.

Findings- Results from a semi-structured questionnaire show that most of the respondents (58.81%) grow *Soranje* variety, which is a variety with long white cassava cuttings that can be grown in the upland and lowland areas. *Sorange* variety has a sweet taste, but the leaves are bitter. Other varieties cultivated in the study area were *Yongwe, Vewiti, Veduze, Gitamisi* and *Mugabo muremure.* Results from FGD, semi-structured questionnaire, and BWS show that farmers prioritized most resistance to diseases compared to other cassava cuttings attributes which include roots yield, taste, maturity time, roots size, hardness and softness. BWS was able to show also the least preferred attributes such as inputs needed, followed by leaves yield, starch content, softness and input price. The study recommends to the Ministry of Agriculture and other development partners involved in cassava cuttings multiplication to avail and considers the prioritized attributes in their interventions and actions.

Research limitation: The study represents attributes prioritization in one district, in Cibitoke province, Burundi. However, this study speculates farmers with representative characteristics in that province are likely to behave the same.

Originality: The paper offers the improved cassava attributes prioritized by farmers by using different methods.

Keywords*:* Cassava Cuttings Attributes, Focus Group Discussion, Semi-structured questionnaire, Best-Worst Scaling, Burundi.

Paper Type: Research paper

2.2 Introduction

Cassava was considered as the food of the poor households (Howeler *et al.*, 2013), yet, it is the staple food of over 800 million in the tropics, including 500 million in Africa (Vernier *et al*., 2018). In sub-

Saharan Africa, cassava is one of the major food crops and ranks second after maize and the third most important crop after beans and bananas in Burundi (Assanvo *et al.*, 2017). Cassava is also the most practiced among tube and roots crops in Burundi with a planted area of 77.5% of the total tuber area (ENAB, 2017). Cassava is also considered as an important crop because it is less demanding in terms of inputs and contains higher energy foods and vitamins (Aloys and Ming, 2006 and Li *et al.,* 2017). All these characteristics make cassava important in the fight against food insecurity (Vernier *et al.,* 2018).

Despite its importance, cassava production in Burundi is very low with average yields of 6029 kg/ha for bitter cassava, and 4819 kg/ha for sweet cassava (ENAB, 2017). This means an average of 10.8tons/ha compared to the yield potential of 30-50tons/ha of the research centers such as the International Institute of Tropical Agriculture (IITA) and the International Center for Tropical Agriculture (CIAT) (Howeler *et al*., 2013; Vernier, 2018). Crop diseases compound the problem further, recent statistics indicate that cassava production has declined by 50% to 100% from 2015 to 2019 due to CMD and CBSV (PRODEMA, 2019). Okonya *et al*. (2019) reported that plant diseases and scarcity of resilient plant material, lead to food insecurity problems in the country. As a way of mitigating such a situation, the government of Burundi, together with its key partners such as IITA and IFAD, have been fighting food insecurity through the multiplication and distribution of resistant cassava cuttings. However, the Assessment of Crops and Food Supplies done in Burundi in 2018 (ACFS) recognized that the outcome of these interventions has often not met the expectations and interests of many farmers. The 2018 ACFS revealed that the use and availability of improved cassava cuttings were very limited, with only two provinces in 18 having 80800 cassava cuttings grown. This low rate of adoption resulted in low productivity (ACFS, 2018). A study done by David (2003) on a sustainable seed supply system in Rwanda, Burundi, DR Congo, and Malawi shows that there should be a regular potential demand for new seeds to be introduced into the local seeds' system. However, farmers do not traditionally buy cuttings; they rely mainly on their stocks or obtain them from other farmers. Cassava is also considered as a public good given its vegetative propagation, which creates little incentives as a business opportunity for private seed suppliers (David, 2003). The question then is whether farmers can buy cassava cuttings. There is, therefore, a need of assessing farmers' prioritization and preferences in terms of quality before the product cassava cuttings reach the market, in the hope of sustainability.

Previous studies explored farmers' prioritization for cassava cuttings by using different methods such as FGD and semi-structured questionnaires where results show that higher productivity, resistance to diseases, maturity time, stay long on the ground, and roots size were prioritized by farmers (Bentley *et al.,* 2017; Acheampong *et al.*, 2018; Teeken *et al*.,2018 and Wossen *et al.*, 2017). But a study done by Walker and Alwang (2015) on a project quantifying the adoption of improved genotype in food crop and dryland regions shows that the adoption of seed variety differs among crops, individuals, regions, and countries. Due to this fact, a study assessing the adoption of cassava cuttings is very crucial in Burundi. Little is known about cassava farmer prioritization in Burundi, especially in the study area.

This paper contributes hence to the body of literature on farmers' prioritization for cassava cuttings by using different methods such as FGD, semi-structured questionnaires, and BWS. More specifically, the study assessed (i) cassava varieties that are grown by farmers in the study area, (ii) and cassava cutting attributes prioritized by cassava farmers in the study area. Two research questions helped to know if the specific objectives were assessed, and were liberated as follow: (i) what are cassava varieties grown by farmers in the study area, and (ii) what are cassava attributes prioritized by farmers in the study area? It is essential to note that knowing the varieties that had already existed in the study area as well as their attributes would allow the actors involved in the seeds' multiplication, to know the superiority of the new variety in key traits and its distinctness. Understanding farmers' prioritization allows policymakers to know farmers’ needs and respond by coming up with relevant technologies.

2.3 Literatures on Preferences for Cassava Cuttings Attributes

Several studies have been carried out on consumers’ preferences for various cassava cuttings and other crops. For example, Acheampong *et al*. (2018) used FGD to get cassava attributes to be used in a discrete choice experiment (DCE) and the results show that higher productivity, resistance to diseases, and longevity of roots storage in the soil, and the purchase price were the traits prioritized by farmers in Ghana.

Bentley *et al*. (2017) and Teeken *et al*. (2018) used also FGD and individual interviews to explain why farmers adopt specific seed varieties and showed preference differences across regions and gender in Nigeria. Traits such as high yields with big roots, early and late maturity for food security, and ability to store were the most attributes preferred by both women and men in Nigeria. By using a monitoring survey to get cassava farmers ‘prioritization, Wossen *et al.* (2017) added that the quality of *fufu* was preferred by more than 70% of cassava farmers in Nigeria. Thus, in addition to this body of literature, the purpose of this study is to assess prioritized cassava cuttings’ attributes in the Rugombo district in Burundi by comparing the results of different methods such as FGD, semi-structured questionnaire, and BWS; since preferences attributes for seeds vary across varieties, regions, and countries according to the methodology used.

2.4 Methodology

2.4.1 Study area

The study was carried out in the Rugombo district located in Cibitoke province (Northwest Burundi). Rugombo district is located in Imbo natural region and borders two countries, Rwanda and the Democratic Republic of Congo, respectively, to the north and the east. It is a region with low rainfall, a tropical climate with a dry season of at lasts 3 to 5 consecutive months depending on the altitude; with an average precipitation of 900 mm. It is an area that experiences a great diversity of food and industrial crops. The value of the soil maintains high fertility, but the development of which requires stringent anti-erosion measures. Rugombo district as a study area was chosen for two reasons. First, it is located in Cibitoke, one of the real granaries of food security in Burundi. For example, it contributed 32% of the national cassava production in 2003. Second, Cibitoke is among the provinces most affected by CMD and CBSV diseases, and it is the one that has recorded a shortage of cassava cuttings since the 2018B season (RERAA, 2018).

2.4.2 Research design and sampling procedure

This study employed cross-sectional data collected in Rugombo district. A structured questionnaire and FGD were used to gather the information necessary to address the two specific objectives of this study. Specifically, the information collected ranged from the farmers' socio-economic characteristics to farmers' preferences and attitudes towards the cassava attributes in question. Moreover, additional information was collected from secondary sources such as official databases, journal articles and reports.

The target population in the study area was cassava farmers, heads of households, beneficiaries of cassava cuttings from the project and non-project beneficiaries. A systematic sampling approach has been used: firstly, the area was purposively chosen because it is one of the regions where cassava is intensively grown. Secondly, stratification of the targeted population was done. After a list of 4132 cassava farmers was obtained from the Burundi Institute of Agronomic Science (ISABU), the sample size was determined using the formula developed by Krejcie and Morgan (1970) as follows:

$$n=\frac{N*x^2*p*q}{d^2*(N-1)+(x^2*p*q)} = 351 \approx 352 \;\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Where n is the sample size, x^2 is the table value of chi-square for one degree of freedom at the desired confidence level (at 95 percent confidence level, x^2 = 3.84), N is the total number of cassava farmers, p is the population proportion considered to be 0.5 to provide maximum sample size, q = (1-p) = 0.5, and d is the degree of accuracy expressed as a proportion (d = 0.05). The study area is constituted of 14 wards, i.e. strata where the production of cassava is popular. The weight of each stratum was obtained by dividing the strata population and total population. Thus, the numbers of farmers to be interviewed for each stratum were obtained by multiplying the weight by the full sample size (352). Thirdly, random sampling by randomly picking each 12th farmer from the list of each ward followed.

2.4.3 Analytical method

2.4.3.1 Focus Group Discussion (FGD)

The study used the FGD to identify important cassava attributes prioritized by cassava farmers in the study area. The researcher led the group discussion, accompanied by agronomists, monitors and local representatives in the Rugombo district. The first discussion distinguished the project beneficiaries of improved cassava cuttings versus non-project beneficiaries. In this session, men appeared to monopolize the conversation and because of this, women and men were then separated into different groups that allowed them to respond comfortably. The rules for discussion groups were proposed by the participants and the facilitators who tempered the debate in the national/local language (Kirundi) to let participants feel free in responding.

The cassava farmers in FGD were asked general questions on cassava attributes and factors that they mostly consider when deciding to grow cassava in the study area; then, participants were asked again to rank the attributes according to their importance. Each group comprised four up to eight people and four groups were sufficient per ward if there was no new information. Moreover, the discussion time was between one up to two hours to ensure an appropriate conversation time for each participant.

The results were analyzed by reviewing all the responses given by the groups, highlighting the characteristics that were repeated many times by the participants. The group discussion ended by warmly thanking all the people who were present at the discussion, and the researcher promised them that, when the results are out, they will be reported to them in brief.

2.4.3.2 A semi-structured questionnaire

A semi-structured questionnaire was used in data collection to get information on household socioeconomic characteristics, varieties cultivated and attributes prioritization. The semi-structured questionnaire is one of the most effective tools for systematically collecting qualitative and quantitative data (Adejimi *et al*.,2010). In this study, the determined questions related to the research objectives were asked. For example, each respondent was asked: i) the cassava varieties grown in the study area ii) the key characteristics of each variety, and iii) key attributes that they consider when deciding to plant cassava. Afterward, the data have been coded and sorted for analytical purposes. The data was then cleaned, especially the open questions where the answers were long from one respondent to another. Sufficient time was used to read and understand all the data collected by four enumerators to get a consistent view of all the data before the analysis. Finally, a descriptive analysis was done using STATA 15 software and a list of varieties grown in the region was established, as well as the percentage of farmers who prefer each respective variety, as well as cassava cutting attribute prioritized by farmers.

2.4.3.3 Best-Worst Scaling (BWS)

BWS is a survey method for assessing individual priorities and it was first introduced by Finn and Louviere (1992), who studied a discrete choice task by asking respondents to select both the best and the worst option in the available set of options. The model identifies the extremes-best and worst items, most and least important factors, and biggest and smallest influences among sets. Therefore, a set of 12 cassava attributes was first arranged and grouped into sub-groups, as shown in Table 2.1. Then R software was used for full factorial design and blocking, which gave 64 profiles (2^4*4 = 64). The profiles were blocked in 8 groups, each block containing eight profiles, therefore, each farmer responded to 8 profiles, made of 5 attributes each. The study was carried out with a sample size of 352 cassava farmers divided into eight groups, i.e. 44 cassava farmers per group, where each group had their block of 8 profiles. Each of 352 respondents to 8 completed profiles, resulting in 2816 for the best, and 2816 for the worst (352 individuals* 8 profiles). Responses from BWS questions were converted into an individual-level scale for each cassava attribute by counting the number of times chosen as most liked, and the number of times selected as least liked.

$$\sum(attrributeB - attributeW)\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

Table 2.1: Attributes used in BWS questions

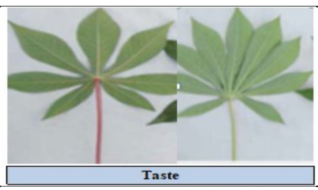
Organoleptic quality	**Roots characteristics**	**Nutritional value**	**Material and financial ressources**	**Agronomic performance**
Softness (How soft cassava is after cooking)	**Roots size**	**Leave Yield** (Amount of leaves/ vegetables)	**Inputs needed** (Amount of chemicals, fertilizers, cuttings and labour needed to produce the cassava)	**Resistance to diseases/Pest**
Hardness (Hard cassava can be stored longer periods underground)	**Roots taste**	**Starch content**	**Price of cassava cuttings**	**Maturity time**
				Roots yield
				Architecture (Branching pattern – more cuttings)

For example, for individual number one in table 2.5 of results from BWS, best minus worst score for disease resistance =2, maturity time= 1, roots taste = 2, roots yield = 1, price of cassava cuttings = 0, hardness= 0, softness = -4, roots size = 0; leave yield = 0; architecture = 0, input needed = 0; starch content = -1. A value of 2 for disease-resistant was obtained because the first respondent selected disease resistance as the most important two times. The same attribute was not chosen as the least important. A value of 1 for maturity time was obtained because the respondent selected maturity time as most important once, and maturity time was not selected as the least important. A value of 0 for the price of cassava cuttings means that cassava cuttings were chosen as the best equally as it is selected as the worst, or the same attribute has never been chosen as the best or the worst. A (-4) for softness was obtained because the attribute was not selected as the best, but it was selected four times as the worst. A value of -2 for leaves yield means that leaves yield has never been chosen as the most important, and it was chosen as the worst two times by the respondent.

A value of -1 for starch content means that the attribute has never been selected as most important, and once as least important (Table 2.5). The individual-level scales can be comparable between respondents and when aggregated across all participants, the net frequency of best minus worst scores gives an overall score for a sample (Jaeger *et al.*, 2008).

Table 2.2: Example of BWS questions

Which of the following issue is most important and which is least important when you decide to grow cassava?

Most Important		Least Important
		
		

	Starch content	
	Input price	
	 Roots Yield	

2.4.3.4 Data analysis

The descriptive statistics revealed cassava variety grown in the study area with their prioritized attributes, while other questions were summarized as general descriptive results. The attributes prioritized by farmers were based on McFadden's (1974) random utility theory, in which utility has deterministic and probabilistic components. First of all, it is necessary to describe the preferences of individuals, that is, how they prefer one good to another. Then, having limited resources, the consumer will seek the maximization of utility under budget constraints (Deaton and Muellbauer, 1980). The combination of preferences and budget constraints determine consumer choices and, more specifically, what combination of goods economic agents will choose to maximize their utility. Several attributes or characteristics determine the utility assigned to each alternative, and since an individual's direct utility cannot be measured, their choices can be observed (Yumbya *et al.,* 2018). The agent gets some utility for each alternative, observed characteristic of the decision-maker and unobserved characteristic. Facing choices among and ***i*** alternatives with Uni and Unj level of utility, the consumer will choose ***i*** if and only

$Uni > Unj, j \neq i.$ ……………………………………………………..…….……..… (3)

By decomposing the utility of each alternative Unj into two components: utility of observed factors Uxj and utility of unobserved factor $\mathcal{E}nj$;

$Unj = Xnj + \mathcal{E}nj;$ …………………………………...………………………………(4)

$Unj = V (Xnj, Sn)$: is called representative utility……………………………….……......…(5)

Xnj**:** vector of attributes of the alternatives, Sn**:** vector of characteristics of the decision-maker, $\mathcal{E}nj$**:** everything that affects utility is not included in Unj**,** and this can be treated as a random form from our perspective. The representative utility can be specified as a linear function where: $Unj = \beta Xnj$…………………………….……….……………..…… (6)

With the linear representative utility, the total utility that alternative j gives a cassava farmer n is:

$Unj = \beta Xnj + \mathcal{E}nj$…………….………………...…………………..…..... (7)

The structural parameter tells how the observable attributes relate to unobservable utility.

2.5 Results and Discussions

2.5.1 Characteristics of the sample

A total of 352 respondents were surveyed for this research, of which one-half were women and the other half were men. The average age of cassava farmers, head of household is 45 years, which is approximately the same as the one found by the National Agriculture Survey done in Burundi in 2017 (ENAB, 2017) which also found the average household age to be 54.2 for the household led by men and 43.7 for the household led by women. The majority of farmers sampled had primary level education i.e. 41.76%, followed by secondary school level with a percentage of 38.92%, while 17.6% of farmers had informal education. Only 1.7% of interviewed farmers had a university education level (Table 2.3).

Table 2.3: Respondents' profile

	Frequency	Percent
Sex		
Male	176	50.00
Female	176	50.00
Education level		
No formal education	62	17.61
Primary	147	41.76
Secondary	137	38.92
University	6	1.7
Land ownership status		
Own	240	68.2

Own and rent land	36	10.2
Rent land	75	21.3
Easy access to cuttings		
Yes	100	28.41
No	252	71.59
Source of cuttings		
Farmers group	6	6.06
Government extension services	6	6.06
Cooperatives	8	7.07
Inputs dealer	7	7.07
Friends	72	72.73

On average, cassava farming experience is 21 years; this suggests that the majority of interviewed farmers have been producing cassava for a long time. Additionally, the findings revealed that an average of 43 Ares is the land for all plants/crops grown and 27 Ares is for cassava (Table 2.4). The findings are almost similar to those of ENAB (2017), whereby the average area cultivated was 107.3 Ares in 2017 on a national level, and the average area cultivated was 54.5 Ares in Cibitoke province where Rugombo district is found within. One acre equal to 40.469 Ares/or one hectare equal to 100 Ares (One Are is also equal to 10m * 10m = $100m^2$).

The land used in producing cassava in the study area falls under 3 categories of holding status that are: own land, rented land, or both. About 68.2 % of cassava farmers sampled have their land (inheritance, land bought, gift land), 10.2 % have both own and rent land, while 21.3% use only the rented land to produce cassava. Among the cassava farmers who were interviewed, 71.58% of them admitted not having easy access to improved cuttings, and 28% of these farmers have access to cassava cuttings. The majority of cassava farmers interviewed (72.73%) admitted using cassava cuttings obtained through informal sources from neighbors, and relatives. However, 28% of cassava farmers grow cassava cuttings obtained through official sources such as farmers' groups, cooperatives, and inputs dealers (Table 2.3). These figures reflect the predominance of informal sources of cassava cuttings in the research area. In addition, the study results revealed that the distance from the cassava farm to the market is on average 3 km, with a minimum, and maximum of 1 and 6km, respectively (Table 2.4).

Table 2.4: Farmers' organizations (observation=352)

Variables	Mean	Minimum	Maximum
Age	45	19	92
Farm size	42.95	5	200
Cassava farm size	27.44	2	130
Experience in cassava farming	21.43	2	65
Distance to the market	3	1	6

2.5.2 Cassava varieties grown by farmers in the study area

The respondents indicated that cassava varieties grown in their fields were *Soranje, Veduze, Vewiti, Gitamisi, Yongwe, Inakarasi, Mugabo muremure,* and *Mpambo y'urgendo.* Farmers attributed these names according to the characteristics of each variety, and its appearance in the field. For example, *Vewiti* is a cassava variety with short cuttings, high yield, big and long roots, with a sweet taste. The leaves can be eaten since they are not bitter. *Vewiti* variety is planted in high altitude lands, not lowland areas. *Vewiti* name was given based on the size of their big roots. Usually, *Vewiti* is *V8*, a French name representing a car with an 8-cylinder engine in V. *Veduze* variety is almost the same as *Vewiti*, the difference is in the size of cuttings, and cassava roots that are bigger, and longer compared to *Vewiti* variety. *Veduze* is V12 in French, the name of a car with a 12-cylinder engine in V. *Gitamisi* variety has long cuttings, the root and the leaves are bitter, but it has a good quality of the flour. *Gitamisi* is a Burundian name that means going beyond the days. Farmers admitted that the variety can exceed the maturity period and remain under the ground for a long time. *Yongwe* variety has large long roots with a bitter taste, high yield and their leaves are good as vegetables. It is mainly cultivated in upland than lowland areas. Farmers testified that it is the first variety with a good quality of flour. *Yongwe* is a Burundian name which means something that is very bitter. *Yongwe* can cause illness once eaten fresh. *Sorange* is a cassava variety with long roots and a sweet taste with bitter leaves. It has long white cassava cuttings that can be grown in the plains and mountains. *Soranje* is "*Solange*" in French which is the first name of a girl or a woman. This variety name came from white color of the cuttings and the roots. *Mugabo Muremure* variety has long cassava cuttings, long roots depending on where they are planted. The variety allows also to have more cassava cuttings. The cassava roots have sweet taste and the leaves are proper for consumption. *Mugabo muremure* is a Burundian name that means a tall man. Therefore, this name was given based on the size of the roots. *Mpambo yurugendo variety* has roots with a medium-size and sweet taste. *Mpambo y urungendo* is a Burundian name, which represents something that someone can travel with and eat it when he/she is hungry. The roots are very good for chewing and can be cooked. *Inakarasi* roots are medium-sized with a bitter taste but they produce a good quality flour. The cuttings are white, the leaves provide very good vegetables.

Among varieties, the most preferred is *Soranje*, followed by *Yongwe*, *Vewiti*, *Veduze*, *Gitamisi and Mugabo muremure*. About 58.81 % of farmers prefer *Soranje* variety, 16.48% prefer *yongwe* variety, 10.23% prefer *Vewiti*, 9.38% prefer *Veduze*, 3.13% prefer Gitamisi, 1.99% prefer Mugabo Muremure (Figure 2.1). Therefore, the first research question which asked the cassava varieties grown by farmers in the study area has been answered.

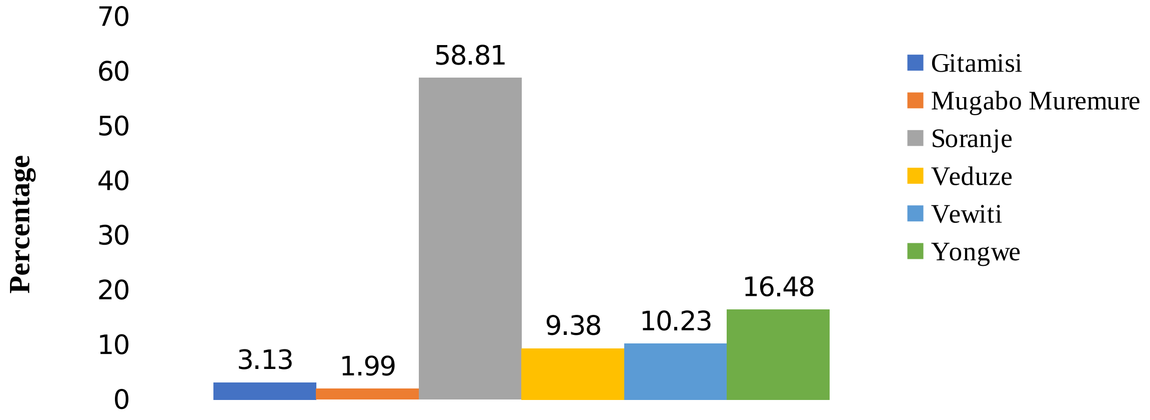


Figure 2.1: Most preferred cassava varieties

The preference was influenced by the availability of the cuttings, the needs of the consumers, the culture, the experience of growing cassava and other farm characteristics. For example, farmers prefer cassava with a bitter taste for good cassava flour and its low risk of being stolen or harvested by random passengers desiring direct consumption at row status before the effective harvesting period. For the sweet taste attribute, cassava with such attribute is preferred for its possible immediate consumption and if produced for the market. After harvest, such cassava roots can be boiled and eaten without further processing. The maturity time for cassava crops in the Rugombo community varies between 6-12 months and 8-12 months. Early maturity allows farmers to meet food needs, and to grow other crops at the time. Farmers admitted that eight months are enough for the cassava to mature and have hard cassava roots that can be stored for longer periods under the ground, which helps mitigate food insecurity shocks.

It is mostly preferred for the cassava variety with a higher yield because it allows farmers to meet food needs and increase income. Most of the varieties (*Soranje*, *Vewiti*, *Veduze*) were chosen because of their resistance to *mosaic* diseases, while *Yongwe* and *Gitamisi* are old local varieties.

2.5.3 Farmers' prioritization for improved cassava cuttings attributes

2.5.3.1 Farmers' prioritization for improved cassava cuttings attributes: FGD and semi-structured questionnaire

In FGD, the discussion started with a revised list of 14 cassava attributes to determine the final list of attributes. These attributes were disease resistant, drought resistant, roots yield, sensory-taste, roots size, starch content, maturity time, inputs price, hardness (hard cassava can be stored longer periods underground), softness (how soft cassava is after cooking, or less cooking time), inputs needed, leaves yield, architecture (meaning branching pattern and more cuttings), the color of the cassava. Finally, a list of four attributes was selected to be prioritized by cassava farmers, which were, i) resistance to diseases, ii) maturity time, iii) roots yields, and iv) taste, respectively. The results converge with those of existing literature but the yield level was in the pic when FGD was used to assess farmers' prioritization. For example, results from Acheampong *et al*. (2018) show that higher productivity was the first to be prioritized by farmers, in Ghana followed by resistance to diseases, the longevity of roots storage in the soil and purchase price. Bentley *et al.* (2017) and Teeken *et al.* (2018) used FGD to show preference differences across regions and gender in Nigeria where traits yield level was also the first to be prioritized, followed by big roots (roots size), maturity time, and ability to store in the ground.

Results from a semi-structured questionnaire show that among the same 14 cassava attributes used in FGD but presented individually to respondents, resistance to disease, yield level, taste, maturity time, hardness, softness and more leaves were prioritized by farmers in this order. The results are in line with those of Wossen *et al*. (2017) who found that yield level, roots size and earlier maturity time were among traits preferred by more than 70% in Nigeria, when they were using a monitoring survey. The results are also in line with those of Nakabonge *et al.,* 2017 who found that storability in the ground and early maturity time were among cassava attributes prioritized by farmers, in Uganda.

2.5.3.2 Farmers' prioritization for improved cassava cuttings attributes: BWS methods

The results from BWS in Table 2.5 show that cassava farmers in the study area most prioritized disease resistance with a higher score of 677 compared to other attributes. The results align with those got in this study when used FGD and semi-structured questionnaire; but the yield level was on top of existing literature that used different methods (Acheampong *et al.*, 2018; Bentley *et al.*, 2017; Teeken *et al.*, 2018 and Wossen *et al*., 2017). Other cassava attributes prioritized by farmers in the study area were the taste of cassava roots with a score of (542), followed by roots yield (454), maturity time (288), roots size (64), hard cassava that can be stored longer periods underground (45), and architecture (3). These findings are consistent with the findings of Teeken *et al*. (2018) who found that roots yield, maturity time and roots size were the most important traits for both men and women cassava farmers processors in Nigeria. In addition, a study done by Bentley *et al.* (2017), Nakabonge *et al*. (2017) and Acheampong *et al*. (2018) while using a FGD and semi-structured questionnaire, found also that storability in the ground was among the most preferred cassava attributes in Ghana, Uganda and Nigeria respectively.

Using B-W choices, the advantage is that the resulting scaling is known and increased discrimination among items is achieved. For instance, the least preferred attributes in the study area are inputs needed (-835) followed by leaves yield (-732), starch content (-369), softness (-294), and input price with a score of (-63) (Table 2.5).

Table 2.5: Results from BWS

Observation	Diseases resistance (B - W)	Maturity time (B-W)	Taste (B-W)	Roots yield (B-W)	Price (B - W)	Hardness (B - W)	Softness (B - W)	Roots size (B - W)	Leaves yield (B - W)	Architecture (B - W)	Inputs needed (B-W)	Starch content (B - W)
1	2	1	2	1	0	0	-4	0	-2	0	0	-1
2	2	1	2	2	0	0	-4	0	-2	0	0	-1
3	2	1	2	1	-1	0	-2	0	-3	0	-1	0
4	2	1	3	0	-2	-4	0	1	0	0	-2	0
5	1	1	3	1	0	0	0	-2	-4	1	-1	-1
6	2	1	2	2	-3	0	0	0	-1	1	-4	0
7	1	1	3	1	-1	1	-2	0	-4	0	-1	0
8	1	1	3	1	-1	1	-2	-1	-2	-1	-1	0
9	2	2	1	2	0	1	-2	0	-3	0	-2	-1
10	2	1	2	1	0	1	-2	0	-4	0	-1	-1
352	2	1	2	2	0	1	-2	-1	-1	0	-2	-2
Total	**677**	**288**	**542**	**454**	**-63**	**45**	**-294**	**64**	**-732**	**3**	**-835**	**-369**
Ranking	1	4	2	3	8	6	9	5	11	7	12	10

2.5.4 Comparison of results from different methods

This study used three (3) methods to assess farmers' prioritization attributes in the study area that are FGD, semi-structured questionnaire, and BWS questions. Between 14 cassava attributes presented to farmers, four attributes were chosen to be the most important in FGD and those attributes are i) resistance to diseases, ii) roots yields, iii) taste, and iv) maturity time. When those 14 attributes were used in semi structured questionnaire, resistance to diseases was the most preferred, followed yield, taste (sensory), maturity time, hardness, softness, and leaves yield respectively. Results from BWS show that attributes prioritized by respondents were diseases resistance (677), taste (542), roots yield (454) maturity time (288), roots size (64), hardness (45) and architecture (3) (Table 2.5).

In conclusion, the FGD, semi-structured questionnaire, and BWS gave the same four important attributes that were resistance to diseases, roots yield, taste, and maturity time, but the classification was not the same as discussed. The second research question which asked the attributes of cassava cuttings prioritized by farmers when deciding to grow cassava has been answered. Also, the prioritization was different according to the methodology used as shown in Table 2.6. For example, roots size and hardness were the fifth and sixth to be prioritized by respondents in semi-structured questionnaire and BWS method respectively, while they were not mentioned as priority in the FGD. Architecture attribute was the seventh to be prioritized in the BWS while it was not in the FGD, and individual questionnaire. Softness was the seventh (the last) to be prioritized in semi structured questionnaire while the attribute was among the least preferred attributes after inputs price in the BWS. The BWS was able to show the least preferred attributes that were not shown in the FGD and semi-structured questionnaire. Those attributes were inputs needed, followed by leaves yield, starch content and inputs price (Table 2.5).

Table 2.6: Farmers' prioritization for improved cassava cuttings attributes

FGD	Semi-structured questionnaire	BWS	
		Most important	**Least important**
Resistance to diseases	Resistance to diseases	Resistance to diseases	Inputs needed
Roots yields	Roots yield	Taste	Leaves yield
Taste	Taste	Roots yield	Starch content
Maturity time	Maturity time	Maturity time	Softness
	Roots size	Roots size	Inputs price
	Hardness	Hardness	
	Softness	Architecture	

2.6 Conclusions and Recommendations

2.6.1 Conclusion

The goal of this study was to assess farmers' prioritization for improved cassava cuttings attributes in Rugombo district, Burundi. The cassava varieties that are grown as well as cassava cutting attributes prioritized by cassava farmers when they decide to grow cassava were assessed. A systematic sampling approach was carried out, along with a cassava farmer survey, among 352 in the study area.

Results from a semi-structured questionnaire show that about 58.81 % of farmers prefer *Soranje* variety, 16.48% prefer *yongwe* variety, 10.23% prefer *Vewiti*, 9.38% prefer *Veduze*, 3.13% prefer *Gitamisi* and 1.99% prefer *Mugabo muremure.* In general, results from three methods used (FGD, semi-structured, and BWS) show that farmers prioritized the most resistance to diseases as compared to other cassava cuttings attributes but their classification differed. First, after resistance to diseases, other attributes prioritized by farmers in FGD were maturity time, roots yield and taste in this order. Second, results from a semi-structured questionnaire show that resistance to disease was followed by yield level, taste, maturity time, hardness softness (less cooking time), and more leaves in this order. At last, BWS results show that disease-resistant, taste, roots yield, maturity time, roots size, hardness and architecture were prioritized respectively. BWS was able to show the least preferred attributes in the study area that were inputs needed, leaves yield, starch content, and input price respectively.

2.6.2 Recommendations

From the conclusion, farmers grow some key varieties with specific characteristics. Therefore, the study recommends to Burundian's Ministry of Agriculture and private actors involved in the multiplication of cassava cuttings to consider the varieties that already existed in study area as well as its attributes because this will allow them to know the superiority of the new varieties in key trait, and its distinctness.

Farmers also prefer cassava attributes that help them to fight against to food insecurity. Therefore, the study recommends also to actors involved in the multiplication of cassava cuttings to consider the attributes preferred by cassava farmers of the study area in their intervention and action of developing cassava crops.

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CHAPTER THREE

3.0 Farmers'Willingness to Pay for Improved Cassava Cuttings Attributes in Rugombo District, Burundi

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3.1 Abstract

Despite cassava being both a staple food, a major source of calories, and the third-largest crop after banana, and beans in Burundi, its seeds system is characterized by informal sectors, and the unavailability of clean and healthy planting material. These challenges, together with the traditional poor farming practices have attributed to low cassava productivity. Therefore, this study used a discrete choice experiment (DCE) to assess farmers' WTP for improved cassava cuttings attributes in Rugombo district, Burundi. Specifically, the study assessed i) farmers' preferences for improved cassava cuttings attributes ii) WTP for attributes of improved cassava cuttings and iii) factors influencing farmers' preferences and WTP for improved cassava cuttings attributes. Primary data were collected in Rugombo district, Cibitoke province in Burundi where cassava is intensively grown. From a list of cassava farmers, a systematic sampling method was employed to select 352 respondents for this study. Results indicate that respondents have strong preferences for higher yield and they were willing to pay more for that attribute (BIF 70) compared to other attributes like resistance to diseases (BIF 36), sweet taste (BIF 35) and early maturity time (BIF 18). Additionally, the study found that preferences, and WTP for improved cassava cuttings attributes are influenced by higher education, land ownership status (both owned and rented land), cassava land size, high experience in producing cassava, project beneficiaries, and distance to the market. The study recommends to the Ministry of Agriculture and development partners involved in cassava cuttings multiplication to avail and consider the preferred attributes in their interventions and actions.

Keywords: Improved Cassava Cuttings Attributes, Willingness to Pay, Choice experiment, Burundi.

3.2 Introduction

The agricultural sector is the backbone of the economy in developing countries. It is the primary source of income for more than 80% of the poor population, and it plays a crucial role in reducing poverty and improving food security (Bouwmeester *et al*., 2012). Vegetative propagated crops such as roots, tube, and banana (RTB) are central in the agriculture production system and consumption choice throughout much sub-Saharan Africa (Wossen *et al*., 2020). For example, cassava is the main food crop in Sub-Saharan Africa and it is the second most common staple food after maize (Assanvo *et al*., 2017). It is the third major crop in Burundi, after banana and beans (Bigirimana *et al*., 2007). Cassava is easily grown with a low level of inputs (water and fertilizer), is drought-resistant (Barratt *et al*., 2006) and is a high energy food (Li *et al*., 2017), making it an important nutritional food to combat food insecurity (Vernier *et al*., 2018).

Despite its importance, cassava production as other RTB is also constrained by several challenges including, informal sectors' dominance, the inaccessibility of clean and healthy planting material and the traditional poor farming practices. These challenges have attributed to low cassava productivity, and food insecurity (Howeler *et al*., 2013). In response to these problems, a decentralized farmers' grouping approach has been used for the multiplication of improved cassava cuttings, and free cuttings delivery (Okonya *et al.*, 2019). However, it is assumed that these efforts can only be impactful if the seeds' system becomes sustainable, meaning that all small-scale farmers have to get access to a suitable variety and quantity of cassava cuttings in their communities. Therefore, there is a need to tackle the problem through a seeds system applying market rules to achieve sustainability. The question then is whether farmers can buy cassava cuttings and, if so, how much are they willing to pay? Given the situation that the product has no market value, hence it is believed that when the product reaches the market, there will be hope for sustainability.

A study done by Walker and Alwang (2015) on project quantifying the adoption of improved genotype in food crop and in dryland regions show that the adoption of seed variety differs among different crops, regions, and countries. Due to this, a study in assessing adoption of cassava cuttings is very crucial in Burundi. Another study done by Almekinders *et al.* (2019) when looking at why seed system interventions for RTB crop do not attain their maximum potential, it becomes obvious that the economic sustainability of seed system interventions cannot be assured because farmers' demand for seeds is unclear. Therefore, more information is required to influence decision-making by the farmers about the replacement of their degenerated seeds.

There is a pool of literature that has focused on adoption of cassava, and other products. For example, a study done by Wossen *et al.* (2017) on adoption of cassava variety in Nigeria show that farmers prefer attributes such quality of flour, higher yield, big roots, and earlier maturity time. Other studies conducted in Tanzania and Ghana assessed willingness to pay for cassava seeds among farmers (Maggidi, 2019; Baidoo and Amoatey, 2012), results show that WTP for cassava seeds is influenced by age, cassava land size, cassava varieties, livestock and family labour, access to information on proposed agricultural services, market access, distance to the market, land ownership matters, source of income, farmers 'income. These studies did not show what farmers prefer when they want to grow cassava. The studies done on commercialization of certified cassava seeds, as well as conservation of cassava varieties in Uganda show that a high quality of planting material, traditional knowledge on variety, cassava's capacity to be stored in the ground, and its quality when cooked are among factors that influence adoption (Awio *et al*., 2019; Nakabonge *et al.,* 2018).

Meanwhile in Burundi, different studies have also been done to increase cassava production. For example, studies done by Bigirimana *et al*. (2011) and Bowmeester *et al.* (2012) recognized the existence of diseases and pests, while Okonya *et al*. (2019) show the quantity of cassava loss due to diseases and pests. Aloys *et al*. (2006) on the other hand demonstrates that cassava should be processed industrially, not traditionally, while Lambri *et al*. (2013) suggested several enhanced cassava cyanide reduction methods. The paper at hand contributes to the existing body of knowledge by assessing (i) farmers preferences for improved cassava cuttings' attributes, farmers' WTP for improved cassava cuttings attributes and factors influencing farmers ’preferences and WTP for the improved cassava cuttings' attributes by using CE approach. Three research questions helped to know if specific objectives were assessed: (i) which cassava cuttings attributes are preferred by farmers when they decide to grow cassava? (ii) what is the WTP for improved cassava cuttings attribute preferred by farmers? (iii) Is there existence of preference heterogeneity for improved cassava cuttings attributes and what are its determinants? It is essential to note that understanding farmers preferences enable policymakers to know farmers' needs and respond by coming up with relevant and required technologies. Information on WTP will also shed light on the maximum or minimum amount of money farmers can pay for the cassava cuttings, and design appropriate marketing strategies to improve adoption.

3.3 Methodology

3.3.1 Research design and sampling procedure

The research was conducted in the Rugombo district of Cibitoke province (Northwest of Burundi), which was purposefully chosen as the study area. The study employed cross-sectional data using a questionnaire to obtain information from the farmers’ socio-economic to cassava cuttings attributes. The target population in this study was cassava farmers, both those who received cassava cutting for free from the project (project beneficiaries) and those who did not get cassava cuttings from the project (non- project beneficiary). A systematic sampling approach was applied: firstly, the area was chosen because it is one of the regions where cassava is intensively grown. It is also a region that has been seriously affected by CMD and CBSV diseases over the last years. Secondly, stratification of the targeted population was done. After a list of 4132 cassava farmers was obtained from ISABU, and the sample size was determined using the formula developed by Krejcie and Morgan (1970) as follows:

$$n=\frac{N*x^2*p*q}{d^2*(N-1)+(x^2*p*q)} = 351 \approx 352 \quad \text{………………………………..………………… (1)}$$

Where n is the sample size, x^2 is the table value of chi-square for one degree of freedom at the desired confidence level (at 95 percent confidence level, x^2 = 3.84), N is the total number of cassava farmers, p is the population proportion considered to be 0.5 to provide maximum sample size, q = (1-p) = 0.5, and d is the degree of accuracy expressed as a proportion (d = 0.05).

The study area is constituted of 14 wards, i.e. strata where production of cassava is popular. The weight of each stratum was obtained by dividing the strata population and total population. Thus, the numbers of farmers to be interviewed for each stratum was obtained by multiplying the weight by the full sample size (352). Thirdly, random sampling by randomly picking each 12th farmer from the list of each ward followed.

3.3.2 Experimental design and analytical method

3.3.2.1 Cassava attributes identification

The FGD was used in this study to identify important cassava attributes level used in DCE. The researcher led the group discussion, accompanied by agronomists, monitors and local representatives in the Rugombo district. The first discussion distinguished the project beneficiaries of improved cassava cuttings versus non-project beneficiaries. In this session, men tended to monopolize the conversation and because of this, women and men were then separated into different groups that allowed them to respond comfortably. The rules for working in groups were proposed by the participants and the facilitators who tempered the debate in the national/local language (Kirundi), to let participants feel free in responding.

The cassava farmers in FGD were asked general questions on cassava attributes and factors that they mostly consider when deciding to grow cassava; participants were then asked to rank the attributes in order of importance. The discussion started with a revised list of 14 cassava attributes to come up with the final set of attributes and their levels (disease resistant, drought resistant, roots yield, sensory-taste, roots size, starch content, maturity time, inputs price, hardness, softness, inputs needed, leaves yield, architecture, the color of the cassava). In addition, for each attribute, levels were given by IITA, and ISABU and cassava farmers confirmed other attributes levels.

Each group comprised four up to eight people, and four groups were sufficient per ward if there was no new information. Moreover, the discussion time was between one up to two hours to ensure an appropriate conversation time for each participant. The results were analyzed by reviewing all the responses given by the groups, highlighting the characteristics that were repeated many times by the participants. Finally, a list of five attributes were selected for the DCE, which was, i) resistance to diseases, ii) maturity time, iii) roots yields, iv) taste and v) inputs price. The group discussion ended by warmly thanking all the people who were present at the discussion, and the researcher proposed to them that, when the results are out, they will be reported to them in brief. The table 3.1 show the attributes and attribute levels employed in DCE.

Table 3.1: Attributes and attributes' levels for DCE in Rugombo District

Cassava attributes	Attributes Levels	
Diseases resistant	1.	Resistant for CMD and CBSV
	2.	Susceptible to CMD and CBSV
Roots yield	1.	500 – 600 Kg/Are
	2.	100 - 340Kg/Are
	3.	30Kg/Are
Maturity time	1.	6 months
	2.	8 months
Taste	1.	Sweet taste
	2.	Bitter taste
Price	1.	BIF 800/ 100 cuttings
	2.	BIF 1000/ 100 cuttings
	3.	BIF 12000/ 100 cuttings

1 Are =0.0247 Acre
One cassava cutting = 8, 10 or BIF12 where, BIF 1 = TZS 1.15; USD 1= BIF 2002.27 (Exchange rate last updated February 23th,2022: 12:19 UTC)

100 cuttings are required for one Are
10 000 cuttings are required for 1 hectare

3.3.2.2 Design and construction of a choice set

In developing a CE, the researcher established the relevant cassava attributes and their levels and the number of possible cassava combinations was determined by SPSS software. There is 72= ($2^3 * 3^2$) ways of combining the attributes and their levels used in the designing the CE. To make the decision cards more manageable for the farmers, orthogonal design in SPSS software was used to end up with 16 profiles. The orthogonal design profiles gave eight choice sets; each choice set was made up of two scenarios and an opt-out option. Choice cards were presented to 352 sampled respondents, each responding to 8 completed choices, each choice having three scenarios resulting in 8448 observations (352 individuals* 8 choices* 3 options for each choice). Table 3.2 shows an example of choice set used in this study.

Table 3.2: Example of choice set

Attributes name	**Profile 1**	**Profile 2**	**I don't prefer any option**	**Choice Tick of 1 0r 2**
Diseases resistant	Susceptible for CMD and SBCD	Resistance to CMD and SBCD		
Roots yield	Higher yield (500 – 600 kg/Are)	Low Yield (30Kg/Are)		
Maturity time	Maturity time: 6 months	Maturity time: 8 months		
Taste	Bitter taste (Leaves are light green; leaf petiole is yellowish green)	Bitter taste (Leaves are light green; leaf petiole is yellowish green)		
Price	BIF 800/ 100 cuttings	BIF 12,000/ 100 cuttings		

3.3.3 Model specification: mixed logit model

This study used mixed logit model to analyze the preferences, WTP for improved cassava cuttings' attributes, and factors that influence preferences and WTP for improved cassava cuttings' attributes. McFadden (1974) developed the basic choice logit model known as multinomial logit, or conditional logit model. A variety of logit models such as binary logit, nested logit, and mixed logit (MXL) have been developed and applied to inform policies in different fields. Mixed logit has been proven to be a very flexible model in random models (McFadden and Train, 2000), and it allows for random variation in preferences and unobserved correlation between factors over time (Hensher and Greene, 2002). The model incorporates preference heterogeneity in the sample by considering the coefficient as random rather than fixed (Rockers *et al*., 2012; Ryan *et al*., 2012), and the model accounts for repeated choices by the same respondent by adjusting standard errors of utility estimates (Ryan *et al*., 2012). The coefficients used in the model are interpreted as a relationship between the explanatory variables, and the probability of choice.

Therefore, the decision maker *n* obtains from choosing alternative *j* is given by:

$$U_{nj} = V_{nj} + \varepsilon_{nj} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(4)}$$

Where, V_{nj} is a function of observable attributes of the alternative X*nj*, and the decision maker, Z*n*. ε_{nj} is unknown and treated as random. The probability that decision maker *n* chooses alternative *i* is

$$P_{¿} = Pr\left(U_{¿} ¿ ¿ U_{nj}\right) \quad j \neq i ¿ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(5)}$$

$$P_{¿} = Pr\left(V_{¿} + ¿ \varepsilon_{¿} > V_{nj} + \varepsilon_{nj}\right) \quad j \neq i ¿ \ldots\ldots\ldots\ldots\ldots\ldots \text{(6)}$$

$$P_{¿} = Pr\left(\varepsilon_{nj} ¿ - \varepsilon_{¿} < V_{¿} - V_{nj}\right) \quad j \neq i ¿ \ldots\ldots\ldots\ldots\ldots\ldots \text{(7)}$$

By making the assumption that the random terms are independent and identically distributed type, the conditional logit model is obtained:

$$P_{¿} = \exp \frac{\left(\sigma_n V_{¿} ¿\right)}{\sum_{j=1}^{J} \exp\left(\sigma_n V_{nj}\right)} ¿ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(8)}$$

The representative utility is specified to be a linear in parameter function

$$V_{¿} = x_{¿}^{'} \beta + z_n^{'} \gamma_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(9)}$$

The conditional logit model assumes that respondents have the same preferences and it assumes equal proportional substitution between the alternatives:

$$\frac{\partial P_{¿}}{\partial x_{nj}^{¿}}\frac{x_{nj}^{¿}}{P_{¿}}=-x_{nj}^{¿}P_{nj}\beta^{¿}\text{..(10)}$$

Another consequence of conditional logit model is the Independence of Irrelevant Alternative properties where:

$$\frac{P_{¿}}{P_{nk}}=\frac{\exp(V_{¿})/\sum_{j=1}^{J}\exp(V_{nj})}{\exp(V_{nk})/\sum_{j=1}^{J}\exp(V_{nj})}=\frac{\exp(V_{¿})}{\exp(V_{nk})}\text{..(11)}$$

Therefore, mixed logit model solves these limitations by allowing the coefficients in the model to vary across decision makers; implying that decision makers may have varied preferences. The probability of a specific set of selections is calculated as follows:

$$P_{¿}=\int\exp\frac{(x_{¿}^{'}\beta¿)}{\sum_{j=1}^{J}\exp(x_{nj}^{'}\beta)}f(\beta\vee\theta)d\beta¿\text{.. (12)}$$

Where, $f(\beta\vee\theta)$ is density function of β

Also, an individual can make several choices, and the probability of a particular sequence of choices is given by:

$$S_{n}=\int\prod_{t=1}^{T}\prod_{j=1}^{J}¿¿¿¿¿\text{.. (13)}$$

Where Y*njt* = 1 if individual chose alternative *j* in choice situation *t* and 0 otherwise

Th**e** θ parameters can be estimated by maximizing the simulated log-likelihood (SLL) function:

$$SLL=\sum_{n=1}^{N}\ln\{\frac{1}{R}\sum_{r=1}^{R}\prod_{t=1}^{T}\prod_{j=1}^{J}¿¿¿¿¿¿¿\text{..................................... (14)}$$

Where $\beta_{n}^{¿r\vee¿¿}$ is the r-th draw for individual *n* from the distribution of β.

Therefore, WTP is derived from a random utility model.

$Uijk = \alpha 1+\beta 1X1n+\beta 2X2n+\ldots\beta mXmni + \varepsilon n$ .... (15)

Where the betas β provide quantitative information on the strength of the preference for each attributes level and monetary value. Inclusion of the price allows estimating the monetary value of cassava cuttings' attributes. This can be estimated as the ratio of the value of the coefficient of interest to the negative cost of attributes.

$$MWTP = ¿ \frac{\partial U / \partial Xij}{\partial U / \partial \rho ij} = -\beta i / \gamma i \text{ .... (16)}$$

Where ρij denotes the cost parameter or price of alternative j, Xij, denotes the other observed attributes of choice alternatives, γi is the coefficient for the cost parameter, βi is the coefficient vectors for the other attributes.

The heterogeneity in the mean parameter can be obtained by the interaction of respondent's profiles, with random variables (Hensher *et al.*, 2005). Therefore, four attributes namely input price, resistance to diseases, sweet taste and low yield were not significant according to their standard deviation (Table 3.7), and this means that they were random across individuals. Two others attributes namely higher yield, and earlier maturity were treated as non-random variables referring to their non - significance in standard deviation. To identify factors that influence preferences and WTP for improved cassava cuttings attributes, interaction between random cassava attributes and cassava farmers' characteristics were computed, by using STATA 15 software.

3.3.4 Description of variables used in the estimation

Table 3.3 presents cassava attributes levels that enter in the analysis of utility function of mixed logit model. The utility-maximizing alternative is the choice made by cassava farmers. The choice is a binary dependent variable, with 1 indicating the selected option, and 0 indicating the non-chosen option. Among the levels of five main attributes chosen after FGD, resistance for diseases, higher yield, early maturity time, and sweet taste are expected to increase utility. Disease resistance allows farmers to have cassava that is not sick to prevent the spread of disease and its devastating consequences on food security. High yield (500 – 600 kg/Are or six up to seven bags per Are) and medium yield (100 – 340 kg/ Are or 1.25 – 4.25 bags/Are) allow farmers to increase production and income. Early maturity will allow to have crops on time and also have time to replace cassava with other crops. These attributes have a beneficial effect on cassava production.

Table 3.3: CE variable coding and expected signs

Variables	**Units**	**Expected sign**
Resistance to diseases	1= tolerant, -1 = otherwise	Positive for tolerant
Yield	1= higher Yield (500 – 600 kg/Are) -1 = medium yield (100 - 340Kg/Are) 0=low yield (30Kg/Are), 0 otherwise	Positive for higher yield
Maturity Time	1= earlier maturity time, -1=later maturity time	Positive for earlier maturity time
Taste	1= Sweet, -1= Bitter	Positive/Negative
Price of 100 cuttings	Price in BIF	Negative

Similarly, susceptible to diseases low yield, and later maturity time are expected to decrease utility in cassava production function. Disease is spread by infected cuttings and by whitifies, the leaves could be yellow, mottled and distorted; it may cause a loss in yield. The low yield (30kg/Are or 1/3 bag per Are) is the last level of cassava roots yield where a farmer can't meet food need or increase its income. Farmers admitted that eight months are enough for the cassava to mature, and have hard cassava roots that can stay long underground, which helps mitigate food insecurity shocks. Depending on an individual's preferences, the taste' coefficient can be positive or negative. For instance, the sweet taste allows farmers to have cassava that is directly consumable and sold in the market after the harvest. Bitter cassava cannot be stolen from the field before harvest, and it presents a good quality of flour and also cooked Earth (*Ubuswage*). The coefficient associated with the input price is expected to have a negative sign, as money is a limited resource, an increase in utilities occurs when the cost of related alternatives declines (Debertin, 2012). To estimate the choice model, some attributes were entered in the estimation process as coded using various coding such as effects coding (e.g. sweet taste = 1, bitter taste = -1) and other attributes entered in the estimation using the face value of their levels (e.g. price of 100cutting per Are). Effect coding is used in estimating choice model as the utility associated with the base level will not get confounded with the overall utility associated with attributes levels of an alternative (Hensher *et al*., 2005). Dummy coding is used for qualitative variables as shown in Table 3.4.

Table 3.4: Description of variables used in the analysis

Variables	Code /units	Expected Signs
Age	Number of years	+
Education	Number of years	+
Land ownership		
Own land	1= own land, 0 = otherwise	+
Rented land	1= Rented Land, 0 = otherwise	-
Both own and rented land	1= both own and rented, 0= otherwise	+
Cassava land size	Number of Ares	+
Project membership	1= Yes, 0 = otherwise	+
Distance to the market	Number of kilometer	+

3.4 Results and Discussions

3.4.1 Respondent's profile

A total of 352 respondents were surveyed for this research, of which one half were women and the other half were men. The average age of cassava farmers heard of household is 45 years, which is approximately the same with those found by the National Agriculture Survey done in Burundi in 2017 (ENAB, 2017) which also found the average household age to be 54.2 for the household led by men and 43.7 for the household led by women. Majority of farmers sampled had primary level education i.e. 41.76% followed by secondary school level with a percentage of 38.92%, while 17.6% of farmers had informal education. Only 1.7% of interviewed farmers had a university education level (Table 3.5).

Table 3.5: Respondents' profile

	Frequency	Percent
Sex		
Male	176	50.00
Female	176	50.00
Education level		
No formal education	62	17.61
Primary	147	41.76
Secondary	137	38.92
University	6	1.7
Land ownership status		
Own	240	68.2
Own and rent land	36	10.2
Rent Land	75	21.3
Easy access to cuttings		
Yes	100	28.41
No	252	71.59
Source of cuttings		
Farmers group	6	6.06
Governent extension services	6	6.06
Cooperatives	8	7.07
Inputs dealer	7	7.07
Friends	72	72.73

On average, cassava farming experience is 21 years; this suggests that the majority of interviewed cassava farmers have been producing cassava for a long time. Additionally, the findings revealed that an average of 43 Ares is the land for all plant grown, and 27 Ares is for cassava (Table 3.6). The findings concur with those of ENAB (2017), whereby the average area cultivated was 107.3 Ares in 2017 nationally, and the average area cultivated is 54.5Ares in Cibitoke province where Rugombo district is found within. One acre equal to 40.469 Ares/or one hectare equal to 100 Ares (One Are is also equal to 10m * 10m = 100m^2).

The land used in producing cassava in the study area is own land, rented land, or both. About 68.2 % of cassava farmers sampled have their land (inheritance, land bought, gift land), 10.2 % have both own and rent land, while 21.3% use only the rented land to produce cassava. Among the cassava farmers who were interviewed, 71.58% of them admitted not having easy access to improved cuttings, and 28% of these farmers have access to cassava cuttings. The majority of cassava farmers interviewed (72.73%) admitted using cassava cuttings obtained through informal sources from neighbors and relatives. However, 28% of cassava farmers grow cassava cuttings obtained through official sources such as farmers' groups, cooperatives, and inputs dealers (Table 3.5). These figures reflect the predominance of informal sources of cassava cuttings in the research area. In addition, the study results revealed that the distance from the cassava farm to the market is on average 3 km, with a minimum and maximum of 1, and 6km, respectively (Table 3.6).

Table 3.6: Farmers' organizations (observation=352)

Variables	Mean	Minimum	Maximum
Age	45	19	92
Farm size	42.95	5	200
Cassava farm size	27.44	2	130
Experience in cassava farming	21.43	2	65
Distance to the market	3	1	6

3.4.2 Farmers' preferences for improved cassava cuttings attributes: mixed logit model

This study used the mixed logit model to assess farmers' preferences, and WTP for cassava cuttings attributes. The sign of each of the estimated parameters was coherent with the expected theoretical signs. For instance, the results from Table 3.7 below show that the coefficient of the higher yield attribute was positive, and considerably greater than other coefficients estimated in the model (0.331), indicating the most preferred attribute among cassava farmers in the study area. This finding is in line with the findings by Bentley *et al.* (2017) and Teeken *et al*. (2018), who revealed that higher yield was the most attribute preferred by farmers in adoption of cassava seeds in Nigeria. The coefficient of resistance to diseases attribute was positive, with a magnitude of 0.170, indicating the second to be preferred by respondents in the study area after higher yield. The result is consistent with the findings by Acheampong *et al*. (2018) who found that resistance to disease was an important cassava attributes during adoption of improved cassava variety in Ghana.

Table 3.7: Farmers' preferences for cassava cuttings attributes, mixed logit model

Choice	**Coefficient**	**Standard Error**	**P-value**
Resistance to diseases	0.170**	0.077	0.027
Sweet taste	0.165***	0.032	0.000
Low yield	-1.144***	0.066	0.000
High yield	0.331***	0.081	0.000
Earlier maturity time	0.085**	0.038	0.023
Price of 100 cuttings	-0.005***	0.000	0.000
CONST	-6.081***	0.248	0.000
Standard Deviation			
Resistance to diseases	1.176	0.079	0.000
Sweet taste	0.184	0.076	0.016
Low yield	0.627	0.077	0.000
High yield	0.008	0.234	**0.974**
Earlier maturity time	-0.004	0.072	**0.960**
Number of observations = 8448			
LR chi2(5) = 328.20			
Log likelihood = -2205.794			
Prob > chi2 = 0.0000			

Note: *, **** indicate that coefficients are statistically significant at 1 and 5 %, respectively, using p-value in maximum likelihood estimation.

In addition, coefficient estimation results of sweet taste attribute show a positive relationship with a magnitude of 0.165, indicating that cassava farmers in the study area prefer cassava with sweet taste over bitter taste. When the estimated coefficient of early maturity time attribute is considered, results indicate that it is positive and significant at 5%, with a magnitude of 0.085, meaning that farmers in the study area prefer cassava that is matured faster (6 months) compared to late maturity time (8 months). The least preferred attribute by cassava farmers in the study area was early maturity time. This results is consistent with Bentley *et al.* (2017); Nakabonge *et al*. (2017); Teeken *et al*. (2018) and Wossen *et al*. (2017) who found that earlier maturity time attribute was preferred by farmers during adoption of cassava in Nigeria and Uganda.

The low yield was significant at 1 % with a negative estimated coefficient and the findings are as expected as a rational decision-maker trying to maximize profit (McFadden, 1986). Cassava farmers preferred higher yields that would allow them to maximize their utility. Low yield was not desired, as it was shown by its higher absolute magnitude (-1.144) compared to other attributes. On the side of the price of 100 cassava cuttings, negative and statically significant relationship was observed at 1% of the significance level. The negative sign of the price means that cassava farmers are less likely to choose cassava that is expensive, holding other factors constant. The absolute magnitude coefficient of the input price is very small (0.005) indicates that a small price change didn't affect the preference of other attributes. This finding is in line with the results by Kimathi *et al.* (2021), who found that a small change in potato input price did not affect the preferences of other potato attributes. The constant parameter is strongly significant, and negative (-6.081), indicating a negative preference for no buy choice alternatives associated with zero utility, indicating that cassava farmers selected the other two options, which were associated with different cassava levels.

Briefly, the results in Table 3.7 show that preferred improved cassava cuttings attributes by farmers in the study area are higher yield, resistance to diseases, sweet taste, earlier maturity time and cassava cuttings with low price.

3.4.3 Farmers'WTP for improved cassava cuttings attributes

This subsection presents results on the estimation of WTP for cassava cuttings attributes. The price represented the purchasing price of 100 cassava cuttings that is required for one Are, with a general space of 1m*1m as recommended by the Burundian Ministry of Agriculture. The mean WTP(MWTP) in STATA software was computed in Burundian International Franc (BIF)

BIF 1 = TZS 1.15 or USD 1= BIF 2,002.27 (Exchange rate last updated February 23th,2022: 12:19 UTC).

Table 3.8: MWTP for improved cassava cuttings attributes

	Resistance to diseases	Sweet taste	Low yield	Higher yield	Early maturity time
MWTP	36	35	**-241**	**70**	18

Low boundaries	4	21	-271	40	2
Upper boundaries	69	48	-210	103	39

Table 3.8 shows that cassava farmers were willing to pay BIF 70 for higher yielding cassava cuttings attributes, rather than medium yield. Similarly, they are willing to pay BIF36 for resistant to diseases cassava cuttings attributes, rather than susceptible for diseases attribute. BIF 35 is monetary value that cassava farmers are willing to sacrifice to receive cassava cutting attributes with a sweet taste, rather than bitter taste. Farmers are also willing to sacrifice BIF 18 to receive short period maturity time cassava cuttings attributes, rather than a long maturity period attribute. The results are similar to Kimathi *et al.* (2021), who found that youth Kenyan attribute a higher monetary value to the higher yield and resistance to disease potatoes attributes.

3.4.4 Factors influencing farmers' preferences and WTP for improved cassava cuttings attributes

Results from the interaction effect of random cassava attributes (Table 3.9) with respondents 'profiles indicated that the number of years in school show a negative and significant interaction with the price (-0.000***) but a positive and significant interaction on resistance to diseases (0.052**). This implies that, households that are more educated were likely to choose the cassava cuttings alternative in the CE with low prices and resistance to diseases attributes. This is because educated farmers may be better to conceptualize the advantages and benefits of using improved cassava cuttings resistant to diseases by minimizing costs and having a high yield. Additionally, both owned and rented land shows a positive interaction with price (0.002***) and significant negative interaction with a sweet taste (-0.313***). This means that respondents who had both own, and rented land were more likely to choose the cassava cuttings alternative in the CE with bitter taste, and with higher input price. This should be because farmers who have their own land may have the land and time to experiment with different varieties compared to those who use the leased land only. The results converge with Awio *et al.* (2019) who found that owning land enhances the acceptability of new agriculture technology with investment on a long-term basis in Uganda.

Results also revealed a positive and significant interaction between cassava farm size and price (0.000***), but a negative interaction with low yield (-0.015***). This means that farmers with large land cassava size were more likely to prefer the alternative in the CE with higher yield, compared to low yield, and with higher input price. These findings converge with Ulimwengu and Sanyal (2011) who also found that farmers' WTP for agriculture services in Uganda increase as their land increases. Other existing literature demonstrated that farmers who have a small area to cultivate often do not have the means to invest in new technology and farmers who have a large farm size benefit from economies of scale, adopt improved variety and observe good economic practice (Mwalongo *et al.*, 2020).

Table 3.9: Interaction of respondents' profile with random attributes

Choice	Coefficient	Standard Error	P-value
Age			
Price	0.000	0.000	0.104
Resistance to diseases	-0.001	0.013	0.923
Sweet taste	0.004	0.005	0.437
Low yield	-0.006	0.010	0.504
Education			
Price	-0.000	0.000	**0.000**
Resistance to diseases	0.052	0.022	**0.018**
Sweet taste	-0.013	0.009	0.151
Low yield	-0.016	0.016	0.309
Owned land			
Price	0.000	0.000	0.650
Resistance to diseases	0.345	0.281	0.219
Sweet taste	-0.127	0.117	0.276
Low yield	0.048	0.211	0.820
Both Owned and Rented Land			
Price	0.002	0.000	**0.000**
Resistance to diseases	0.379	0.238	0.110
Sweet taste	-0.313	0.096	**0.001**
Low yield	-0.173	0.176	0.327
Cassava Farm size			
Price	0.000	0.000	**0.000**
Resistance to diseases	0.004	0.004	0.369
Sweet taste	-0.000	0.002	0.983
Low yield	-0.015	0.003	**0.000**

Experience in farming cassava			
Price	-0.000	0.000	0.143
Resistance to diseases	0.022	0.013	0.099
Sweet taste	-0.009	0.005	**0.089**
Low yield	0.005	0.010	0.607
Project beneficiaries			
Price	-0.000	0.000	0.158
Resistance to diseases	0.673	0.155	**0.000**
Sweet taste	-0.067	0.062	0.281
Low yield	-0.373	0.114	**0.001**
Distance to the market			
Price	-0.000	0.000	**0.000**
Resistance to diseases	-0.031	0.075	0.682
Sweet taste	0.079	0.030	**0.009**
Low yield	-0.132	0.055	**0.017**
CONST	-6.627	0.269	0.000

Number of observations = 8448
LR chi2(5) = 306.47
Log likelihood = -2064.5098
Prob > chi2 = 0.0000

Experience in farming cassava shows significant negative interaction with sweet taste (-0.009*). This means that farmers who have more experience in producing cassava in study area prefer cassava cuttings that is bitter than sweet. This can be due to their familiarity with growing cassava as they prefer cassava with a bitter taste for good cassava flour, but also due to its low risk of being stolen or harvested by random passengers desiring direct consumption at raw status before the effective harvesting period. Uddin *et al.* (2016) also found that age and higher experience in farming were among determinants of WTP for agriculture extension service in Bangladesh.

When the interaction of project members with cassava cuttings attributes is considered, findings show positive and significant interaction with resistance to diseases (0.673***), and significant negative interaction with low yield (-0.373***). This means that cassava farmers who were beneficiaries of a project, received improved cassava cutting for free before, preferred cassava cuttings that are resistant to disease with a higher yield compared to cassava cuttings with low yield. Being part of project beneficiaries helps to solve problems linked to information asymmetry by providing to farmers knowledge and skills for the increasing adoption of new agricultural technology. The results of this study are similar to those of Wossen *et al.* (2015), who mentioned that being a project beneficiary and having access to credit provides respectively social capital and facilitates the acquisition of essential assets related to seeds uptake.

In fine, distance to the market shows a positive interaction with sweet taste (0.079***), but a negative interaction with price (-0.000***) and low yield (-0.132**). This suggests that households living far from the market were more likely to select the CE option with the lowest input price, highest yield, and sweetest taste. The results of this study are similar to those of Ulimwengu and Sanyal (2011) who found that market access was among factors that influence WTP for agriculture services in Uganda.

In responding to the third research question which aimed at assessing preference heterogeneity for cassava cuttings attributes and its determinants, the interaction of respondents profile with random cassava cuttings attributes such as price, resistance to diseases, sweet taste and low yield, was performed. Results indicates that, sources of heterogeneity among respondents were found to be education level, land ownership status (both owned and rented land), cassava land size, high experience in producing cassava, project beneficiaries, and distance to the market.

3.5 Conclusionsand Recommendations

3.5.1 Conclusions

The goal of this study was to assess farmers' WTP for improved cassava cuttings attributes in Rugombo district, Burundi. FGD was used for cassava cuttings prioritization, while a CE was carried out, along with a cassava farmer survey, among 352 in the study area. Mixed logit model was used to assess preferences, WTP, and source of heterogeneity for cassava cuttings attributes.

Results from FGD show that, disease resistance, roots yield, taste, maturity time, and input price were the most cassava attributes prioritized by farmers in the study area, in this order. The CE results show that farmers are willing to pay more for higher yield (BIF 70), and resistance to diseases attributes (BIF 36). Interaction of respondents' profile with random cassava cuttings attributes show that preferences and WTP for cassava cuttings attributes are influenced by higher education, land ownership status, cassava land size, level of experience in producing cassava, project beneficiaries, and distance to the market.

3.5.2 Recommendations

This research is more efficient for improving cassava seed systems in Burundi. Therefore, Burundian's Ministry of Agriculture and private actors engaged in the multiplication of cassava cuttings would consider the attributes preferred by cassava farmers of the study area in their intervention and action of developing cassava crops. Factors that influence references, and WTP should be taken into consideration in promoting the use of agriculture technology in the study area. The study suggest that farmers should also look forward to adopting these cassava cuttings for improving their livelihood and food security especially in rural areas for farmers to have easy access to the cassava cuttings, as results show that, 71.59% of the farmers in the study area testified that they didn't have easy access to cassava cuttings. The study recommend also to seed producers to establish land produce site.

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CHAPTER FOUR

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusion

The goal of this study was to assess farmers' WTP for cassava cuttings attributes in Rugombo district, Burundi. The preference for cassava cuttings attributes as well as WTP were assed, with its determinants. Therefore, the study concludes the results under two main subsections: cassava attributes prioritization using FGD, semi-structured questionnaire and BWS. Cassava cuttings attributes preferences and WTP were assessed by using choice experiment.

Attributes prioritization

Results from FGD show that, disease resistance, roots yield, taste, maturity time, and price were the most cassava attributes prioritized by farmers in the study area, in this order. These attributes were used in performing the CE. Results from a semi-structured questionnaire show that resistance to disease, yield level, taste, maturity time, hardness, and more leaves were prioritized by farmers in this order. However, BWS results show that disease-resistant, taste, roots yield, maturity time, roots size, hardness, and architecture were prioritized in this order. Therefore, the attributes were used in the CE to assess preferences and WTP where disease resistance, roots yield, taste, maturity time, and inputs price were found to be among the most preferred attributes.

Attributes preferences and WTP

A discrete choice experiment was carried out, along with a cassava farmer survey, among 352 in the study area. Mixed logit model was used to assess preferences, WTP, and source of heterogeneity for cassava cuttings attributes. CE results show that farmers are willing to pay more for higher yield (BIF 70) and resistance to diseases attributes (BIF 36). Cassava farmers were also willing to pay for sweet taste (BIF 35), and earlier maturity time (BIF 18). Therefore, the findings responded to the first and second research questions which asked the preferred cassava cuttings attributes, and their WTP. The third research question aimed at assessing factors that influencing preferences and WTP for cassava cuttings attributes. Therefore, education level, land ownership/status, increase in size of cassava land, level of experience in producing cassava, project beneficiaries, and distance to the market are among the factors that influence preferences and WTP for cassava cuttings attributes in study areas.

4.2 Recommendations

This research is more efficient for improving cassava seed systems in Burundi. Therefore, Burundian's Ministry of Agriculture and private actors involved in the multiplication of cassava cuttings should consider the attributes preferred by cassava farmers of the study area in their intervention and action of developing cassava crops.

Farmers prefer cassava attributes that help them to get higher productivity on time, with a good sensory (sweet taste), and they are willing to pay more for these attributes. Therefore, innovators should also look forward to adopting these cassava cutting for improving farmers' livelihood, and food security.

Factors such as level of education of the household head, cassava farm size, land ownership status, experience in producing, project beneficiaries, and distance to the market should be taken into consideration in promoting the use of agriculture technology in the study area. Moreover, the study recommends also to seed producers that they should look forward to establishing and producing site, especially in rural areas for farmers to have easy access to the cassava cuttings, as results show that, 71.59% of the farmers in the study area testified that they did not have easy access to cassava cuttings.

APPENDICES

Appendix 1 : Field questionnaire

FARMERS' WILLINGNESS TO PAY FOR IMPROVED CASSAVA CUTTINGS ATTRIBUTES IN RUGOMBO DISTRICT, BURUNDI: INDIVIDUAL QUESTIONNAIRE

Date of interview: [______/______/_____] Date/Month/Year

Name of interviewer: …………………………………………

Welcoming speech

This survey is about assessing farmers'WTP for cassava cuttings in Rugombo district, Burundi. Insights on farmers WTP will help to put in place measures related to sustaining cassava production by making available enough cassava cuttings that are resistant to CMD and SBSD diseases. Your participation to this study will therefore be highly valued as it will contribute to improving cassava seed system. You are going to answer some questions, and choose the best among presented scenarios.

PART I. RESPONDANTS' IDENTIFICATION

1. Name of respondent ……………………………...
2. Province : ………………………………...
3. Commune : …………………………………………………….....................
4. Zone : …………………………………………………………......................
5. Area:

5.a Rural

5.b Urban

PART II: FACTORS THAT INFLUENCE PREFERENCES AND WTP FOR CASSAVA CUTTINGS

6. Age of respondent: ……………years
7. Gender:

7.a Male

7.b Female

8.Marital status:

8.a Single

8.b Married

8.c Divorced

8.d Widow

8.e Separated

9. Household size: ……………… persons

10. Education level:

10.a No formal education

10.b Primary

10.c Secondary

10.d University

10.e Adult education/literacy school

10.f Other (specify) ....

11. Occupation (Primary activity of household)

11.a Crop farming

11.b Livestock

11.c Salaried employment

11.d Small trade

11.e Others (Specify)

12. How did you obtain the land under cassava plantation? (land ownership)

12.a Inheritance

12.b Bought land

12.c Rent land

12.d Gift land

13. How big is the land (Farm size)? ……… Ares

14. How big is the land that is planted cassava?..........Ares

15. How long have you been a farmer? .... years

16. How long have you been growing cassava? ………... years

17. What is your main reason for producing cassava?

17.a Food

17.b Market

17.c Both

18. What is the main type of labour used in producing cassava?

18.a Family labour

18.b Hired labour

18.c Both

19. What type of cassava variety do you grow? Rank in order of production

i) ………………. ii) ………………….

iii) ………………. iv) …………..……....

20. Which is the most preferred?.........

21. Why?...............

22. Which attributes do you prefer when deciding to grow cassava?

23. Do you have easy access to improved cassava cuttings?

23.a Yes

23.b No

24. If yes, from where can you get it?

24.a Government extension services

24.b Organization (NGO)

24.c Farmers associations/Cooperatives

24.d Inputs dealer

24. e Neighbors (friends)

24. f Others (Specify) ....

25. Have you ever heard an improved cassava cuttings that is resilient to CMD and CBSV diseases?

(Existing information)

25.a Yes

25.b No

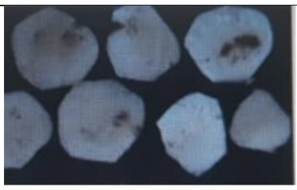
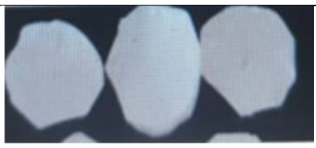
26. If yes, from who?

PART III: FARMERS'WTP FOR IMPROVED CASSAVA CUTTINGS

27. Which profiles would you choose? And why?

Choice Set 1

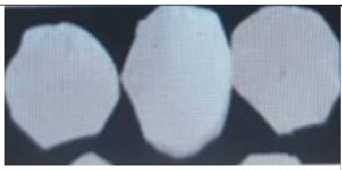
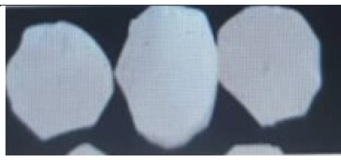
Attributes name	**Profile 1**	**Profile 2**	**I don't prefer any option**	**Choice Tick of 1 0r 2**

Diseases resistant	 Susceptible for CMD & SBCD	 Strong for CMD & SBCD		
Roots yield	 500 - 610 kg/Are 6.25 - 8 bag of 80kg/Are	 30kg/Are 1/3 bag of 80kg/ Are		
Maturity time	 Maturity time 8 months	 Maturity time 8 months		
Taste	 Sweet taste (leaves are dark green and leaf petiole is red)	 Bitter taste (leaves are light green, leaf petiole is yellowish green)		
Price	 20 cuttings for BIF 240 100 cuttings of **BIF 1,200** are required for 1 Are	 20 cuttings for BIF 160 100 cuttings for **BIF 800** are required for one Are		

Why that choice? ……

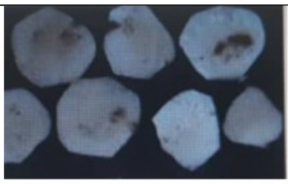
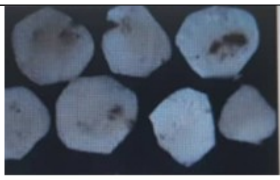
Choice set 2

Attributes name	**Profile 1**	**Profile 2**	**I don't prefer any option**	**Choice Tick of 1 0r 2**

Diseases resistant	 Strong for CMD & SBC	 Strong for CMD & SBCD		
Roots yield	 500 - 610 kg/Are 6.25 - 8 bag of 80kg/Are	 500 - 610 kg/Are 6.25 - 8 bag of 80kg/Are		
Maturity time	 Maturity time: 6 months	 Maturity time 8 months		
Taste	 Bitter taste (leaves are light green, leaf petiole is yellowish green)	 Sweet taste (leaves are dark green and leaf petiole is red)		
Price	 20 cuttings for BIF 160 100 cuttings for **BIF 800** are required for one Are	 20 cuttings for BIF 200 100 cuttings of **BIF 1,000** are required for 1 Are		

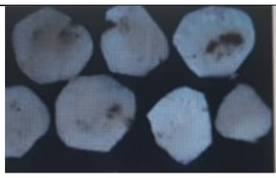
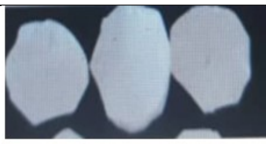
Why that choice?

Choice set 3

Attributes name	**Profile 1**	**Profile 2**	**I don't prefer any option**	**Choice Tick of 1 0r 2**
Diseases resistant	 Susceptible for CMD & SBCD	 Susceptible for CMD & SBCD		
Roots yield	 30kg/Are 1/3 bag of 80kg/ Are	 30kg/Are 1/3 bag of 80kg/ Are		
Maturity time	 Maturity time: 6 months	 Maturity time 8 months		
Taste	 Sweet taste (leaves are dark green and leaf petiole is red)	 Bitter taste (leaves are light green, leaf petiole is yellowish green)		
Price	 20 cuttings for BIF 200 100 cuttings of **BIF 1,000** are required for 1 Are	 20 cuttings for BIF 200 100 cuttings of **BIF 1,000** are required for 1 Are		

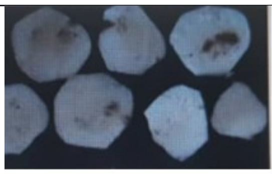
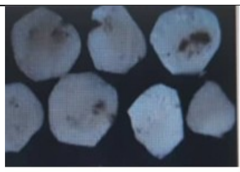
Why that choice? …..

Choice set 4

Attributes name	**Profile 1**	**Profile 2**	**I don’t prefer any option**	**Choice Tick of 1 0r 2**
Diseases resistant	 Susceptible for CMD & SBCD	 Strong for CMD & SBCD		
Roots yield	 500 - 610 kg/Are 6.25 - 8 bag of 80kg/Are	 30kg/Are 1/3 bag of 80kg/ Are		
Maturity time	 Maturity time: 6 months	 Maturity time 8 months		
Taste	 Bitter taste (leaves are light green, leaf petiole is yellowish green)	 Bitter taste (leaves are light green, leaf petiole is yellowish green)		
Price	 20 cuttings for BIF 160 100 cuttings for **BIF 800** are required for one Are	 20 cuttings for BIF 240 100 cuttings of **BIF 1,200** are required for 1 Are		

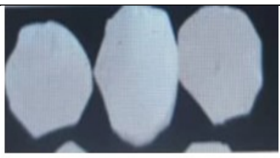
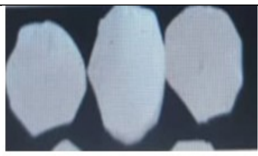
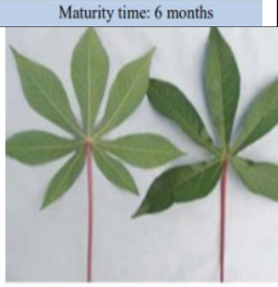
Why that choice? ……

Choice set 5

Attributes name	**Profile 1**	**Profile 2**	**I don't prefer any option**	**Choice Tick of 1 0r 2**
Diseases resistant	 Susceptible for CMD & SBCD	 Susceptible for CMD & SBCD		
Roots yield	 100 – 340kg/Are 1.25 — 4.25 bag of 80kg/ Are	 30kg/Are 1/3 bag of 80kg/ Are		
Maturity time	 Maturity time 8 months	 Maturity time 8 months		
Taste	 Sweet taste (leaves are dark green and leaf petiole is red)	 Bitter taste (leaves are light green, leaf petiole is yellowish green)		
Price	 20 cuttings for BIF 160 100 cuttings for **BIF 800** are required for one Are	 20 cuttings for BIF 160 100 cuttings for **BIF 800** are required for one Are		

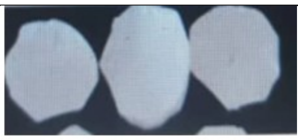
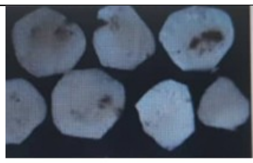
Why that choice? …..

Choice set 6

Attributes name	Profile 1	Profile 2	I don’t prefer any option	Choice Tick of 1 0r 2
Diseases resistant	 Strong for CMD & SBCD	 Strong for CMD & SBCD		
Roots yield	 100 – 340kg/Are 1.25 — 4.25 bag of 80kg/ Are	 30kg/Are 1/3 bag of 80kg/ Are		
Maturity time	 Maturity time: 6 months	 Maturity time: 6 months		
Taste	 Bitter taste (leaves are light green leaf petiole is yellowish green)	 Sweet taste (leaves are dark green and leaf petiole is red)		
Price	 20 cuttings for BIF 200 100 cuttings of BIF 1,000 are required for 1 Are	 20 cuttings for BIF 160 100 cuttings for BIF 800 are required for one Are		

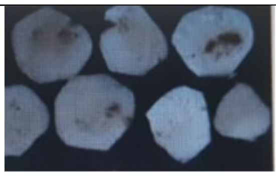
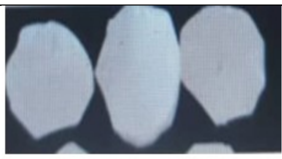
Why that choice? ……

Choice set 7

Attributes name	**Profile 1**	**Profile 2**	**I don't prefer any option**	**Choice Tick of 1 0r 2**
Diseases resistant	 Strong for CMD & SBCD	 Susceptible for CMD & SBCD		
Roots yield	 30kg/Are 1/3 bag of 80kg/ Are	 30kg/Are 1/3 bag of 80kg/ Are		
Maturity time	 Maturity time: 6 months	 Maturity time: 6 months		
Taste	 Sweet taste (leaves are dark green and leaf petiole is red)	 Sweet taste (leaves are dark green and leaf petiole is red)		
Price	 20 cuttings for BIF 240 100 cuttings of **BIF 1,200** are required for 1 Are	 20 cuttings for BIF 160 100 cuttings for **BIF 800** are required for one Are		

Why that choice? …….

Choice set 8

Attributes name	Profile 1	Profile 2	I don't prefer any option	Choice Tick of 1 0r 2
Diseases resistant	 Susceptible for CMD & SBCD	 Strong for CMD & SBCD		
Roots yield	 100 – 340kg/Are 1.25 — 4.25 bag of 80kg/ Are	 100 – 340kg/Are 1.25 — 4.25 bag of 80kg/ Are		
Maturity time	 Maturity time: 6 months	 Maturity time 8 months		
Taste	 Bitter taste (leaves are light green, leaf petiole is yellowish green)	 Sweet taste (leaves are dark green and leaf petiole is red)		
Price	 20 cuttings for BIF 240 100 cuttings of **BIF 1,200** are required for 1 Are	 20 cuttings for BIF 160 100 cuttings for **BIF 800** are required for one Are		

Why that choice? …….

PART IV: FARMERS' PREFERENCES TOWARDS CASSAVA CUTTINGS ATTRIBUTES

28. Among attributes of each card, a farmer will choose the most and the least important attribute.

BLOCK 1
Cards 1

1.1 Most important		Least important
	Hardness	
	Softness	
	Leaves yield	
	Inputs needed	
	Architecture	

Card 2

2.1 Most important		Least important
	Taste	
	Softness	
	Starch content	
	Inputs needed	
	Roots yield	

Card 3

3.1 Most important		Least important
	Hardness	
	Roots size	
	Leaves yield	
	Price	
	Roots yield	

Card 4

4.1 Most important		Least important
	Hardness	
	Softness	
	Starch content	
	Price	
	Diseases resistants	

Card 5

5.1 Most important		Least important
	Hardness	
	Roots size	

	Starch content	
	Inputs needed	
	Maturity time for cassava roots	

Card 6

6.1 Most important		Least important
	Taste	
	Roots size	
	Leaves yield	
	Inputs needed	
	Diseases resistant	

Card 7

7.1 Most important		Least important
	Taste	
	Roots size	
	Starch content	
	Price	
	Architecture	

Card 8

8.1 Most important		Least important
	Taste	
	Softness	
	Leaves yield	
	Price	
	Maturity time for cassava roots	

BLOCK 2
Card 1

1.2 Most important		Least important
	Hardness	
	Softness	
	Leaves yield	
	Inputs	
	Roots yield	

Card 2

2.2 Most important		Least important
	Taste	
	Softness	
	Leaves yield	

	Price	
	Diseases resistant	

Card 3

3.2 Most important		Least important
	Taste	
	Roots size	
	Starch content	
	Price	
	Roots yield	

Card 4

4.2 Most important		Least important
	Hardness	
	Roots size	
	Leave yield	
	Price	
	Architecture	

Card 5

5.2 Most important		Least important
	Taste	
	Roots size	
	Leaves yield	
	Inputs	
	Maturity time for cassava roots	

Card 6

6.2 Most important		Least important
	Hardness	
	Softness	
	Starch content	
	Price	
	Maturity time for cassava roots	

Card 7

7.2 Most important		Least important
	Taste	
	Softness	
	Starch content	
	Inputs	

	Architecture	

Card 8

8.2 Most important		Least important
	Hardness	
	Roots size	
	Starch content	
	Inputs	
	Diseases resistant	

BLOCK 3
Card 1

1.3 Most important		Least important
	Taste	
	Softness	
	Starch content	
	Inputs	
	Diseases resistant	

Card 2

2.3 Most important		Least important
	Taste	
	Roots size	
	Starch content	
	Price	
	Maturity time for cassava roots	

Card 3

3.3 Most important		Least important
	Taste	
	Roots size	
	Leaves yield	
	Inputs	
	Roots yield	

Card 4

4.3 Most important		Least important
	Hardness	
	Softness	
	Leaves Yield	
	Inputs	

	Maturity time for cassava roots	

Card 5

5.3 Most important		**Least important**
	Taste	
	Softness	
	Leaves yield	
	Price	
	Architecture	

Card 6

6.3 Most important		**Least important**
	Hardness	
	Roots size	
	Starch content	
	Inputs	
	Architecture	

Card 7

7.3 Most important		**Least important**
	Hardness	
	Softness	
	Starch content	
	Price	
	Roots yield	

Card 8

8.3 Most important		**Least important**
	Hardness	
	Roots size	
	Leaves yield	
	Price	
	Diseases resistant	

BLOCK 4
Card 1

1.4 Most important		**Least important**
	Hardness	
	Softness	
	Starch content	
	Price	
	Architecture	

Card 2

2.4 Most important		Least important
	Taste	
	Roots size	
	Starch content	
	Price	
	Diseases resistant	

Card 3

3.4 Most important		Least important
	Taste	
	Softness	
	Starch content	
	Inputs needed	
	Maturity time	

Card 4

4.4 Most important		Least important
	Taste	
	Softness	
	Leaves yield	
	Price	
	Roots yield	

Card 5

5.4 Most Important		Least Important
	Hardness	
	Roots size	
	Leaves yield	
	Price	
	Maturity time	

Card 6

6.4 Most important		Least important
	Hardness	
	Roots size	
	Starch Content	
	Inputs	
	Roots yield	

Card 7

7.4 Most important		Least important
	Taste	
	Roots size	
	Leaves yield	
	Inputs	
	Architecture	

Card 8

8.4 Most important		Least important
	Hardness	
	Softness	
	Leaves yield	
	Inputs	
	Diseases resistant	

BLOCK 5

Card 1

1.5 Most important		Least important
	Hardness	
	Softness	
	Starch content	
	Inputs need	
	Diseases resistant	

Card 2

2.5 Most important		Least important
	Taste	
	Roots size	
	Leaves yield	
	Price	
	Diseases resistant	

Card 3

3.5 Most important		Least important
	Hardness	
	Roots size	
	Starch content	
	Price	
	Maturity time for cassava roots	

Card 4

4.5 Most important		Least important
	Hardness	
	Roots size	
	Leaves yield	
	Inputs	
	Roots yields	

Card 5

5.5 Most important		Least important
	Taste	
	Softness	
	Starch content	
	Price	
	Roots yield	

Card 6

6.5 Most Important		Least Important
	Hardness	
	Softness	
	Leaves yield	
	Price	
	Architecture	

Card 7

7.5 Most important		Least important
	Taste	
	Softness	
	Leaves yield	
	Inputs	
	Maturity time for cassava roots	

Card 8

8.5 Most important		Least important
	Taste	
	Roots size	
	Starch content	
	Inputs	
	Architecture	

BLOCK 6

Card 1

1.6 Most important		Least important
	Taste	
	Softness	
	Leaves yield	
	Inputs	
	Diseases resistant	

Card 2

2.6 Most important		Least important
	Taste	
	Roots size	
	Starch content	
	Inputs	
	Roots yield	

Card 3

3.6 Most important		Least important
	Taste	
	Roots size	
	Leaves yield	
	Price	
	Maturity time for cassava roots	

Card 4

4.6 Most Important		Least Important
	Hardness	
	Roots size	
	Leaves yield	
	Inputs	
	Architecture	

Card 5

5.6 Most important		Least important
	Hardness	
	Softness	
	Starch content	
	Inputs	
	Maturity time for cassava roots	

Card 6

6.6 Most important		Least important
	Hardness	
	Softness	
	Leaves yield	
	Price	
	Roots yield	

Card 7

7.6 Most important		Least important
	Hardness	
	Roots Size	
	Starch Content	
	Price	
	Diseases resistant	

Card 8

8.6 Most important		Least important
	Taste	
	Softness	
	Starch content	
	Price	
	Architecture	

BLOCKS 7

Card 1

1.7 Most Important		Least Important
	Hardness	
	Softness	
	Leaves yield	
	Price	
	Maturity time for cassava roots	

Card 2

2.7 Most important		Least important
	Hardness	
	Roots size	
	Starch content	
	Price	
	Architecture	

Card 3

3.7 Most important		Least important

	Hardness	
	Roots size	
	Leaves yield	
	Inputs	
	Diseases resistant	

Card 4

4.7 Most important		**Least important**
	Taste	
	Roots size	
	Leaves yield	
	Price	
	Roots yield	

Card 5

5**.7 Most Important**		**Least Important**
	Taste	
	Roots size	
	Starch content	
	Inputs	
	Maturity time for cassava roots	

Card 6

6.7 Most important		**Least important**
	Taste	
	Softness	
	Leaves yield	
	Inputs	
	Architecture	

Card 7

7.7 Most important		**Least important**
	Hardness	
	Softness	
	Starch content	
	Inputs	
	Roots yield	

Card 8

8.7 Most important		**Least important**
	Taste	

	Softness	
	Starch content	
	Price	
	Diseases resistant	

BLOCK 8
Card 1

1.8 Most important		Least important
	Taste	
	Roots size	
	Leaves yield	
	Price	
	Architecture	

Card 2

2.8 Most important		Least important
	Hardness	
	Roots size	
	Leaves yield	
	Inputs	
	Maturity time for cassava roots	

Card 3

3.8 Most important		Least important
	Hardness	
	Softness	
	Starch content	
	Input	
	Architecture	

Card 4

4.8 Most important		Least important
	Taste	
	Roots size	
	Starch content	
	Inputs	
	Diseases resistant	

Card 5

5.8 Most important		Least important

	Hardness	
	Roots size	
	Starch content	
	Price	
	Roots yield	

Card 6

6.8 Most important		**Least important**
	Taste	
	Softness	
	Starch content	
	Price	
	Maturity time for cassava roots	

Card 7

7.8 Most important		**Least important**
	Taste	
	Softness	
	Leaves yield	
	Inputs	
	Roots yield	

Card 8

8.8 Most important		**Least important**
	Hardness	
	Softness	
	Leaves yield	
	Price	
	Diseases resistant	

ADDITIONAL QUESTIONS

29. How big is the land for improved cassava (Improved cassava farm size)? ……Ares

30. How big is the land for traditional cassava (Traditional cassava farm size)? ……Ares

31. How big is total farm size own (inheritance, bought land and gift land)?...........Ares

32. How big is total farm size under cultivation own?.........Ares

33. Total farm size with cassava own (mixed/mono) ……. Ares

34. If mixed, what percentage does cassava occupy? %

35. How big is total farm size rent?...............Ares

36. How big is total farm size under cultivation rent?.........Ares

37. How big is the total farm with cassava rents (mixed/ mono) ……Ares

38. If mixed, what percentage does cassava occupy?.%

39. What is your estimated annual farm income? .... BIF (crops, livestock for all season added)

40. What is your estimated annual non-farm income? ...... BIF (including off farm)

41. What percent does cassava contribute to total income now?

42. What percent did cassava contribute to total income five years ago?

43. What percent does cassava contribute to food production now?

44. What percent did cassava contribute to food production five years ago?

45. What percent does cassava contribute to food consumption now?

46. What percent did cassava contribute to food consumption five years ago?

47. How often do you use extension services in season?

47.a ………

47.b. Never

48. Have you ever used such service for cassava production/processing?

48.a Yes

48.b No

49. Did you obtain credit/loan in the last season?

49.a Yes

49.b No

50. Are you a member of any cassava production or marketing association/cooperative?

51. a. Yes

51. b. No

52. What is the distance to the nearest market for cassava? ………….. Km

53. Wat is the distance from the farm with cassava to the road……….. Km

54. How do you transport cassava production to the market?

54.a By car

54.b By motorbike

54.c By bicycle

54.d Carrying on head

54.e Buyers coming to collect from farm

54.f Other (Specify) ....