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Research article

# Why cassava processors will patronize mechanized cassava peeling machine service

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**Abstract.** Cassava peeling machines are available but are inaccessible and prohibitively expensive, especially for small-scale processors to acquire. This paper examines the perception and willingness of smallholder cassava processors to pay for cassava peeling machine services using data from 300 cassava processors in the Bono East Region of Ghana. A perception index from a 5-point Likert Scale and Cragg's Double Hurdle model were the methods of analysis. The results revealed a perception index of 2.54 and this implies that cassava processors have neutral perception about the cassava peeling machine service. Also, it was found that majority of the processors (75.33%) are not aware of existence of the cassava peeling machine. In addition, we find that 99.63% of the cassava processors are willing to patronize the services of the cassava peeling machine. Moreover, cassava processors are willing to pay an average amount of GH₵ 4.21 for a 50 kg bag of cassava peeled using the services of the cassava peeling machine. Furthermore, the study revealed that factors such as educational level, quantity produced per processing cycle and the dependence on cassava processing as the main source of income positively and significantly influenced willingness to pay for the services. Finally, the amount processors were willing to pay was influenced by educational level, household size, source of income, perception about machine's complications and group membership. The study recommends that investors consider installing cassava peeling machines to provide commercial cassava peeling services in processing areas. While generating income to investors, it will contribute to reducing postharvest losses during cassava processing. Future efforts should focus on raising awareness about the availability and benefits of commercialization of mechanized peeling of cassava.

**Keywords**: cassava peeling machine, cassava processors, Ghana, perception, willingness to pay.
**JEL codes**: C21, C24, D71, O14, O33.

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HIGHLIGHTS

- Cassava processors have neutral perception about the cassava peeling machine service.
- Majority of cassava processors are not aware of existence of the cassava peeling machine.
- Cassava processors are willing to patronize the services of the cassava peeling machine.
- Educational level influences both processors' willingness to pay and the amount they are willing to pay.

## 1. INTRODUCTION

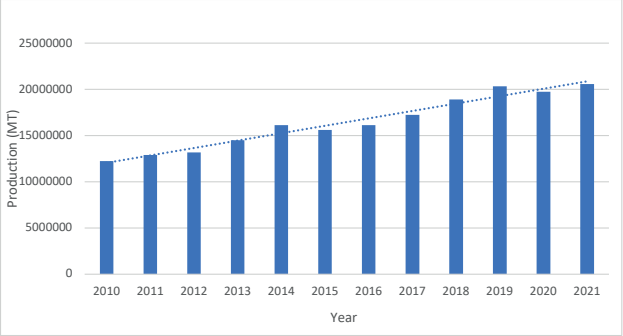
### *1.1. Cassava production and patronage of the cassava peeling machine*

Cassava is one of the important staple food crops and a major source of income for rural households (Rozi *et al.*, 2023). According to FAOSTAT (2023), there has been a significant rise in global cassava production with an increase of 240 million metric tons since 2010. This increase is due to global demand for cassava as a raw material for the production of several industrial products (Hafif *et al.*, 2023; FAOSTAT, 2023). FAOSTAT (2023) projections indicate that by 2025, approximately 62% of the world's cassava production will be sourced from sub-Saharan Africa. Ghana is the sixth highest global producer of cassava in terms of value, and the third in Africa, with about 70 percent of local farmers producing over 20 million metric tonnes every year (Adjei *et al.*, 2023; FAOSTAT, 2023). Cassava produced in Ghana increased to a total of 17,212,760 metric tonnes in the year 2015, 17,798,220 metric tonnes in 2016, and over 20,000,000 metric tons in 2021 (Figure 1).

One disadvantage of cassava production as a commercial crop is its short shelf life (Zainuddin *et al.*, 2023). Cassava roots are extremely perishable as deterioration starts immediately after harvest. Once harvested, it has to be either consumed immediately or processed into more stable product forms (Okeowo, 2016). Due to its highly perishable nature, harvested cassava roots are mostly processed to curb post-harvest losses (Davies *et al.*, 2008; Mbinda and Mukami, 2022). Food and Agriculture Organization (2005) observed that the increase in production of cassava has caused widespread cassava processing into various shelf-stable and semi-stable products by traditional cassava processors and small-scale commercial processing units.

In Ghana, cassava roots are processed into four main products namely, gari, cassava chips (konkonte) or flour, starch and semi-fermented mash (agbelima) (Sackey and Bani, 2007). The first operation in the processing of cassava for human consumption is the removal of the cassava peels. Osei (2020) stated that cassava peeling in the olden days was done by the use of stones and wooden flint before evolving to the simple household knife. Several problems are encountered during indigenous processing which has created an urgent need for mechanization and upgrading of processing (FAO, 2015). Traditionally, cassava peeling is known to be done manually by slitting along the length of the cassava with a sharp object and removing the peels with the help of the hands. The manual approach of peeling cassava has been characterized by drudgery, high rate of injury and also places a limit on the peeling speed (Diop and Calverley, 1998; Osei, 2020). Regardless, this method is preferred by local processors and small-scale farmers because they believe it yields the best of results and it is the only method available to them. In an attempt to enhance the peeling of cassava, other methods have been introduced. According to Osei (2020), cassava can be peeled mechanically, chemically and by steaming. Chemical peeling of cassava was identified to be costly and can lead to food poisoning whereas steam peeling can lead to premature cooking of the cassava tuber (Kadurumba and Aririguzo, 2021). Manual peeling of cassava has been a serious global challenge to cassava processors, especially to large scale processors (Mensah, 2017). According to Kolawole *et al.* (2010), processing cassava cannot be done without peeling and a number of cassava peeling machines with different efficiencies are on the market. Regardless of the numerous global improvements made in cassava peeling, cassava processing in Ghana is fraught with the lack/limited availability of mechanized peeling machines that could help boost the operation. Even when available, these efficient technologies cannot be afforded by many and are inaccessible to those at the farm level where most of the cassava root processing takes place (Mensah, 2017).

**Figure 1.** Cassava Production in Ghana.




*Source:* FAOSTAT, 2023.

Despite the fact that some studies analyzed the design (Gumanit and Pugahan, 2015, Nwaigwe *et al*., 2012), construction or fabrication (Gumanit and Pugahan, 2015) and performance (Gumanit and Pugahan, 2015; Mensah, 2017; Nwaigwe *et al*., 2012; Osei, 2020) of the cassava peeling machine, there is limited or no information on cassava processors' perception about the cassava peeling machine and their willingness to patronize the technology. This paper addresses three questions, viz. Q1: Are cassava processors aware of existence of cassava peeling machine? Q2: what is the perception of cassava processors on the cassava peeling machine? and Q3: What factors influence cassava processors' willingness to pay for cassava peeling machine as well as the amount they are willing to pay? Cassava processors play a crucial in the cassava value chain by adding value to raw fresh cassava, and converting it into marketable products such as cassava flour, starch, chips, and gari. They often operate small-scale processing units which employs various techniques and technologies to enhance the quality and shelf life of the cassava products. The focus of this study is to examine how these cassava processors in the Bono East Region of Ghana perceive and express their willingness to pay for the services provided by a cassava peeling machine.

The contributions of this paper are twofold. First, to improve and facilitate the processing of cassava into various commodities in order to improve its shelf-life, there is the need for the introduction of appropriate cassava processing technologies. With the Government of Ghana interested in improving the production and processing of cassava in the country, this research will inform policy makers about cassava processors' readiness for technologies aimed at improving their ventures. Secondly, despite the introduction of improved cassava processing technologies in Ghana, there is inadequate information related to the awareness, perception and use of these improve cassava processing technologies. Since most cassava processors are used to the indigenous processing methods, it is imperative to assess the willingness of these processors to pay for the services of introduced technologies and gauge the amount they are willing to pay. This information will aid the government and all other stakeholders in formulating policies and strategies to help promote the use of improved cassava processing technologies. The study will serve as a foundation for evidence-based decision-making and the formulation of policies and strategies aimed at promoting the adoption of improved cassava processing technologies. By aligning the efforts of the government and other stakeholders, Ghana can enhance the competitiveness and sustainability of its cassava processing industry, leading to economic growth, increased employment opportunities, improved livelihoods for cassava processors as well as help improve product quality, decrease processing time and reduce tuber losses. The remaining sections of the paper are structured as follows. In the next section, we complete the introduction by presenting the underlying theoretical framework of the study. This is followed by a literature review on the topic in section two. Following that, the research methodology is presented in section three. The results and discussion are presented in section four and in section five, we present the conclusions and make recommendations for policy.

### *1.2. Theoretical Framework*

Economic theory and behavioral economics were considered the theoretical underpinnings of this study. The decision-making process of the processor was explained using a few essential concepts:

1. Cost-Benefit Analysis: It is evidently clear that cassava processors and other interested parties would weigh the costs and advantages of purchasing a cassava peeling equipment. The benefits of greater productivity, time savings, enhanced product quality, and potential increases in market prices for processed cassava products would be weighed against the cost of the machine, maintenance costs and operating expenses. Whether the apparent benefits outweigh the price of the machine would determine whether or not to purchase the technology.
2. Technology Adoption and Innovation: According to Jain *et al.* (2023), farmers' decisions to accept new technologies are impacted by how beneficial and simple such technologies are regarded to be. Cassava processors may be more inclined to pay for the peeling machine if they believe it is a useful invention that will increase their production and profitability. Adoption may also be influenced by factors including training, technical support, and demonstrations of the machine's efficacy.
3. Market Demand and Price Premium: The high demand for cassava products can have an impact on processors' willingness to pay for the services of a cassava peeling machine. The purpose of the machine is to reduce the drudgery and time involved in manually peeling of cassava. If there is significant demand for cassava products like gari, flour, and starch, processors may see investing in the machine as a way to meet consumer preferences and capture higher prices in a shorter period of time.
4. Social Norms and Peer Influence: According to Gächter *et al.* (2013), peer behavior (behavioral economics) and social norms might have an impact on

decision making. Other processors could be more likely to use cassava peeling machines if nearby farmers or significant community members have done so effectively and reaped the rewards. Farmers' willingness to pay for the technology can be influenced by peer pressure, social learning, and shared experiences.

5. Risk and Uncertainty: When making an investment in procuring a cassava peeling machine, investors and processors may take into account the risks and uncertainties involved. Their decision-making may be impacted by uncertainty over market demand, machine dependability and financial hazards. Investors' trust and desire to invest in the technology might be boosted by providing them with information and support about potential dangers and mitigation techniques.

## 2. LITERATURE REVIEW

Ghana is second to Nigeria in cassava root production in West Africa, and produces about 15,113,000 metric tonnes of cassava annually (FAO, 2015; Richards, 2023). Cassava is now cultivated in every region in Ghana. Based on the average volume produced by each region between 2012 to 2014, Bayitse *et al.* (2017) indicated that the five principal regions in terms of cassava production in Ghana are the Eastern, Brong Ahafo (now Bono, Ahafo and Bono East regions), Ashanti, Central and the Northern regions.

Anning-Dorson (2023) maintained that about one-fifth of Ghana's agricultural GDP is made up of income generated from cassava production and post-harvest processing. Acheampong *et al.* (2022), stated that 60% of the daily caloric intake of the Ghanaian population is obtained from cassava. FAO (2015) reinforced the fact that cassava is an important source of farm income particularly in Ghana and Nigeria. Income from cassava was higher for farmers that had access to mechanized cassava processing equipment for the preparation of gari in Ghana and Nigeria (FAO, 2015). MoFA (2021) also added that cassava is a major source of income and food security in some districts in Ghana, particularly Suhum-Kraboa-Coaltar District. Cassava is of significant importance to the economy of Ghana and accounts for 22% of the national GDP (Anning-Dorson, 2023).

The key focus of cassava production is for human consumption, as more than 90% of cassava produced is intended to be consumed by humans (FAOSTAT, 2023). Asogwa *et al.* (2013) and FAOSTAT (2023) argue that, with an annual output exceeding 34 million metric tonnes, cassava is one of the most important food crops in the world. According to Ani *et al.* (2013) and Hafif *et al.* 2023, processed cassava is not only used for household consumption but also serves as livestock feed and industrial raw material used for producing bakery products, adhesives, dextrin, dextrose glucose, lactose and sucrose that can be transformed into ethanol. Cassava products in Africa can be classified into five common groups: fresh root, granulated products, dried roots, pasty products and cassava leaves (FAO, 2015).

Peeling is the first and major operation unit in cassava processing and is still mainly done manually using a knife (Bayitse *et al.*, 2017). The increasing demand for cassava products has caused the need to design technologies to improve cassava processing. Cassava processing thus deserves serious attention in order to meet the local and international demand for cassava products. The unit operations involved in the processing of cassava includes peeling, grating, boiling/parboiling, drying, milling, sieving, extrusion and frying. Several processes for the above-mentioned operations have been mechanized successfully. However, cassava peeling remains a serious global challenge in cassava processing (Kadurumba and Aririguzo, 2021).

According to Amoah *et al.* (2022), there is a relatively higher adoption rate of modern cassava processing techniques, mainly because the operation is quite easy. A major factor influencing adoption of postharvest cassava technology is the level of awareness of the technology. Amaza *et al.* (2016), indicated that the knowledge and level of awareness of the mechanized processing technology has a correlation with rate of adoption of the processing technology. Amaza *et al.* (2016), also added that factors such as the processor's gender, distance from processing site to the nearest tarmac road and the cost of capital do influence the decision to adopt a High-Quality Cassava Flour (HQFC) processing technology. A study by Udensi *et al.* (2017), also revealed that the adoption of post-harvest processing technology among cassava farmers is influenced by factors such as the household size of the farmer, income of the household head, the number of processing equipment and the years of experience. Ehinmowo and Fatuase (2016) also added educational level, source of information, source of raw materials and source of credit as key determinants of adoption of improved cassava processing technologies.

Once we have considered the determinants of adoption of cassava processing technologies, the next step is to analyze processor's willingness to pay for the technologies. Willingness to pay (WTP) is defined by Gunatilake *et al.* (2007), as the economic value of goods or commodities to an individual or a household under

given conditions. Dimitri and Greene (2002) added that it is important to distinguish between willingness to pay and willingness to accept. Contrary to willingness to pay, willingness to accept describes the maximum amount a person is willing to take in order to give up a good (Dimitri and Greene, 2002; Martín-Fernández *et al.*, 2010). Two sequential processes, which can be considered as either a joint or separate decision, can be used to address the decision to pay or not pay a given premium. Most literature (Adepoju and Oyewole, 2013; Bhatta *et al.*, 2009 and Meenakshi *et al.*, 2011) indicated that either a linear model such as Ordinary Least Squares (OLS) or Dichotomous models, such as the Logit, Probit and Tobit, can be employed in assessing the determinants of willingness to pay. The current study employed Cragg's double hurdle model because different factors influenced processors' willingness to pay as well as the amount they are willing to pay and also because of the insignificance of the Mill's ratio of the Heckman's model (Okoffo *et al.*, 2016; Wodjao, 2008).

## 3. METHODOLOGY

### *3.1. Methods*

The study was undertaken in the Bono East Region of Ghana. The region is referred to as the "food basket" of Ghana as most people in the region are farmers. Generally, these farmers produce cash crops like coffee, tobacco, cashew and rubber. Food crops such as beans, cassava, yam, maize, plantain, rice, cocoyam and tomatoes are also grown. Cassava processing is one of the predominant industrial establishments that serves as a source of livelihood to most people in the region (BERCC, 2020).

Descriptive statistics comprising means, standard deviations and percentages were used to analyse and describe the socioeconomic characteristics of the processors. Also, a perception index was used to assess the perception of processors about the cassava peeling machine. A five-point Likert scale (1 = Strongly agree, 2 = Agree, 3 = Neutral, 4 = Disagree, 5 = Strongly disagree) was employed to obtain the perception level of the respondents on various statements relating to the cassava peeling machine. The mean scores of all the processors with regards to each of the perception statements was then calculated. The mean score of each perception statement was computed as follows:

$$Mean\ score = \frac{[(fsa\times1)+(fa\times2)+(fn\times3)+(fd\times4)+(fsd\times5)]}{x} \quad (1)$$

where,

fsa = frequency of strongly agree,
fa = frequency of agree,
fn = frequency of neutral
fd = frequency of disagree
fsd = frequency of strongly disagree
$x$ = number of cassava processors who responded to the perception statements

The overall perception index was finally computed as the average of all the mean scores for all the perception statements ranked by the processors. This was calculated as follows:

$$Perception\ index = \frac{1}{n}(\sum_{i}^{n} \mathrm{MS_{PS1}} + MS_{PS2} + MS_{PS3} + \cdots\cdots\cdots\cdots MS_{PSn}) \quad (2)$$

where
$n$ = number of perception statements,
$MS$ = mean score of each perception statement and
$PS_{1\ldots n}$ = each perception statement.

The willingness to pay for services of the cassava peeling machine was analyzed using descriptive statistics. In the survey questionnaire, the double bound contingent valuation approach was used to evaluate the processors' response in the absence of an actual price in offering the cassava peeling service. The double bound contingent valuation (CV) model was introduced by Mäler and Vincent (2003), which aims at introducing a second bid as a follow-up question to the initial bid. The second bid is a higher amount if the respondent answers yes to the initial bid. However, if the response to the first bid is no, a lower amount is asked as the second bid. According to Fonta *et al.* (2011), contingent valuation method is important in assessing the level of readiness of communities or groups of individual participants in community-based projects or services aimed at improving welfare. Also, the CV approach has the potential of resolving the issue where there is lack of knowledge or exposures of existing technologies or methodologies. Taneja *et al.* (2014), stated that the contingent valuation (CV) method makes use of surveys that are particularly intended for measuring preferences and willingness to pay. It helps in estimating the amount processors are willing to pay using various elicitation techniques. The method, which has been used by several researchers, is rated as the best choice especially in situations of little or no market information (Okoffo *et al.*, 2016). The implication is that it helps in simulating the concept of choice in market situations as processors have the opportunity of accepting or rejecting the product. Following the importance of the CV method, it has been highly used in several studies in agriculture where it has been used to elicit information on farmers' willingness

to pay for a product, technology or service. Due to the importance of contingent valuation approach in willingness to pay studies, we adopted this method for our study. The responses expected from the utilization of the double bound contingent valuation are mathematically presented as:

$Yi = (1,1) = (yes, yes)$,
$Yi = (1,0) = (yes, no)$
$Yi = (0,1) = (no, yes)$
$Yi = (0,0) = (no, no)$

The first represents the response to the first bid and the second represents the response to the second bid.

The Tobit, Cragg double hurdle and Heckman selection models were employed in examining the determinants of cassava processors' willingness to pay for cassava peeling machine services as well as the amount processors were willing to pay for these services. The Tobit model has an underlying assumption that the decision on processors' willingness to pay and the amount they are willing to pay are made simultaneously whereas Cragg's model assumes the two decisions are made in two different stages (Mal *et al.*, 2012). Buraimo *et al.* (2010), indicated that it is possible to compare the two models using a standard likelihood ratio test. The hypothesis to be tested are:

$H_0$: *There is no significant difference between the two models*
$H_1$: *There is a significant difference between the models*

A rejection of the null hypothesis indicates that there is a difference in the models and the decision on processors' willingness to pay and the amount they are willing to pay are made differently, hence Cragg double hurdle is superior. The null hypothesis is rejected when the likelihood ratio statistic is greater than the chi-square value. According to Greene (2012), the likelihood ratio statistic can be computed as:

$$LR = -2\,[log\,LT - (log\,LP + log\,LTR)] \quad (3)$$

where *LT*, *LP* and *LTR* are log-likelihoods of the Tobit, Probit, and truncated regression models respectively and *LR* is the likelihood ratio statistic. The degree of freedom $(n - k)$ for the hypothesis was identified to be infinity.

To confirm the appropriateness of the Cragg Double Hurdle model, the Heckman Selection model was estimated. As proposed by Heckman (1979), the Heckman model is a two-step estimator model that checks for selection bias and corrects them. Puhani (2000) stated that the first stage of the model is a probit model, whereas the second stage is OLS. The Mill's ratio of the Heckman model serves as the basis of decision for its appropriateness to be employed for a particular study. A significant Mill's ratio indicates the existence of selection bias, in which case the Heckman model is more appropriate (Waithaka *et al.*, 2007). On the contrary, if the Mill's ratio is insignificant, the Cragg Double Hurdle is the preferred model. Therefore, in this study the Heckman model (Appendix 1) revealed insignificant Mill's ratios which necessitated the use of the Cragg Double Hurdle model. The first stage of the Cragg Double Hurdle (probit model) is modelled as:

$$WTPCPM = 1 \text{ if } WTPCPM > 0 \text{ and}$$
$$WTPCPM = 0 \text{ if } WTPCPM \leq 0 \quad (4)$$
$$WTPCPM = Z_i\alpha + \varepsilon_i \quad (5)$$

where
*WTPCPM* = a dichotomous variable which assumes a value of 1 if processors are willing to patronize the machine and 0 if they are unwilling to patronize it.
*Z* = Vector of cassava processors' characteristics
$\alpha$ = Vector of parameters to be estimated
$\varepsilon_i$ = Error term

The second stage equation in the Cragg Double Hurdle model (truncated regression) which models the amount cassava processors are willing to pay for the service offered is given as:

$$WTPfee = WTPfeei \text{ if } WTPfeei > 0 \text{ and}$$
$$WTPfeei = 0 \text{ if otherwise} \quad (7)$$
$$WTPfeei = Xi\beta + Ui \quad (8)$$

where
*WTPfeei* = observed response on how much cassava processors are willing to pay for the mechanized cassava peeling machine service
*X* = Vector of cassava processors' characteristics
$\beta$ = Vector of parameters to be estimated
*Ui* = Error term

### 3.2. Data Collection, Sources and Type of Data

Generally, primary cross-sectional data was used in the study and this was collected using structured questionnaires administered on cassava processers. The processors were selected using a multi-stage sampling technique. In the first stage, the Bono East Region of Ghana was purposively selected because it is noted to be one of the major cassava growing and processing regions in the country (Bayitse *et al.*, 2017). Purposive sampling

was also used to select Techiman Municipal, Nkoranza North District and the Atebubu-Amantin Municipal as areas for the study in the second stage. These are well known cassava processing areas with communities noted for cassava processing (UNIDO, 2019). Simple random sampling technique was used to select 100 respondents from each district in the third stage, giving a total sample size of 300 respondents. The choice of sampling was driven by the need to focus on well-known cassava processing areas, while stratification in relation to the study ensured representativeness. The subsequent use of simple random sampling within each study area ensured fairness and enhanced the potential generalizability of the findings to the larger population of cassava processors in the study area.

Questionnaires were administered in local dialect and English in order to make communication easy and enhance the quality of the data. Field visit was adopted to obtain information from respondents through face-to-face interview. Primary data was collected using structured questionnaires consisting of closed and open-ended questions. Specific questions were asked to obtain personal information about the cassava processors, characteristics of their processing operation, their perceptions about the cassava peeling machine, willingness to pay for the services of the cassava peeling machine, the amount willing to be paid, associated constraints as well as the cost and returns of commercializing a cassava peeling machine in the Bono East region. The study strategically chose to administer the questionnaire during the peak cassava processing season, which typically starts in the middle of the year. By aligning the questionnaire administration with the period of high cassava processing activities, the study maximized the opportunity to capture accurate and relevant information from the processors. Data was also sourced from journal articles, dissertations and other technical documents that relate to this particular study. This was mainly used in the review of literature concerning various subject matters relating to the study. This also helped in the selection of the variables used in the Cragg double hurdle regression model.

## 4. RESULTS AND DISCUSSION

### *4.1. Socioeconomic characteristics of cassava processors*

The socioeconomic characteristics of respondents are presented in Tables 1 and 2. The socio-economic characteristics of the cassava processors were analyzed using both descriptive and differential analysis methods. These approaches provided a comprehensive understanding of the data, allowing for the examination of various factors and variables related to the processors' socio-economic situation. By employing descriptive analysis, key features and patterns were identified and summarized. Additionally, differential analysis enabled comparisons and contrasts to be made among different groups or variables, revealing variations and relationships within the data. Together, these analytical techniques offered valuable insights into the socio-economic aspects of the cassava processors under study. The results showed that majority of the cassava processors (90%) are women (Table 1). This is in line with the results of Otunba-Payne (2020) which revealed that the role of women in the cassava value chain is vital and constitutes majority of the people involved in the marketing and processing of cassava into various forms. On average, cassava processors in the Bono East Region have approximately seven and half years of formal education (Table 1). This agrees with a study by Aidoo *et al.* (2016), which stated that most cassava processors have at least basic level of education. The average age of cassava processors in the Bono East region is 45 years (Table 1). The average household size of the processors in the region was found to be five (5) individuals and generally, they had eight and half years of experience in cassava processing (Table 1).

The most common product produced by cassava processors in the Bono East Region is gari. The study found that 98.3% of the processors had gari as the main product of their activity (Table 2). This is mainly due to the fact that there is a higher demand for gari throughout the year as compared to other cassava products (Anning-Dorson, 2023). Although some processors produce one cycle of product per week and others three times in a week, the most common production cycle undertaken in a week is two. The study further revealed that an average quantity of 1,790 kg of cassava is processed per cycle and 3,580 kg of cassava being processed on a weekly basis (Table 1). This is equivalent to 72 bags (50 kg) of cassava being processed on a weekly basis in the study area. The study also revealed that majority of the processors were the owners of the enterprise they operated as 94% of the respondents gave a positive response as being the owners (Table 1).

The results presented in Table 1 also shows that a small portion of cassava processors in the Bono East Region do have access to credit as credit was accessible to 22.7% of cassava processors, out of which few (15.7%) were actually able to receive credit in the last 12-month period. This is an indication that most cassava processors have very limited access to credit, with most of their credit being obtained from informal sources. Majority (34%) of the credit received by cassava processors

**Table 1.** Socio-economic Characteristics (Descriptive Statistics).

| Variable | Description | Min. | Max. | Mean | S.D. |
|---|---|---|---|---|---|
| Gender | 0=Male; 1=Female | 0 | 1 | 0.09 | 0.291 |
| Marital status | 1= Married; 0= Single | 0 | 1 | 0.87 | 0.333 |
| Own cassava processing enterprise | 1= Yes; 0= No | 0 | 1 | 0.94 | 0.238 |
| Other occupation aside cassava processing | 1= Yes; 0= No | 0 | 1 | 0.79 | 0.405 |
| Main source of income | 1= Cassava processing; 0= Other occupation | 0 | 1 | 0.94 | 0.233 |
| Part of processors' assoc. | 1= Yes; 0= No | 0 | 1 | 0.15 | 0.358 |
| Access to any credit source | 1= Yes; 0= No | 0 | 1 | 0.23 | 0.419 |
| Received credit | 1= Yes; 0= No | 0 | 1 | 0.16 | 0.364 |
| Form of credit received | 1= Cash; 0= Input | 0 | 1 | 0.98 | 0.146 |
| Willing to pay for the services of cassava peeling machine | 1= Yes; 0= No | 0 | 1 | 0.96 | 0.188 |
| Age | Age | 21 | 65 | 45 | 9.602 |
| Years of education | Years of schooling | 0 | 13 | 7.49 | 3.89 |
| Household size | Number of people living with processor | 1 | 10 | 5 | 1.40 |
| Household members assisting in processing | Number of people assisting in farm work | 0 | 5 | 1 | 0.891 |
| Years of cassava processing | Number of years of operation | 3 | 37 | 8.5 | 3.261 |
| Processing cycle per week | Number of times processing is done in a week | 1 | 3 | 2 | 0.816 |
| Quantity processed per cycle (kg) | Kilograms of cassava processed per production cycle | 50 | 4700 | 1790.27 | 1010.759 |
| Amount received as credit | Monetary value of credit received | 150.00 | 2900.00 | 1,128 | 717.717 |
| Amount willing to pay for 50 kg bag of cassava to be mechanically peeled | Amount to be paid | 2.00 | 6.00 | 4.21 | 211.4 |

*Source*: Field Survey, 2020.

was obtained from friends and families, with the bank accounting for only 21.3% of credit received (Table 2). Almost all credits were received in the form of cash, with only 2% of the credit received being in kind. Manu *et al.* (2016), confirmed that about 76.7% of gari processors do not receive credit for production.

Although most of the cassava processors had their own farms, majority (68%) indicated that the cassava they used came from various cassava farmers in and around their area of operation even though 31.7% combined produce from their farm with supplies from other farmers (Table 2). This is consistent with Adeyemo (2013) who stated that majority of cassava for processing are supplied by small holder farmers. In addition to their cassava processing activities, most of the respondents (80.9%) engaged in farming activities even though majority (94.3%) indicated their main source of income was from the processing of cassava (Table 2). Majority of the processors (85%) were not members of any cassava processors association (Table 2).

However, with the 15% that were members of cassava processors association, some respondents stated that the association is now dysfunctional and ineffective, making their reason for joining not met. This implies that, although cassava processing is predominant in the area, processors do not have a united front with which they can channel their grievances. Cassava processing and gari traders' associations exist mainly to promote the welfare of its members (Aidoo *et al.*, 2016). Majority of cassava processors (64.7%) indicated that the main outlet for the marketing of their products was through retailers (Table 2). This is in line with Odongo and Etany's (2018) findings that among the cassava marketing channels, the producer to retailer channel had the highest gross margins. For this reason, majority of processors prefer to sell directly to retailers. However, the sale of products by a processor was not limited to only retailers. Processors did not discriminate and were willing to sell to any available outlet once the product was ready for the market.

As indicated in Table 1, 96% of cassava processors agreed that they were willing to patronize the cassava peeling machine and 47.92% of them were willing to pay a fee for the service because they believe the technology is an easier and faster way of peeling cassava for processing (Tables 1 and 2). Whilst 46.87% of the respondents indicated that their willingness to pay for the services will help increase their production in a given period, 4.51% were also of the view that patronage of the cassava peeling machine service is a means of mitigating the problems of getting labour to manually peel cas-

**Table 2.** Socioeconomic Characteristics (Categorical variables).

| Variables | Frequency | Percentage |
|---|---|---|
| *Main cassava processing product* | | |
| *Gari* | 295 | *98.3* |
| Cassava dough | 3 | *1.0* |
| Flour | 2 | *0.7* |
| *Major source of cassava for production* | | |
| Farmers | 204 | *68.0* |
| Farmers & Own farm | 95 | *31.7* |
| Own farm | 1 | *0.3* |
| *Source of credit received* | | |
| Relatives and friends | 16 | *34.0* |
| Husband | 15 | *31.9* |
| Banks | 10 | *21.3* |
| Co-operatives | 3 | *6.4* |
| Others | 3 | *6.4* |
| *Main marketing channel* | | |
| Retailers | 194 | *64.7* |
| Consumers | 53 | *17.7* |
| Institution | 45 | *15.0* |
| Wholesalers | 8 | *2.7* |
| *Other occupations* | | |
| Farming | 190 | *80.9* |
| Trading | 38 | *16.2* |
| Food vendor | 4 | *1.7* |
| Seamstress | 2 | *0.8* |
| Teaching | 1 | *0.4* |
| Reason for joining association | | |
| Access to raw materials | 32 | *71.11* |
| Financial support | 31 | *68.89* |
| Effective in processing | 10 | *22.22* |
| Access to labour | 2 | *4.44* |
| *Reasons for patronizing* | | |
| Make peeling easier and faster | 138 | *47.92* |
| Increase quantity produced | 135 | *46.87* |
| To mitigate the problem of getting labour to manually peel cassava and risk involved | 13 | *4.51* |
| Reduce drudgery | 1 | *0.35* |
| Reduce cost of manual peeling | 1 | *0.35* |
| *Reason for non-patronize* | | |
| Satisfied with manual peeling | 4 | *33.33* |
| Cannot afford the services of the cassava peeling machine | 3 | *25* |
| Never heard of cassava peeling machine | 2 | *16.67* |
| Does not know the cassava peeling machine operates | 2 | *16.67* |
| May add additional cost to production | 1 | *8.33* |

*Source*: Field Survey, 2020.

sava and risk involved which include some of the cassava roots going waste (Table 1). Amongst the cassava processors who were unwilling to pay for the services, 33.33% attributed their unwillingness to being satisfied with manual peeling and the results it produces. Others also indicated that they do not have the financial power to pay for the services of the cassava peeling machine. Recording 16.67% each, amongst the reasons for the non-patronage was lack of operators for the cassava peeling machine and unawareness of the existence of the cassava peeling technology. Finally, the results show that cassava processors are willing to pay an amount of GH₵ 4.21 for a 50 kg bag of cassava processed (Table 1).

Table 3 compares the characteristics of processors who are willing to pay (WTP) and those who are unwilling to pay (UWTP) for the services of the cassava peeling machine in the study area. The results of the t-test indicate that there was no significant difference in the characteristics of the two groups for most of the variables. However, the mean difference of some socioeconomic characteristics, namely, main source of income, membership of processors' association, access to, source of and receipt of credit, years of education and quantity processed per week were statistically significant. This indicates that there is a difference in these characteristics between those who were WTP and those who were UWTP for the services of the cassava peeling machine.

### *4.2. Awareness and Ownership of Cassava Peeling Machine*

About a quarter of the respondents (24.67%) indicated they were aware of the cassava peeling machine (Table 4). This means that majority of the sampled cassava processors (75.33%) were not aware of the existence and availability of the cassava peeling machine technology and therefore had no knowledge of it. Out of the processors who were aware of the cassava peeling machine, majority (68.92%) of them got to know of it through other cassava processors, indicating the importance of processors in disseminating information on improved technologies. Amongst the cassava processors who were aware of the cassava peeling machine technology, only one processor owned and used the machine. The implication is that the machine is yet to be patronized by most processors. That is, the traditional peeling of cassava by hand using a knife is still in use by majority. This resonates with the observation made by Alamu *et al.* (2019) who indicated in their study that the level of awareness or knowledge on improved cassava processing equipment among processors is still low. That is, most farmers and cassava processors are only conversant with traditional, rudimentary and laborious tools such as knives rather than improved processing equipment like the cassava peeling machine.

**Table 3.** Differences in characteristics of consumers who are WTP and those UWTP.

| Variables | WTP | UWTP | Mean difference | t-test |
|---|---|---|---|---|
| Gender | 0.09 | 0.18 | 0.092 | 1.0262 |
| Marital status | 2.02 | 1.82 | -0.199 | -1.2789 |
| Own the processing enterprise | 0.94 | 0.91 | -0.032 | -0.4385 |
| Other occupation | 0.8 | 0.64 | -0.164 | -1.3160 |
| Main source of income | 0.95 | 0.82 | -0.13 | 1.71* |
| Part of processors' association | 0.13 | 0.55 | 0.41 | -1.8165* |
| Access to any credit source | 0.21 | 0.73 | 0.52 | 4.14*** |
| Received credit | 0.15 | 0.36 | 0.21 | 1.9296* |
| Form of credit received | 1.02 | 1.00 | -0.023 | -0.302 |
| Age | 44.48 | 42.55 | 2.952 | -0.7659 |
| Years of education | 8.51 | 6.77 | 2.12 | 1.68* |
| Household size | 4.64 | 4.27 | 0.43 | -0.8538 |
| Hhd members involved in processing | 1.31 | 1.45 | 0.274 | 0.5097 |
| Years of processing | 8.426 | 9.00 | 1.00 | 0.5727 |
| Weekly Processing cycles | 2.01 | 1.91 | 0.25 | 0.4174 |
| Quantity processed per cycle (kg) | 1190.49 | 1306.25 | 362.86 | 1.669* |
| Credit received | 1,088.89 | 1,480 | 337.15 | 1.601 |
| Religion | 1.20 | 1.27 | 0.072 | 0.3687 |
| Main cassava product | 1.04 | 1.00 | -0.038 | 0.3375 |
| Major source of cassava | 2.63 | 2.73 | 0.101 | 0.3507 |
| Source of credit | 2.84 | 5.25 | 2.41 | 2.165** |
| Main marketing channel | 2.97 | 2.73 | -0.255 | -1.2633 |

*Source*: Field Survey, 2020.

**Table 4.** Awareness of Cassava Peeling Machine.

| | Category | Frequency | Percentage (%) |
|---|---|---|---|
| Awareness | Yes | 74 | *24.67* |
| | No | 226 | *75.33* |
| Usage (Based on the level of awareness) | Yes | 1 | *1.35* |
| | No | 73 | *98.64* |
| Ownership | Yes | 1 | *1.35* |
| | No | 73 | *98.64* |
| Medium of awareness | Other cassava processors | 51 | *68.92* |
| | Extension agents | 20 | *27.03* |
| | Training (Workshop) | 3 | *4.05* |

*Source*: Field Survey, 2020.

### *4.3. Perception of Cassava Processors on Cassava Peeling Machine*

Table 5 indicates the perception cassava processors have on the cassava peeling machine and its usage. The perception index of all the statements presented in the table is 2.54, implying that most of the cassava processors had close to a neutral perception on the peeling machine. Given the low level of awareness of the cassava peeling machine among cassava processors (Table 4), it is not surprising that their perception about issues relating to the cassava peeling machine was inconclusive, leading to an indifferent perception. This is in line with Jha *et al.* (2020), that stated that the indecisive and low perception about agriculture technologies is due to low adoption and scaling up of the technologies.

With a mean score of 3.23, cassava processors in the study area held a neutral point of view that the cassava peeling machine is very expensive. This was the only statement that came close to being agreed on by the respondents, with 32.7% of the cassava processors agreeing to the statement. The near agreement to the statement could be because processers compared the cost of the processing machine to cheap ones imported from especially China. This follows Ampah *et al.* (2021) statement that the proliferation of imported processing equipment mainly from China has become a major preference for most processors because of its superior aesthetic quality and being significantly affordable. Also 48% disagreed that the usage of the cassava peeling machine is quite complicated. However, a mean score of 3.03 indicates that the respondents are neutral about

**Table 5.** Perception of Cassava Processors on Cassava Peeling Machine.

| Perception Statement | Strongly disagree | Disagree | Neutral | Agree | Strongly Agree | Mean Score |
|---|---|---|---|---|---|---|
| Cassava peeling machine is very expensive | 46 (*15.3%*) | 51 (*17%*) | 48 (*16%*) | 98 (*32.7%*) | 57 (*19%*) | 3.23 |
| The usage of cassava peeling machine is complicated | 2 (*0.7%*) | 144 (*48%*) | 49 (*16.3%*) | 52 (*17.3%*) | 53 (*17.7%*) | 3.03 |
| Local repairers do not have the capacity and know-how in repairing the cassava peeling machine in case of damage | 49 (*16.3%*) | 199 (*66.3%*) | 50 (*16.7%*) | 1 (*0.3%*) | 1 (*0.3%*) | 3.02 |
| Maintenance of cassava peeling machine is very expensive | 0 | 100 (*33.3%*) | 196 (*65.3%*) | 2 (*0.7%*) | 2 (*0.7%*) | 2.69 |
| Revenue from the usage of cassava peeling machine is not enough compared to the cost of operation | 50 (*16.7%*) | 147 (*49%*) | 100 (*33.3%*) | 1 (*0.3%*) | 2 (*0.7%*) | 2.19 |
| Cassava peeling machine does not help reduce postharvest losses | 5 (*1.7%*) | 247 (*82.3%*) | 46 (*15.3%*) | 1 (*0.3%*) | 1 (*0.3%*) | 2.15 |
| There is no difference in the income of cassava peeling machine users and non-users | 54 (*18%*) | 149 (*49.7%*) | 94 (*31.3%*) | 1 (*0.3%*) | 1 (*0.3%*) | 2.15 |
| Cassava peeling machine do not produce the expected outcome | 97 (*32.3%*) | 148 (*49.3%*) | 49 (*16.3%*) | 4 (*1.3%*) | 1 (*0.3%*) | 1.88 |
| Perception Index | | | | | | 2.54 |

*Source*: Field Survey, 2020.

the complexity of usage of the technology. In addition, mean scores of 3.02 and 2.69 show that the respondents continued to remain indifferent about the incapability of local repairers to maintain faulty cassava peeling machine and high cost involved in its maintenance respectively. Lips and Burose (2012) opined that the costs of repair and maintenance of agriculture machinery tend to increase with the age of the machine and therefore the findings of the current study call for further studies on maintenance of the peeling machine.

The results also showed that the respondents disagreed to the statement that the cassava peeling machine does not help in the reduction of postharvest losses. The implication is that, cassava processors perceive the use of the cassava peeling machine as a means of reducing postharvest losses since a greater quantity of cassava can be peeled in a day and made ready for further processing. Adeleye *et al.* (2021) and Sugri *et al.* (2021), obtained similar results, stating that post-harvest losses resulting from use of processing machines are minimal. Also, cassava processors disagreed to the statement that there is no difference in the income of cassava peeling machine users and non-users. This means that though the processors are yet to patronize the service, they believed the technology would be beneficial. Finally, cassava processors disagreed to the perception that the revenue generated from the use of the cassava peeling machine is not enough compared to the cost involved in operating the machine, also indicating their confidence in the technology. This finding affirms similar results by Adeleye *et al.* (2021), that utilization of improved processing technologies is beneficial and therefore must be introduced to processors to help increase their incomes and livelihoods.

### *4.4. Determinants of processors' willingness to pay for cassava peeling machine services*

Table 6 presents the results of factors influencing cassava processors' willingness to pay as well as the amount they are willing to pay for the services of a cassava peeling machine. The calculated likelihood ratio statistic is 261.52 and is well above the tabulated value (21.67). This implies that the null hypothesis indicating that there is no significant difference between the models should be rejected. Therefore, Cragg's model, instead of the Tobit model, is preferred and better fits the data used in modelling cassava processors' willingness to pay and the amount they are willing to pay. Also, the insignificance of the Mill's ratio from the Heckman model (Appendix 1) indicates the absence of selection bias, confirming the appropriateness of the Cragg Double Hurdle for the current study.

The results of the probit model in Table 6 show that factors such as level of education, quantity produced per cycle of production and processors' main source of income were significant in the decision to patronize the services of the cassava peeling machine. The results show that level of education is significant at 1% and has

a positive coefficient. The results show that the probability that a cassava processor will pay for the services of the cassava peeling machine increases by 42.68% if the processor's educational level increases by one year. The implication is that educated processors are more likely to pay for the services of the cassava peeling machine in the study area. This finding is consistent with similar results reported by Odebode (2008), Abass *et al.* (2016), as well as Ehinmowo and Fatuase (2016) in which educational level was considered to be a major factor influencing the use of improved cassava technologies. Also, the quantity processed per cycle by cassava processors in the study area was significant at 1% and had a positive coefficient. The coefficient of 0.003 implies that the likelihood of a cassava processor to accept to pay for the services of a cassava peeling machine increases by 0.3% if there is a unit (kilogram) increase in the quantity of cassava processed in a cycle. This implies that processors who process relatively larger quantities of cassava are more likely to pay for the services of the cassava peeling machine. This finding is in line with those of Apurba *et al.* (2020), Alemayehu (2014) and Chia *et al.* (2020), that concluded that farmers are willing to pay for improved technologies that will maximize their output. The main source of income of the cassava processor also significantly influences the willingness of cassava processors to pay for the services of the cassava peeling machine, and this was significant at 1% (Table 6). The coefficient of 0.6031 implies that cassava processors who depended more on cassava processing as their source of income will experience a 60.31% increase in the probability that they will be willing to pay for the services of a cassava peeling machine. This is because, they may like to speed up the rate of processing in order to produce more quantities and earn relatively larger income than they use to earn. This finding corroborates with reports from previous studies (Ulimwengu and Sanyal, 2011; Dogan *et al.*, 2020).

### *4.5. Determinants of the amount processors are willing to pay for cassava peeling machine services*

Although most respondents were willing to pay for the services of the cassava peeling machine, the amount they were willing to pay differed among them. The results of the truncated regression in Table 6 presents the factors that influence the amount the processors were willing to pay for the services of the cassava peeling machine in the study area. The results show that factors such as educational level, household size, major source of income, perception about the complicated nature of the cassava peeling machine and membership in cassava processors association significantly influenced the amount the processors were willing to pay for the services of the cassava peeling machine. The study found that the years of formal education received is a significant factor in the decision of the amount they were willing to pay. Years of formal education is significant at 5% and positively influences the amount they were willing to pay.

This means that as the years of education received by a processor increases, the more likely he/she will be willing to pay higher amounts for the services of the cassava peeling machine. Odebode (2008), Abass *et al.* (2016), and Ehinmowo and Fatuase (2016) also found educational level to be a major factor influencing use of improved cassava technology. The results show that household size is significant at 5% and has a negative relationship with the amount they were willing to pay for the services of the cassava peeling machine. This means that cassava processors with larger households will likely be willing to pay a minimum amount for the services of the cassava peeling machine. According to Ulimwengu and Sanyal (2011), larger households are more likely to pay more for technologies that require more labour. However, with the cassava peeling machine requiring less labour, processors with larger households will be willing to pay lower amounts. Having cassava processing as the main source of income had a positive correlation with the amount the processors were willing to pay and the effect was significant at the 1% level. The positive coefficient implies that processors who depended on cassava processing as a major source of their household income will be willing to pay more for the services rendered by the cassava peeling machine. This is due to the fact that respondents with cassava processing as their main source of income view the cassava peeling machine as a necessary equipment in their operation and a means of increasing their output, hence are willing to pay a premium for its services. The perception of cassava processors on the complicated nature of the cassava peeling machine is also significant at 5% and negatively related to the amount they were willing to pay. The implication is that as the perception of the cassava processors increase (approaches agreeing), the less likely they will be willing to pay higher amounts for the services of the machine. Therefore, the amount they will be willing to pay increases as they disagree with the statement that the cassava peeling machine is a complicated equipment to be employed in their business. Membership to any cassava processing association is also significant at 5% and had a corresponding negative coefficient. This means that members of cassava processors' association are willing to pay a minimum amount for the services rendered by the cassava peeling machine. As

**Table 6.** Factors Influencing Willingness to Pay and Amount Willing to Pay for the Services of Cassava Peeling Machine.

| Variables | Probit | | Truncated regression | | Tobit | |
|---|---|---|---|---|---|---|
| | Coeff. | Std. err. | Coeff. | Std. err. | Coeff. | Std. err. |
| Age | -0.007 | 0.019 | -0.01 | 0.022 | 0.021** | 0.0097 |
| Gender | -0.4993 | 0.436 | 0.005 | 0.698 | -0.277 | 0.212 |
| Years of education | 0.4268 | 0.136 | 0.082** | 0.036 | 0.146** | 0.067 |
| Household size | 0.0803*** | 0.094 | -0.477** | 0.225 | 0.012 | 0.046 |
| Other occupation | 0.1539 | 0.318 | -0.046 | 0.086 | -0.227 | 0.157 |
| Main cassava product | -1.329 | 0.408 | 0.781 | 136.356 | 0.299 | 0.217 |
| Own processing enterprise | 0.1347 | 0.518 | 0.536 | 0.700 | -0.222 | 0.256 |
| Years of processing | 0.0449 | 0.056 | 0.027 | 0.020 | -0.047 | 0.029 |
| Member of processing assoc. | 0.0402 | 0.422 | -1.176** | 0.482 | 0.034 | 0.204 |
| Processing cycle per week | 0.0821 | 0.151 | 0.059 | 0.268 | -0.085 | 0.074 |
| Quantity processed per cycle | 0.0003*** | 0.0001 | 0.00009 | 0.0002 | -0.0002*** | 0.00006 |
| Access to credit | 0.2748 | 0.350 | 0.094 | 0.096 | 0.124 | 0.172 |
| Main marketing channel | -0.118 | 0.191 | -0.074 | 0.052 | -0.151 | 0.095 |
| Awareness of cassava peeling machine | -0.0985 | 0.293 | 0.213 | 0.569 | -0.033 | 0.142 |
| Main source of income | 0.6031*** | 0.542 | 1.273* | 0.680 | -0.236 | 0.276 |
| Perc. cassava peeling machine is expensive | 0.4782 | 0.285 | -0.734 | 0.488 | -0.005 | 0.141 |
| Perc. cassava peeling machine is complicated | -0.390 | 0.326 | -1.048** | 0.529 | -0.075 | 0.161 |
| Perc. cassava peeling machine does not produce expected results | | | 0.897 | 0.357 | -0.316 | 0.542 |
| Perc. revenue not enough compared to cost | | | 0.345 | 0.555 | -1.88** | 0.756 |
| _cons | 6.782 | 1.42 | -1.044 | 136.375 | 2.811 | 0.707 |
| Log likelihood | | | -191.73 | | -399.47 | |

***significant at 1%, **significant at 5% and *significant at 10%.
*Source*: Field Survey, 2020.

a processor becomes a member of a cassava processors' association, the lesser the amount the individual will be willing to pay. This may be because members of various agriculture related associations do enjoy subsidies on various technologies, hence creating an impression of paying a relatively lesser amount for the services of the cassava peeling machine.

## 5. CONCLUSION AND POLICY IMPLICATIONS

The introduction of the cassava peeling machine has been a major step in the quest to quickly process the highly perishable cassava tubers into various forms in order to reduce postharvest losses. Despite the efficiency of the cassava peeling machine compared to manual peeling, the inability of cassava processors in the country to own this machine due to financial constraint is a bottleneck to patronizing this technology. This study therefore assessed the willingness of cassava processors to pay for the services of the cassava peeling machine in Ghana. The results showed that cassava processors were indifferent with their perception on the cassava peeling machine. However, they perceived the cassava peeling machine to be one that can produce the expected peeling outcome, reduce postharvest losses, provide enough revenue over its associated cost and also cause a difference in the income of its users.

The study revealed that a greater majority of the cassava processors are willing to patronize the services of the cassava peeling machine. This concludes that regardless of their inability to purchase the cassava peeling machine due to the high cost involved, they are willing to pay in order to enjoy its service. The processors attributed the reasons for their willingness to pay for the services of the machine to the machine's ability to make peeling easier and faster and increase the quantity of cassava they can process in a given time period. On the contrary, respondents who were unwilling to pay for the services of the cassava peeling machine gave some reasons for their decision. Among the reasons are their satisfaction with manual peeling, the inability to afford the services of the cassava peeling machine, and their unawareness of the cassava peeling machine and its operation.

Cassava processors in the Bono East Region of Ghana are willing to pay GH₵ 4.21 (US$ 0.70) for mechani-

cally peeling a 50 kg bag of cassava. With an initial bid of GH₵ 4.00 and a follow-up second bid, the study revealed that most of the respondents are willing to pay for the initial bid but rejected the idea of paying a second bid which was higher than the initial bid. Only a handful of respondents were willing to pay beyond the initial bid for the services of the cassava peeling machine. The study further revealed that factors such as years of formal education, quantity produced per processing cycle and having cassava processing as the main source of income were significant in determining the willingness to pay for the services of the machine by the processors. All the factors had a positive correlation with the decision to pay for the services of the cassava peeling machine. This shows that an increase in any of these factors causes an increase in the likelihood of a cassava processor willing to patronize or pay for the services of the cassava peeling machine. Moreover, the amount processors were willing to pay for the services of the cassava peeling machine is influenced by factors such as years of formal education, household size, having cassava processing as the main source of income, perception about complicated nature of the cassava peeling machine and membership in cassava processors association. These factors are essential and need critical consideration in the quest to promote the use of the cassava peeling machine in cassava processing operations.

Based on the results and findings of the study, it is recommended that cassava processors should be educated or exposed to key information about the cassava peeling machine, more importantly with regards to how the technology operates. Also, since cassava processors have expressed their willingness to pay for the services of the cassava peeling machine, government agencies, non-governmental organizations and private business individuals are encouraged to consider installing cassava peeling machines in various cassava processing areas to help provide services to cassava processors at a fee. For instance, government can do this by collaborating with the private sector in especially the one district one factory (1D1F) policy initiative of the Government of Ghana. To this end, government needs to create awareness of the benefits of the cassava peeling machine vis-à-vis manual peeling using its available communication apparatus. While providing trainings for uneducated cassava processors, this sensitization should also target the educated especially unemployed graduates to help enhance patronage of the technology thereby ensuring the profitability of provision of mechanized peeling service. The government of Ghana can therefore take advantage of provision of mechanized cassava peeling services to help create jobs to absorb her numerous unemployed graduates into the cassava processing business. This can be of great benefit to the graduates as well as benefit investors.

From the foregoing, this paper recommends that further studies should be conducted on the profitability of provision of a cassava peeling machine service on commercial basis. This will serve as a basis for potential investors to consider adopting and investing in the technology as one of their businesses. Also, there is the need for studies aimed at examining different business models and service delivery mechanisms for cassava peeling machine services. To this end, the viability and efficacy of various service models, such as equipment leasing, service contracts, or shared facilities, may be examined in this regard. Considering these models' scalability, viability, and profitability might help in the creation of marketable service offerings.

The conduct of the current study was not without limitations. Firstly, most of the cassava processors had no idea about the existence of the cassava peeling machine and how it operates. With no model of the cassava peeling machine available during the conduct of the study, most of the questions regarding the cassava peeling machine were asked hypothetically. This could influence the appropriateness of responses given by the respondent cassava processors. Also, the quantity to be processed by the cassava peeling machine was represented by the quantity of cassava processed by the respondents who were willing to pay for the services of the cassava peeling machine. There is a possibility that respondents who said they were willing may not use it when it is made available and others who said otherwise may show interest afterwards.

## REFERENCES

Abass A., Amaza P., Bachwenkizi B., Wanda K., Agona A., Cromme B. (2017). The impact of mechanized processing of cassava on farmers' production efficiency in Uganda. *Applied Economics Letters*, 24: 102-106. DOI: https://doi.org/10.1080/13504851.2016.1167817

Acheampong P.P., Addison M., Wongnaa C.A. (2022). Assessment of impact of adoption of improved cassava varieties on yields in Ghana: An endogenous switching approach. *Cogent Economics & Finance*, 10(1), 2008587. DOI: https://doi.org/10.1080/23322039.2021.2008587

Adepoju A.O., Oyewole O.O. (2013). *Households' perception and willingness to pay for bread with cassava flour inclusion in Osogbo Metropolis*, Osun State, Nigeria. Invited paper presented at the Fourth International Conference of the African Associa-

tion of Agricultural Economists, 22-25 September, Hammamet, Tunisia. DOI: https://doi.org/10.22004/ag.econ.160285.

Adeleye A.S., Omoghie E.S., Yusuf A.S., Ojedokun C.A., Ibikunle K.Y. (2021). Assessment of cassava processing techniques on the livelihood of agro-forestry farmers in Edo state, Nigeria. *Journal of Applied Sciences Environmental Management*, 25(2): 189-193. ISSN 1119. DOI: https://doi.org/10.4314/jasem.v25i2.8

Adeyemo A.A. (2013). Strengthening Farmers-Agroprocessor Relationship in Cassava Value Chain: A Case Study of Matna Foods Company and Small-scale Cassava Farmers in Owo LGA of Nigeria, Larenstein University of Applied Sciences,Wageningen, the Netherlands. https://edepot.wur.nl/279048

Adjei E.O., Ayamba B.E., Buri M.M., Biney N., Appiah K. (2023). Soil quality and fertility dynamics under a continuous cassava-maize rotation in the semi-deciduous forest agro-ecological zone of Ghana. *Frontiers in Sustainable Food Systems*, 7, 1095207. DOI: https://doi.org/10.3389/fsufs.2023.1095207

Aidoo R., Osei Mensah J., Appiah I.B., Aboagye E.T., Assamoah-Cobbinah G., Yirenkyi A.K. (2016). *Structure, conduct and performance of the gari market in Mampong and Techiman Municipalities in Ghana*. Roots and Tubers in Ghana: Overview and Selected Research Papers, 24.

Alamu E.O., Ntawuruhunga P., Chibwe T., Mukuka I., Chiona M. (2019). Evaluation of cassava processing and utilization at household level in Zambia. *Food Security*, 11: 141-150. DOI: https://doi.org/10.1007/s12571-018-0875-3.

Amaza P.S., Abass A.B., Bachwenkiz B., Towo E.E. (2016). Adoption of mechanized postharvest cassava processing technologies and the determinants of High-Quality Cassava Flour (HQCF) processing in Tanzania. *Tropicultura*, 34(4): 411-423. DOI: https://hdl.handle.net/20.500.12478/1497

Amoah F., Bobobee E.Y.H., Addo A., Darko J.O., Akowuah J.O. (2022). A review of mechanical cassava peeling and its adoption by processors. *Journal of the Ghana Institution of Engineering*, 22: 23-38. DOI: https://doi.org/10.56049/jghie.v22i1.37

Ampah J., Ribeiro J.X.F., Bugyei K.A., Kumi F., Akowuah J.O., Ofori H., Otchere C. (2021). Status, challenges and prospects of food processing equipment fabricators in Ghana. *Scientific African*, 12, e00843, ISSN 2468-2276. DOI: https://doi.org/10.1016/j.sciaf.2021.e00843.

Ani S.O., Agbubga I.K., Baiyegunhi L.J.S. (2013). Processing and Marketing of Selected Cassava Products in South-east Nigeria. *Journal of Economics*, 4(2): 105-111. DOI: https://doi.org/10.1080/09765239.2013.11884970

Anning-Dorson T. (2023). Cassava-gari value chain participation and rural women's wellbeing: an exploratory study. *African Journal of Food, Agriculture, Nutrition and Development*, 23(1): 22117-22131. https://www.ajol.info/index.php/ajfand/article/view/244987

Asogwa B.C., Ezihe J.A.C, Ater P.I (2013). Socio-economic analysis of cassava marketing in Benue State, Nigeria. *International Journal of Innovation and Applied Studies*, 2(4): 384-391. http://www.issr-journals.org/ijias/

Bayitse R., Tornyie F., Bjerre A.B. (2017). Cassava cultivation, processing and potential uses in Ghana. Handbook on Cassava. *Nova Science Publishers*, Inc, 313-333. ISBN: 978-1-53610-291-8

Baidoo I., Amoatey H. (2012). Willingness to Pay for Improvement in the Agricultural Activities of Some Six Selected Villages in West Akim District of Ghana. *International Journal of Development and Sustainability*, 1(2): 326-337. https://isdsnet.com/ijds-v1n2-20.pdf

Bono East Regional Coordinating Council (BERCC) (2020). Profile of Bono East Region.

Bhatta G.D., Doppler W., Bahadur K.K.C. (2009). Potentials of organic agriculture in Nepal. *Journal of Agriculture and Environment*, 10: 1-14. DOI: https://doi.org/10.3126/aej.v10i0.2124

Buraimo B., Humphreys B., Simmons R. (2010). *Participation and engagement in sport: A double hurdle approach for the United Kingdom*. The Selected Works of Dr Babatunde Buraimo. United Kingdom: University of Central Lancashire.

Davies R.M., Olatunji M.O., Burubai W. (2008). A survey of cassava processing machinery in Oyo State. *World Journal of Agricultural Sciences*, 4(3): 337-340. http://www.idosi.org/wjas/wjas4(3)/9.pdf

Dogan H.P., Aydogdu M.H., Sevinç M.R., Cançelik M. (2020). Farmers' Willingness to Pay for Services to Ensure Sustainable Agricultural Income in the GAP-Harran Plain¸Sanlıurfa, Turkey, Harran University, Sanlıurfa, Turkey. *Agriculture*, 10(5), 152. DOI: https://doi.org/10.3390/agriculture10050152.

Diop A., Calverley D.J.B. (1998). Storage and Processing of Roots and Tubers in the Tropics. Food and Agriculture Organization of the United Nations, Agro-industries and Post-Harvest Management Service, Agricultural Support Systems Division.

Dimitri C., Greene C. (2003). Recent growth patterns in the US organic foods market. *ERS Agriculture Information Bulletin*, 33715. DOI: https://doi.org/10.22004/ag.econ.33715

Ehinmowo O.O., Fatuase A.I. (2016). Adoption of Improved Cassava Processing Technologies by Women Entrepreneur in South – West, Nigeria. *World Journal of Agricultural Research*, 4(4): 109-113. DOI: https://doi.org/10.12691/wjar-4-4-2

Fonta W.M., Ichoku H.E., Nwosu E.N. (2011). Contingent Valuation in Community Based Project Planning: The Case of Lake Bamendjim Fishery Restocking in Cameroon. African Economic Research Consortium, Nairobi, Kenya.AERC Research Paper 210.

FAOSTAT (2023). FAO Statistics, Food and Agriculture Organization of the United Nations.

Food and Agriculture Organization (FAO) (2015). *Food Outlook, Biannual report on global food markets*.

Greene W.H. (2012). *Econometric Analysis*. 7th eds. Upper Saddle River, NJ: Prentice Hall.

Gumanit K., Pugahan J. (2015). *Design, fabrication and performance evaluation of an automated combined cassava peeler, grater and presser for small scale processing*. Published Doctoral dissertation submitted to the Caraga State University, Philippines.

Gunatilake H., Yang J.-C., Pattanayak S., Choe K.A. (2007). *Good practices for estimating reliable willingness-to-pay values in the water supply and sanitation sector: Asian Development Bank, Manila, Philippines*.

Gächter S., Nosenzo D., Sefton M. (2013). Peer Effects in Pro-Social Behavior: Social Norms or Social Preferences?. *Journal of the European Economic Association*, 11(3): 548-573. DOI: https://doi.org/10.1111/jeea.12015.

Hafif B., Pujiharti Y., Yani A., Sjafrina N., Asnawi R., Wibowo N.A., Frediansyah A., Nurida N.L., Dariah A. (2023). *Industrial Raw Material on Acid Soil in Indonesia. Cassava* - Recent Updates on Food, Feed and Industry. intechopen.com. DOI: https://doi.org/10.5772/intechopen.109709

Heckman J.J. (1979). Sample selection bias as a specification error. *Econometrica: Journal of the econometric society*, 153-161. DOI: https://doi.org/10.3386/w0172

Jain M., Soni G., Verma D., Baraiya R., Ramtiyal B. (2023). Selection of Technology Acceptance Model for Adoption of Industry 4.0 Technologies in Agri-Fresh Supply Chain. *Sustainability*, 15(6), 4821. DOI: https://doi.org/10.3390/su15064821.

Kadurumba C.H., Aririguzo J.C. (2021). An Innovative Design and Development of A Cassava Peeling Machine. *Nigeria Agricultural Journal*, 52(2): 269-276.

Kolawole P.O., Agbetoye L., Ogunlowo S.A. (2010). Sustaining world food security with improved cassava processing technology: The Nigeria experience. *Sustainability*, 2(12): 3681-3694. DOI: https://doi.org/10.3390/su2123681

Lips M., Burose F. (2012). Repair and Maintenance Costs for Agricultural Machines. *International Journal of Agricultural Management*, 1(3): 1-7. DOI: https://doi.org/10.22004/ag.econ.149750

Manu I., Mensah-Bonsu A., Anim-Somuah H., Osei-Asare Y.B. (2016). Trust, governance, upgrading and market power in the cassava value chain of southern Ghana. Roots and Tubers in Ghana: Overview and Selected Research Papers, 45.

Mal P., Anik A.R., Bauer S., Schmitz P.M. (2012). Bt Cotton Adoption: A Double-hurdle Approach for North Indian Farmers. *AgBioForum* 15(3): 294-302. http://hdl.handle.net/10355/35116

Mäler K.G., Vincent J.R. (eds.) (2003). *Handbook of environmental economics: valuing environmental changes* (Vol. 2). Elsevier.

Martín-Fernández J., del Cura-González M.I., Gómez-Gascón T., Oliva-Moreno J., Domínguez-Bidagor J., Beamud-Lagos M., Pérez-Rivas F.J. (2010). Differences between willingness to pay and willingness to accept for visits by a family physician: a contingent valuation study. *BMC Public Health*, 10(1): 1-11. DOI: https://doi.org/10.1186/1471-2458-10-236

Mbinda W., Mukami A. (2022). Breeding for postharvest physiological deterioration in cassava: problems and strategies. *CABI Agriculture and Bioscience*, 3(1): 1-18. DOI: https://doi.org/10.1186/s43170-022-00097-4

Menakashi J.V., Tomlins K.I., Owori C. (2011). Are Consumers in Developing Countries Willing to Pay More for Micronutrient-Dense Biofortified Foods? Evidence from a Field Experiment in Uganda. *American Journal of Agricultural Economics*, 93(1): 83-97. DOI: https://doi.org/10.1093/ajae/aaq121

Mensah P. (2017). *Performance Evaluation of a Cassava Peeler*. Published Thesis Submitted to Kwame Nkrumah University of Science and Technology, Kumasi, Ghana.

Ministry of Food and Agriculture (MoFA) (2021). *Facts and Figure, Agriculture in Ghana, Accra, Ghana*.

Nwaigwe K.N., Nzediegwu C., Ugwuoke P.E. (2012). Design, construction and performance evaluation of a modified cassava milling machine. *Research Journal of Applied Sciences*, *Engineering and Technology*, 4(18): 3354-3362.

Odebode S. (2008). Appropriate Technology for Cassava Processing in Nigeria: User's Point of View. *Journal of International Women's Studies,* 9(3).

Odongo W., Etanny S. (2018). Value chain and marketing margins of cassava: An assessment of cassava marketing in northern Uganda. *African Journals Online*, 18(1). DOI: http://hdl.handle.net/10355/35116 10.18697/ajfand.81.15955

Okeowo T.A. (2015). Profitability of Cassava Processing in Epe Local Government Area of Lagos State. *International Journal of Applied Research and Technology*, 4(9): 39-47.

Okoffo E.D., Denkyirah E.D., Adu D.T., Fosu-Mensah B.Y. (2016). A Double-Hurdle Model Estimation of Cocoa Farmers' Willingness to Pay for Crop Insurance in Ghana. *Springer Plus*, 5. DOI: 10.1186/s40064-016-2561-2.

Osei S. (2020). A Review on the performance of some cassava peeling machines developed. *North American Academic Research Journal*, 3(02): 97-162. DOI: https://doi.org/10.5281/zenodo.3669373

Otunba-Payne G. (2020). *An analysis of the role of women in the cassava value chain in Nigeria*. Masters thesis, Cornell University.

Puhani P. (2000). The Heckman correction for sample selection and its critique. *Journal of economic surveys*, 14(1): 53-68. DOI: https://doi.org/10.1111/1467-6419.00104

Sackey I.S., Bani R.J. (2007). Survey of Waste Management Practices in Cassava Processing to Gari in selected Districts of Ghana, University of Ghana, Legon. *Journal of Food, Agriculture and Environment*, 5(2): 325-328. DOI: https://doi.org/10.1234/4.2007.1024

Richards P. (2023). *Indigenous agricultural revolution: ecology and food production in West Africa* (Vol. 21). Taylor & Francis. DOI: https://doi.org/10.4324/9781003383734

Rozi F., Santoso A.B., Mahendri I.G.A.P., Hutapea R.T.P., Wamaer D., Siagian V., Elisabeth D.A.A., Sugiono S., Handoko H., Subagio H., Syam A. (2023). Indonesian market demand patterns for food commodity sources of carbohydrates in facing the global food crisis. *Heliyon,* 9(6), e16809. DOI: https://doi.org/10.1016/j.heliyon.2023.e16809

Sugri I., Abubakari M., Owusu R.K., Bidzakin J.K. (2021). Postharvest losses and mitigating technologies: evidence from Upper East Region of Ghana. *Sustainable Futures*, 3, 100048. ISSN 2666-1888. DOI: https://doi.org/10.1016/j.sftr.2021.100048.

Taneja G., Pal B.D., Joshi P.K., Aggarwal P.K., Tyagi N.K. (2014). *Farmers preferences for climate-smart agriculture an assessment in the Indo-Gangetic Plain* (No. IFPRI Discussion Paper 01337). DOI: https://doi.org/10.1007/978-981-10-8171-2_5

Udensi U.E., Tarawali G., Ndubueze-Ogaraku M.E., Okoye B.C. (2017). Differentials in Adoption of Cassava Post-Harvest Processing Technology among Farmers in South Eastern, Nigeria. *Journal of Economics and Sustainable Development*, 8(6): 48-54.

Ulimwengu J., Sanyal P. (2011). Joint estimation of farmers' stated willingness to pay for agricultural services. *International Food Policy Research Institute Discussion Paper*, 1070. https://ideas.repec.org/p/fpr/ifprid/1070.html

United Nations International Development Organization (UNIDO, 2019). *A Value-Chain Analysis of the Cassava Sector in Ghana, Accra, Ghana*. DOI: https://doi.org/10.1108/JADEE-05-2019-0066

Waithaka M.M., Thornton P.K., Shepherd K.D., Ndiwa N.N. (2007). Factors affecting the use of fertilizers and manure by smallholders: the case of Vihiga, western Kenya. *Nutrient Cycling in Agroecosystems*, 78(3): 211-224. DOI https://doi.org/10.1007/s10705-006-9087-x

Wodjao T.B. (2008). *A double-hurdle model of computer and internet use in American households*. Department of Economics, Western Michigan University, Michigan.

Zainuddin I.M., Lecart B., Sudarmonowati E., Vanderschuren H. (2023). A method for rapid and homogenous initiation of post-harvest physiological deterioration in cassava storage roots identifies Indonesian cultivars with improved shelf-life performance. *Plant Methods*, 19(1): 1-13. DOI: https://doi.org/10.1186/s13007-022-00977-w

## APPENDIX 1

**Table A.1.** Heckman Model of the Willingness to Pay for the Services of the Cassava Peeling Machine.

| | Coef. | Std. Err. | z | P> \|z\| |
|---|---|---|---|---|
| *Stage 1 – Probit model* | | | | |
| Age | .0184254 | .0084702 | 2.18 | 0.030** |
| Gender | -.2501002 | .1933508 | -1.29 | 0.196 |
| Years of education | .1239456 | .0605088 | 2.05 | 0.041** |
| Household size | .0131408 | .0456568 | 0.29 | 0.773 |
| Other occupation | -.1673135 | .1407322 | -1.19 | 0.234 |
| Main cassava product | .2536415 | .1932808 | 1.31 | 0.189 |
| Own processing enterprise | -.0226198 | .2512374 | -0.09 | 0.928 |
| Years of processing | -.0374449 | .0248322 | -1.51 | 0.132 |
| Part of processors association | -.0126055 | .2732142 | -0.05 | 0.963 |
| Processing cycle per week | -.0762469 | .0682352 | -1.12 | 0.264 |
| Quantity processed per cycle | -.000192 | .0000547 | -3.51 | 0.000*** |
| Access to credit | .0725256 | .1532634 | 0.47 | 0.636 |
| Main marketing channel | -.144712 | .083567 | -1.73 | 0.083* |
| Aware of Cassava Peeling Machine | -.0054748 | .1291074 | -0.04 | 0.966 |
| Main source of income | -.0841386 | .3533063 | -0.24 | 0.812 |
| _cons | 2.486503 | .8195061 | 3.03 | 0.002 |
| *Stage 2 – OLS* | | | | |
| Age | -.0015817 | .0203527 | -0.08 | 0.938 |
| Gender | .037526 | .6126515 | 0.06 | 0.951 |
| Household size | .3949053 | .193601 | 2.04 | 0.041** |
| Main cassava product | 1.271333 | 1.689649 | 0.75 | 0.452 |
| Own processing enterprise | .6237963 | .5949846 | 1.05 | 0.294 |
| Processing cycle per week | .1475169 | .2358521 | 0.63 | 0.532 |
| Quantity processed per cycle | .0000558 | .0001873 | 0.30 | 0.766 |
| Main source of income | 1.442092 | .5711969 | 2.52 | 0.012** |
| Aware of Cassava Peeling | -.0583095 | .4326904 | -0.13 | 0.893 |
| Part of processors association | -1.070105 | .3786763 | -2.83 | 0.005*** |
| _cons | -2.761597 | . | . | . |
| *Mills* | | | | |
| Lambda | .5381038 | 1.243518 | 0.43 | 0.665 |
| Rho | 0.59566 | | | |
| Sigma | .90336745 | | | |
| Number of observations = 300 Wald chi$^2$ (15) = 28.1 Prob > chi $^2$ = 0.0207 | | | | |

***significant at 1%, **significant at 5% and *significant at 10%.