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# Habitual Choice Strategy, Poverty and Urban Consumer Demand for Biofortified Iron Beans

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# Habitual Choice Strategy, Poverty and Urban Consumer Demand for Biofortified Iron Beans

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## Abstract

Increasing urbanization in developing countries creates current and future challenges for the global food system to deliver high quality nutritious foods and provide equitable access for the urban poor. In this paper, we examine the role of habit, poverty and information in urban consumer demand for nutritious foods in the context of biofortified iron beans as a public health intervention in Africa. We used an experimental auction-like technique (Becker-DeGroot-Marschak mechanism) to elicit consumer willingness to pay (WTP) for the nutritional value of iron beans. The provision of information on the nutritional value of iron translates into significant premiums (13 – 15%) for the iron bean varieties while habit has no significant impact. Eliminating participatory fees, as was done in this study, provides an alternative practical approach for identifying 'hypothetical bias' in value elicitations. Results suggest that WTP can be inflated by about 7% when participants have ex ante intentions not to pay out of pocket after getting an opportunity to buy a product in the auction-like experiment. We found that poverty plays a significant role in consumer demand. There is a difference of about 11% in the price that consumers from poor households are willing to pay for an iron bean variety relative to the price that consumers from average households are willing to pay. These results have implications for designing effective and inclusive value chain approach to ensure that urban poor also benefit adequately from biofortification through an equitable pricing system.


Key words: Habitual behavior, urban consumer acceptance, willingness to pay, panel double hurdle, 'hypothetical bias' in experimental auctions, biofortification

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# 1. INTRODUCTION

In more recent years, nutrition policies have been increasingly promoting agricultural-based interventions such as biofortification as a complimentary strategy to food fortification and supplementation in addressing micronutrient deficiencies among undernourished populations in developing countries. Biofortification - the process of breeding staple crops with higher micronutrient content - has been shown to be a cost-effective strategy (Meenakshi et al., 2010, Saltzman et al., 2013). This strategy is based on the premise that poor rural farming households would produce and consume biofortified crops for better nutrition. However, the premise may be constrained by the increasing number of poor households moving out of agriculture in Africa south of the Sahara (Collier and Dercon 2009). In the developing world, Africa has experienced the highest urban growth during the last two decades at 3.5% per year and this rate of growth is expected to hold into 2050 (AFDB, 2012; UN DESA 2014). A significant proportion of poor rural farming households are migrating to densely populated urban areas in search of better income and social services (Bosker et al. 2010). The migrant population may end up trapped in poverty due to high cost of living, and lack of skills and education required to effectively enter the highly competitive urban labor market (Henderson, 2010). Even when rural poor migrating to cities are able to access better social services than in the rural areas, they may still lack access to nutritious foods due to market forces unlike those in the rural area where they produce what they consume.

The urbanization process will drive changes in the consumer demand structure including consumer food preferences, acceptability and affordability. Consumers would seek cheap and more convenient foods with attendant effects on nutritional quality. This therefore creates current and future challenges for the food system to deliver high quality nutritious foods to feed growing urban population and provide equitable access to the urban poor.

Since the urban poor (who are usually more undernourished) may have a limited opportunity to grow biofortified crops for home consumption due to land access constraints, the main channel to reach this population with nutritious biofortified foods is through the market. However, without an equitable pricing process, they may have an inadequate access to biofortified foods due to low purchasing power and income limitations. Thus, it is crucial to understand the price threshold at which urban poor households are willing to pay for biofortified foods compared with the relatively wealthy ones in order to understand the point of equilibrium for equitable pricing. This is the context of this study, which has the primary objective of examining how the willingness to pay (WTP) of the urban poor households for conventionally bred biofortified iron beans compare with that of the relatively wealthy ones in Rwanda, while also investigating the determinants of WTP. The study was conducted in Rwanda because micronutrient malnutrition is a serious public health problem in the country. Thirty eight percent of children under 5 years of age and 17 percent of women of childbearing age suffer from anemia (Demographic Health Survey [DHS] 2010), about 50 percent of which is caused by iron deficiency (de Benoist et al 2008). Rwandans are the highest consumers of beans in the world with a per capita bean consumption estimated at 164 grams (g)/day (CIAT 2004). Thus, the introduction of conventionally bred iron biofortified beans could be an effective and targeted public health intervention to alleviate iron deficiency in the country.

Micronutrients such as iron and zinc are invisible traits in biofortified crops unlike vitamin A biofortified crops, in which the high beta-carotene content changes the crop color from white to either yellow or orange. As such, information on the nutritional value of iron is paramount in promoting biofortified iron beans among consumers. On average, Rwandan households eat beans five days a week (NAS 2008). This suggests the potential role that habit may play in consumer evaluation of iron beans. The literature on the role of information in consumer acceptance of nutritious foods in Africa is vast, but the influence of habits in the process of acceptance for this food category has not been given attention. Since foods such as orange sweet potato, parboiled rice, improved maize and cassava which have been widely tested in the consumer acceptance literature for Africa (Naico and Lusk, 2010; De Groote et al., 2011; Demont et al., 2012; Meenaksi et al., 2012; Banerji et al., 2013; Demont and Ndour, 2014) are common staples that are consumed several times daily, consumer WTP for such foods is likely to be driven by habits.

Therefore, the second objective of this paper is to add to this literature by examining the role of habit and nutrition information in consumer WTP for biofortified iron beans. The consumer behavior literature has mostly investigated the influence of habit on demand in developed countries. Authors such as Hamermesh (2005), Wansink and Sobel (2007) and Duhigg (2012) have shown that consumers can base their choice strategies on past experiences leading to future repetitions. Such habit formation can be located within the phenomenon of state dependence (Heckman 1981) where utility derived from past choices influences current utility.

To address these objectives, we conducted a value elicitation experiment in a central location within a popular urban beans retail market in the capital city of Rwanda (Kigali) where consumer WTP for two iron bean varieties relative to a popular local variety was elicited using the Becker-DeGroot-Marschak (BDM) incentive-compatible auction-like mechanism (Becker, DeGroot, Marschak, 1964). The two iron bean varieties used are RWR 2245, or red mottled iron beans (RMIB), and RWV 3006, or white iron beans (WIB), while the local variety used is traditionally called Mutiki (red mottled in color). Prior to implementing the BDM protocol, we use a hedonic rating method adapted from food science literature (Tomlins et al., 2007) to examine consumer evaluation of the sensory attributes of these bean varieties. In understanding the effect of information on WTP, our sample comprises two experimental groups: (1) a control group without any information about iron beans and importance of iron in diets and (2) a treatment group with information on the iron beans and the importance of iron in diets.

The choice of an iron bean variety (RMIB) with a similar appearance as the local variety is to test the effect of habitual choice strategy on consumer evaluation of iron beans. It is commonly found that consumers use habitual choice strategy to evaluate and buy goods such as low-priced products, personal care products and frequently consumed products (Verplanken et al., 2005). This suggests that consumers may evaluate biofortified iron beans based on bean varieties they usually purchase in the market. Adamowicz and Swait (2012) opined that when presented with a choice task, consumers could resort to two strategies with varied levels of cognitive effort. First, "cognitive miser" consumers can simply repeat the last choice without evaluating their current choice options. Second, in the presence of needs, new information or changes in product environment, consumers may apply a full evaluation strategy considering the choice option that maximizes their utility functions. Following this, we assume that Rwandan urban consumers would apply habitual choice strategy in evaluating iron bean varieties while the provision of nutrition information as an exogenous shock may change this path.

The final objective and another contribution of this paper is to test an alternative practical approach of identifying 'hypothetical bias' in experimental auctions conducted in a field setting. Corrigan and Rousu (2008) noted that because experimental auctions conducted in the field lose some controls of laboratory experiments as a tradeoff for market realities, it is important that value elicitations conducted in field settings be demand revealing both in theory and practice. One of the recent methods for mitigating hypothetical bias in field experiments is the implementation of a 'cheap talk' script (proposed by Cummings and Taylor, 1999), in which participants are reminded not to be hypothetical when participating in the elicitation task (e.g. List, 2001; Ehmke, Lusk and List, 2008; Chowdhury et al., 2011). However, the tone of such 'cheap talk' scripts can be problematic on its own because it can be perceived by the participants as patronizing.

In experimental auctions, participatory fees are usually provided to participants. Morawetz et al. (2011) argued that participatory fees are important for field experiments in poor countries to avoid the ethical issues of pressuring poor participants to pay real money. This may not necessarily be the case when the unit price of product on offer for auctioning constitutes an insignificant portion of household food budget especially for products such as common staples. Payment of participatory fees introduces bias due to “windfall” income effect (Loureiro, Umberger, and Hine, 2003; Corrigan and Rousu, 2006). The literature suggests that the effect has been mixed. While Banerji et al. (2013) showed that participatory fees has no effect on consumers’ WTP for orange maize in Ghana, Morawetz et al. (2011) found a positive effect for yellow maize in Kenya. It is important to mimic market realities as closely as possible. Even when participatory fees are given, in reality many of the participants may end up unable to afford the product in the market due to poverty. Thus, we propose an alternative method of identifying ‘hypothetical bias’ in experimental auctions in the field by eliminating participatory fees and informing participants ex ante that if they agree to participate they may get an opportunity to buy a product and are required to pay out of pocket to acquire it. The advantage of this approach is that even when participants are aware of the out-of-pocket payment requirement, they may subscribe to participate with an ex ante intention not to pay. Such nonpayment intentions would constitute ‘hypothetical bias’ in WTP rather than participatory fees that could mask such bias.

The reminder of this paper is organized as follows. Next, we describe the BDM mechanism used in eliciting WTP followed by a discussion of the experimental design, sample size determination and the data. The econometric strategy applied are subsequently discussed while results are presented and conclusions drawn on the policy implications.

## 2. BECKER DEGROOTE MARSACK (BDM) AUCTION-LIKE MECHANISM

In the consumer acceptance literature operationalizing experimental auction techniques in the field in Africa, BDM mechanism has been mostly favored due to its applicability in independently conducting auction experiments with individuals at home or in a central location (Banerji et al., 2013; Oparinde et al., 2014). In a BDM mechanism, an individual submits a bid (y) for a product being auctioned. Each participant has a chance to buy a quantity of the auctioned product if the bid submitted is greater than or equal to a randomly drawn price (p) from an established price distribution. On the other hand, individuals do not get a chance to buy in the BDM experiment when $y < p$. As an outcome, an individual, A with $y \geq p$, pays the market price i.e. p to acquire the product auctioned while individual, B with $y < p$ does not pay a price and do not get to acquire the product. With this decision rule, BDM is incentive compatible since an individual’s true WTP for a unit of the product is defined as the price that induces indifference between 'winning'[4] [Ui (yi – p)] and 'not winning' [(U(0) = 0)] the unit, where U is an income dependent utility function and p is random. Assume individual i's price expectation is defined by the cumulative distribution function Gi (p) and the probability density function gi(p) associated, rational behavior under this mechanism is to place a bid equal to WTP (Lusk and Shogren 2007). Thus the optimal bid is when $y^* - y_A | y^* - y_B = 0$.

# 3. EXPERIMENTAL DESIGN AND DATA

## *Experimental Procedure*

The experiment presented in this study was originally designed to test the effect of (a) information and (b) information frame, on WTP. As a result, the data were collected with three treatment arms (control versus gain frame information versus loss frame information). However, upon checking the data the effect of information frame is not significant. Therefore, we merged the two information treatment arms into one (i.e. control versus information treatment), and only these two groups are discussed throughout this paper.

### Sample Size

The study was conducted at a popular beans retail market (Kimironko) in Rwanda's Kigali city during 2013 A season. The total sample size was originally determined for three treatment arms with binary comparisons in mind. The total sample size was determined by the average treatment effect. The average of treatment effects across recent consumer studies on biofortified crops suggests that effects of 6 percent to 25 percent or more could be observed, corresponding to 18 to 75 Rwandan franc (RWF)[5] (as a percentage of the average market price of beans at the time of the survey design), respectively, with a standard deviation (SD) of 11 percent corresponding to 33 RWF (e.g. Chowdhury et al. 2011; Meenakshi et al., 2012). Based on these previous results, we assumed (1) a lower or safe effect size of 5 percent (or 15 RWF), and (2) that the effect size is normally distributed with 60 RWF (roughly double) as a maximum expected standard deviation.

Power calculation was conducted using a significance level of 5 percent and a power of 0.8, and treatments were randomized at the individual level. The result of the power calculation shows that if the true difference in the mean response of matched pairs is 15 RWF, a minimum of 128 individuals per treatment was required to be able to reject the null hypothesis that the response difference is zero. Since the original study design has three treatment arms, the sampling is supposed to consist of

[4] This is quoted because no one is worse off in the end and it does not mean that an individual lost.
[5] USD 1≈650 RWF at the time of the survey

384 participants. However, a total of 398 participants (control: 132; treatment arm I: 135 and treatment arm II: 131) were randomly recruited from all segments of the urban bean retail market in Kigali.

A recruiter was trained to invite consumers to participate in the experiment. The recruiter recorded the number of consumers approached and the number that agreed to participate. A total of 427 participants were invited but only 398 consented to participate. This represents a participation rate of 93%, which is high despite the fact that participants were informed during the recruitment exercise about the out-of-pocket payment requirement. The monthly food expenditure of participants' household is 75200 RWF. The fact that the average market price of the local variety (562 RWF) represents only 0.8% of this monthly food expenditure may be responsible for the high participation rate observed. This corroborates our assumption that when the unit price of the product auctioned is not a significant share of the household monthly food budget, ethical concerns about asking the poor to pay in experimental auctions may not be relevant.

## Central Location Tasting (CLT)

A central location within the urban bean retail market was identified and used for the study. Consumers from all segments of the market were randomly invited to the CLT venue. Uninvited consumers were not interviewed to avoid a self-selection bias. Across the recruited participants, female and male consumers over the age of 18 years were invited to the CLT venue. During the recruitment process, participants were informed about the study but without giving any information about the improved varieties or their nutritional values. Also, it was clearly mentioned that the participant will be asked to evaluate beans and participate in a purchasing experiment in which they can get a chance to buy 1kg of bean grains, and that if they get the chance, the participants must pay out of pocket to purchase the bean grains. Once the study was introduced and the recruited consumers agreed and consented to participate, they were escorted to the CLT venue and were randomly allocated into treatment and control groups. Standard identification information was first collected, and this was followed by the collection of information on demographic and socio-economic characteristics.

## BDM Elicitation Procedure

Upon the collection of socio-economic information, the following procedure was followed in eliciting participant WTP for the three bean varieties:

**Step 1 (Provision of nutrition information):** Treatment group participants were first asked to listen to a simulated 1-minute radio message (on MP 3 player) on the nutritional benefit of iron beans and the importance of having enough iron in diets.

**Step 2 (Sensory Evaluation):** Participants were presented with both cooked and raw grains of each of the three varieties tested one by one, and the order of presentation was randomized across participants. They evaluated raw bean color, raw bean size, cooked bean size and taste of the cooked beans without salt or staples. We captured the participant's overall sensory evaluation of these attributes by asking how much participants liked each bean variety in overall terms on a 7-point Likert scale (7. Like very much, 6. Like moderately, 5. Like slightly, 4. Neither like nor dislike, 3. Dislike slightly, 2. Dislike moderately, 1. Dislike very much).

**Step 3 (BDM instruction):** Following the sensory evaluation, participants were instructed in detail on how to participate in the auction. Enumerators first took each participant through a practice round with biscuits in order to get them familiarized with the instructions and steps 3 to 7 in the BDM experiment. It was explicitly explained to the participants that it was optimal for them to state a bid equal to their true WTP because stating a bid higher than their true WTP could result in them having to buy at a higher price than they were originally willing to pay, and that also stating a bid lower than their true WTP could result in them losing out on a profitable opportunity to purchase.

**Step 4 (stating bids):** Participants were asked to submit separate WTP values (bids) for 1kg of each of the three bean varieties they had evaluated. An opaque bag containing three chips labeled correspondingly to each of the three bean varieties was presented to the participants. They were asked to draw the "binding" variety, by randomly picking a chip from the opaque bag. It was explained that the chip randomly picked will be the bean variety that they have an opportunity to purchase in the auction.

**Step 5 (random price selection):** Upon selection of the binding variety, another opaque bag containing price strips with a uniform distribution around the prevailing market price of the local variety was presented to the participants. The price strips ranged from 200 to 1250 RWF. Each participant was informed about the price distribution and was asked to draw a sale price by randomly selecting a price strip from the opaque bag.

**Step 6 (outcome):** At the onset of providing the BDM instructions to participants, the decision rule was explicitly explained to them. If the participant's stated WTP for the binding variety exceeded or equal to the sale price that she or he had drawn, the participant would get a chance to buy 1kg of bean grain of this variety, and pay a price equal to the sale price; if the sale price was higher than the stated WTP, the variety was not sold.

**Step 7 (out-of-pocket payment):** As the participants were already informed during recruitment and reminded while the BDM instruction was being given, they were asked to pay the sales price for the binding variety out of pocket if their WTP bid was higher than or equal to the sales price. Enumerators collected the actual price and recorded the payment outcome (won and paid, won but didn't want to pay, won but could not pay and lost but would not have paid if had won). Reasons for nonpayment decisions were also recorded.

## Data

### Key Socio-economic Characteristics & Wealth Ranking

The participant key socio-economic characteristics selected based on results of a preliminary focus group discussion held in the study location are presented in Table 1. A majority of the participants are females (54%) with an average age of 30 years. About 67% of them are the main decision makers responsible for deciding on beans purchases for home consumption. Almost half of the study participants (44%) had about 5kg of beans at home on average as at the time of the survey. A comparison of the key socio-economic characteristics across treatment groups in Table 2 shows that the data are comparable across treatments since there is no significant difference for a majority of the characteristics. However, there are some significant differences across treatments for three variables. First, there are more males in the treatment group than in the control group ($p$-value<0.05). Second, a higher percentage of participants in the treatment group were aware of iron beans before the survey than for the control group ($p$-value<0.01). Third, control group participants had one more year of education than the treatment group participants on average ($p$-value<0.05).

To investigate the correlation between poverty level and WTP, we computed total asset value for each participant's household. Participants were asked to describe and list the total number of various assets owned by their households. The number of each asset was weighted by the Rwandan 2013 average market price for the asset, and the asset values were summed for each participant's household. The total asset value variable was ranked into terciles where the first tercile is named the "poor" with the mean total asset value of 0.5±0.4 million RWF followed by the second tercile named the "average" with mean total asset value of 51.1±37.3 million RWF. The relatively wealthiest group or the third tercile is named the ‘rich’ with a mean total asset value of 141.2±99.1 million RWF. The mean total asset value is statistically significantly different across the wealth terciles at 1% level. As shown in Table 1, the wealthiest group had significantly more years of education, larger household size and more association memberships than the poor and the average households. Perhaps owing to the higher level of education, a significantly higher percentage of participants from the rich households were aware of iron beans than those from the poor and average households. Again, the data show that wealthier households consumed beans more frequently in the last 24 hours before the survey than the poor households on average. This may be a reflection of the differential in affordability among the poor and the rich, which has implications for equitable access to iron beans for the poor families.

**Table 1: Social and economic characteristics, by treatment group and wealth tercile**

| Variable | Variable Definition | Control | Treatment | Mean Difference[A] | Poor | Average | Rich | F-statistic[B] |
|---|---|---|---|---|---|---|---|---|
| Male | 1 if participant's gender is male, otherwise 0 | 0.38 | 0.49 | 0.11** | 0.45 | 0.48 | 0.44 | 0.30 |
| Aware of anemia | 1 if participant is aware of anemia, otherwise 0 | 0.87 | 0.88 | 0.01 | 0.89 | 0.86 | 0.88 | 0.15 |
| Aware of iron beans | 1 if participant has heard of iron bean varieties before survey, otherwise 0 | 0.03 | 0.15 | 0.12*** | 0.07 | 0.08 | 0.17 | 4.50** |
| Bean purchase decision maker | Participant is the main decision maker on the purchase of bean grains for home consumption, otherwise 0 | 0.65 | 0.68 | 0.03 | 0.74 | 0.74 | 0.54 | 8.18*** |
| Listen to radio | 1 if participant listens to radio, otherwise 0 | 0.95 | 0.94 | -0.01 | 0.89 | 0.95 | 0.98 | 4.61** |
| Age | Participant's age in years | 30.88 (9.83) | 29.94 (7.94) | -0.94 (-1.89) | 29.83 (6.62) | 30.83 (8.35) | 30.10 (10.46) | 0.47 |
| Education | Participant's education in years | 8.24 (4.82) | 7.18 (3.96) | -1.05** (-0.86) | 6.66 (4.37) | 7.14 (3.55) | 8.79 (4.61) | 9.32*** |
| Household size | Participant's household size | 4.84 (2.36) | 4.53 (2.76) | -0.31 (0.40) | 3.91 (1.69) | 4.52 (3.09) | 5.46 (2.69) | 12.43*** |
| Association membership | 1 if participant is a member of an association, otherwise 0 | 0.54 | 0.47 | -0.07 | 0.45 | 0.50 | 0.53 | 0.88 |
| Household has beans at home | 1 if participant's household had beans at home at time of survey, otherwise 0 | 0.48 | 0.42 | -0.06 | 0.32 | 0.44 | 0.56 | 8.41*** |
| Total quantity of beans at home | Quantity (kg) of beans participant had at home at time of survey | 3.73 (10.99) | 6.27 (27.73) | 2.54 (16.75) | 1.39 (4.27) | 2.68 (6.57) | 12.18 (39.21) | 8.63*** |
| Bean consumption frequency | Number of times participant's household consumed beans in the last 24 hours | 1.50 (0.53) | 1.55 (0.51) | 0.05 (-0.02) | 1.38 (0.54) | 1.58 (0.50) | 1.63 (0.48) | 9.63*** |
| Purchasing frequency | Participant's household beans purchasing frequency | 0.26 (0.25) | 0.24 (0.21) | -0.02 (-0.04) | 0.25 (0.22) | 0.28 (0.25) | 0.20 (0.20) | 3.72** |
| Asset value (Poor) | Total asset value in million RWF for the poor households | 0.58 (0.47) | 0.40 (0.37) | -0.18 (-0.10) | - | - | - | |
| Asset value (Avg) | '' average households | 47.70 (37.97) | 52.63 (36.87) | 4.93 (-1.1) | - | - | - | |
| Asset value (Rich) | '' for the rich households | 139.25 (84.91) | 142.20 (105.87) | 2.95 (20.96) | - | - | - | |

Note: *Significant at 10% level, **significant at 5% level, ***significant at 1% level, () = standard deviation; [A]one-sided t-test; [B]one-way ANOVA test, (-) means Not Applicable.

### Sensory Evaluation

Mean overall hedonic score for sensory attributes of three bean varieties tested are presented in Table 2 by treatment group. Most participants scored all products four or above (i.e., 4. "Neither Like nor Dislike," 5. "Like slightly," 6. "Like moderately" or 7. "Like very much"). The mean overall hedonic score is statistically significantly different at 1% level for all varieties when compared between control and treatment groups. The table shows that without information, control group participants liked the sensory attributes of the RMIB variety in overall terms even more than the local variety while the overall liking for the WIB variety is the least. However, with information, the treatment group participants' overall liking for both iron bean varieties is significantly higher than that of the local variety.

**Table 2: Mean Overall Sensory Score**

| Variety | Control | Treatment | t-statistic |
|---|---|---|---|
| Local | 6.09 (1.04) | 5.57 (1.04) | 4.70*** |
| RMIB | 6.26 (0.83) | 6.47 (0.67) | -2.79*** |
| WIB | 5.53 (1.65) | 6.02 (1.23) | -3.34*** |

**Table 3: Percentage of participants that normally buy bean variety**

| Varietal market local name | % Participants (n = 398) | % Poor (n = 132) | % Average (n = 133) | % Rich (n = 133) | Mean reported price* (RWF) | Mean observed market price** (RWF) |
|---|---|---|---|---|---|---|
| Mutiki | 71.61 | 70.45 | 65.41 | 78.95 | 556.81 ± 94.54 | 562.15 ± 46.46 |
| Bivanze (mixed) | 38.19 | 41.67 | 41.35 | 31.58 | 501.05 ± 88.26 | 512.50 ± 25.00 |
| Rwanda Rushya | 16.33 | 15.91 | 17.29 | 15.79 | 551.81 ± 87.10 | 550.19 ± 28.70 |
| Mushingiriro | 10.05 | 12.88 | 10.53 | 6.77 | 637.10 ± 155.44 | 572.50 ± 38.89 |
| Umweru (white) | 4.27 | 4.55 | 1.50 | 6.77 | 900.68 ± 294.10 | 1170.59 ± 68.60 |
| Amabara | 4.02 | 3.79 | 2.26 | 6.02 | 551.54 ± 99.99 | 655.10 ± 41.44 |
| Kolta | 3.77 | 5.30 | 3.01 | 3.01 | 701.16 ± 158.31 | 724.52 ± 39.04 |
| Umuhondo | 2.51 | 2.27 | 3.01 | 2.26 | 637.10 ± 155.44 | - |
| Cerayi | 1.26 | 1.52 | 0.75 | 1.50 | 525.00 ± 93.54 | 575.00 ± 35.36 |

*Price that participants reported that they expected to buy 1kg of bean grains in the market on the day of BDM experiment
**Average of market prices collected daily from randomly selected bean sellers throughout the survey period (*Kimironko* market), -: Not sold in the market during the survey period

### Habitual Choice Strategy

Varieties that participants identified as those they usually purchase for home consumption are shown in Table 3 with Mutiki (the local variety tested) being the most popular (72%). About 47 percent (n = 185) of the participants however also reported that they normally buy the same variety(s) on every visit to the market (84% usually buy Mutiki while 16% usually buy other conventional bean varieties). This suggests that some of the participants could have adopted a habitual choice strategy when stating their bids. For 17% of these habitual choice strategy adopters, bids submitted for the RMIB variety is actually equal to the price that they expected to buy 1kg of the local variety in the market while about 19% of non-adopters (n = 213) submitted same bid values as the expected market price. This is plausible since RMIB has a similar appearance as the local variety, thus 'cognitive miser' participants stated the price of the local variety as their bids for RMIB variety perhaps without fully evaluating the varietal options for utility maximization. Further, the majority of those habitual strategy adopters who also stated bid equal to the expected price for RMIB are in the control group without information while the remaining 19 percent are in the treatment group with information. Again, the proportion of the habitual choice strategy adopters is somewhat evenly distributed across wealth tercile: poor (43%), average (49%) and rich (47%), which suggests that the use of habitual choice strategy is unlikely to be correlated with poverty. This is more likely because beans are a common staple in Rwanda and are widely consumed several times a week by all classes of the population.

### Frequency of buying beans

Table 4 shows the frequency at which a participant's household purchases beans on average for home consumption. The majority of the participant's households usually purchase beans once or twice a week. However, habitual choice strategy adopters usually purchase beans more frequently (0.28 or twice a week) than non-adopters (0.21 or about once a week) on average and this is statistically significantly different at 1% level. We also compare the frequency of purchasing beans across the wealth terciles. The mean frequency for the poor is about 0.25 (or twice a week), 0.28 for the average (twice a week) and 0.20 (or about once a week) for the rich (Table 1). This frequency is significantly different between the rich and other wealth terciles (ANOVA F-statistic: 3.72, prob>F: 0.03). It suggests that relatively wealthier households have lower tendency for repeatedly buying beans than the relatively poor ones. This is consistent since the wealthier households may have more cash at hand to buy large quantities at once than their poorer counterparts. Further, as shown in Table 1, while the rich had about 12kg of beans at home the poor had only about 1kg on average. This is however in contrast to other evidence in the consumer behavior literature (McAlister and Pessemier 1982; Verplanken et al. 2005) which has suggested that higher income is often associated with a higher need for product and thus with repeated purchases.

**Table 4: Urban consumers' frequency of purchasing beans grains for home consumption**

| Frequency | Frequency = Number of times per [period days] | % Participants (pooled sample) | Habitual choice strategy (% adopters) | Habitual choice strategy (% non-adopters) |
|---|---|---|---|---|
| | | **N = 398** | **n = 185** | **n = 213** |
| Every six months | 1/180 | 0.3 | 0.0 | 0.5 |
| Every three months | 1/90 | 0.5 | 0.5 | 0.5 |
| Every two months | 1/60 | 1.0 | 2.2 | 0.0 |
| Once a month | 1/30 | 14.1 | 11.9 | 16.0 |
| Twice a month | 2/30 | 5.5 | 4.9 | 6.1 |
| Once a week | 1/7 | 30.7 | 27.0 | 33.8 |
| Twice a week | 2/7 | 35.4 | 38.4 | 32.9 |
| Three times a week | 3/7 | 6.0 | 4.3 | 7.5 |
| Five times a week | 5/7 | 0.3 | 0.0 | 0.5 |
| Everyday | 7/7 | 6.3 | 10.8 | 2.4 |
| **Mean frequency** | **-** | **0.47** | **0.28**[a] | **0.21**[a] |

[a]significantly different at 1% level (t-test)

## WTP Data, Payment and Hypothetical Bias

Prices observed in the market (for 1kg of the local variety) during the survey ranged from 400 to 700 RWF averaging at 562 RWF (Table 3). Surprisingly however, the WTP data6 show that on average, participants submitted bids ranging from 200 to 1000 RWF (mean: 491) for the local variety, 200 to 1250 RWF (mean: 541) for RMIB variety and 120 to 1500 RWF (mean: 563) for the WIB variety. Before going through the BDM experiment, participants were also asked to state the price at which they expected to buy 1kg of various local varieties in the market. The average market price reported is 557 RWF ranging from 200 to 1000 RWF (Table 3). The bids submitted also follow this pattern rather than the observed market price.

Those bids for the local variety which are outside of the observed market price range are likely due to 'hypothetical bias' from nonpayment. Despite the fact that participants were informed about an out-of-pocket payment requirement before they agreed to participate in the BDM experiment, several of them still did not want to pay (7%) or could not pay due to financial constraints (13%) after getting a chance to buy in the experiment, while several others who did not get the chance to buy in the experiment stated that had they got the chance they would not have paid (15%). This suggests that this category of participants (about 34%) have made an ex ante decision not to pay before even participating in the experiment.

[6] No participant submitted zero bids

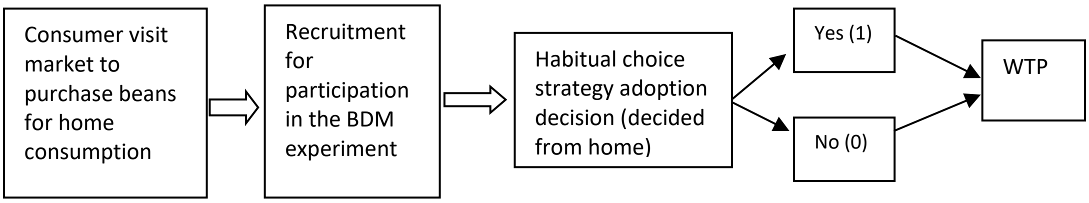
Although it is possible to assume that there could be a misconception and game form recognition effect (Carson and Plott, 2014) as the reason why these participants made no payment or intend not to pay, this is not likely because (1) participants were clearly informed during the recruiting process about the need for them to pay out of pocket if they get a chance to buy a product in the experiment, (2) the experiment was clearly explained to participants by the enumerators using simple examples, (3) each participant went through a practice round, and (4) follow up questions were asked to understand why participants did not pay or would not have paid. About 46% of those participants who did not or would not have paid (n = 136) stated lack of cash on them as the main reason for nonpayment or nonpayment intention, 4% won the variety they liked the least, 2% had the same variety they won at home, 7% had other variety at home, 23% stated that they were not intending to buy beans at the time of the experiment, 4% stated that they were currently facing other expenditure needs while about 13% stated other reasons.

Therefore, we assume that their WTP bids are zeroes due hypothetical bias. The mean WTP of those who won and made no payment is higher than the mean WTP of those who won and paid by 7% for the local variety ($p<0.05$), 11% for RMIB variety ($p<0.01$) and 6% for WIB variety (not significant); which suggests the degree of 'hypothetical bias' due to nonpayment. Thus, we coded these bids as zeroes such that our WTP variable is censored at zero to control for the bias.

## 4. ECONOMETRIC STRATEGY

There are two stages of decision faced by the participants. First, since those participants who stated that they usually adopt habitual choice strategy when purchasing beans would have made that decision before arriving at the market on the day they were recruited for the experiment, within our sample, there are both habitual choice strategy decision adopters and non-adopters (Figure 1). The second stage is the decision taking during the experiment, which is bidding how much to pay. Thus, the first question is why did some participants decided to adopt habitual choice strategy decision and some did not, and the second question is why does the bid amount vary among the participants? We use a Cragg's double hurdle model to examine these two questions (Cragg, 1971). The Cragg's model has been widely applied in examining such a two-tier decision process in the technology adoption literature (e.g. Croppenstedt et al., 2003; Ricker-Gilbert et al., 2011). Similarly, double hurdle model has been utilized in investigating consumer WTP, for instance, as a combination of probit and zero-inflated ordered probit models (Akcura, 2013) or as a combination of double hurdle and spike models (Lera-López et al., 2014). Although the Cragg's model has also been applied to WTP data obtained through choice experiment and experimental auction techniques (Lusk et al., 2001; Mabiso et al., 2005), its application is most common when contingent valuation method is used due to the high probability of zero WTP.

**Figure 1: Decision Process Towards Bidding for Bean Varieties**




Alternatives to Cragg's model could include the Heckman selection model. The choice of the double hurdle model is informed by the source of the zeroes. In the case of the Heckman model, it would be assumed that the habitual choice strategy decision non-adopters will never adopt such as a strategy if for example they visit the market another day. Such an assumption is erroneous since participants could change their behavior if market environment or household need changes. However, the double hurdle model is a quasi-solution for the utility maximization process, where a participant faces the two hurdles of the decisions discussed above. In the literature, the two decisions are commonly assumed to be made at two different stages such that the two hurdles are modeled as independent but they could also be modeled as dependent (Gao et al., 1995). The assumption of independence could be made in this study where participants would have decided ex ante to repeat the purchase of the same bean variety before being recruited for the experiment. Several exogenous factors such as the nutrition information provided could subsequently affect a participant's decision on how much to pay for the bean varieties tested.

The double hurdle model has a two-equation process. The first hurdle equation is a probit model analyzing the factors influencing adoption of the habitual choice strategy, while the second hurdle equation is a modification of Tobit estimator examining the determinants of WTP. Assume that $y_i$ is the observed bid submitted by participant, $i$ for variety, $j$ and $y_i^*$ is the latent bid amount while $h_i$ is the observed adoption of habitual choice strategy and $h_i^*$ is the latent habitual choice strategy adoption variable. Then, the two hurdle equations can be written as:

$$h_i^* = \propto z_i' + \varepsilon_{0,i} \qquad (1)$$

$$y_i^* = \beta x_i' + \varepsilon_{1,i}, \qquad (2)$$

such that with the assumption that the two error terms $[\varepsilon_{0,i} \sim N(0,1)$ and $\varepsilon_{1,i} \sim N(0, \sigma_\varepsilon^2)]$ are independently distributed, the first and second hurdles can be represented as:

$$h_i = \begin{cases} 1, if\ h_i^* > 0 \\ 0, if\ h_i^* \leq 0 \end{cases} and\ y_i = \begin{cases} y_i^*, if\ y_i > 0\ and\ h_i > 0 \\ 0, if\ otherwise \end{cases}, \qquad (3)$$

where $z_i'$ and $x_i'$ are the vectors of explanatory variables for the first and second hurdles respectively. With equation 3, we have assumed a cross-sectional data. However, since participants submitted bids for $J^{th}$ bean varieties, we control for the individual-specific effects by estimating a random-effects double hurdle model following Dong and Kaiser (2008), where, $y_i$ is denoted as $y_{ij}$. The first hurdle in this case has only one outcome per participant across varieties such that if $h_i$ = 0, then $y_{ij} = 0, j = 1, 2, 3$. Therefore, with the participant-specific random-effects term, $u_i$ being introduced, equation 2 can be re-written as:

$$y_{ij}^* = \beta x_{ij}' + u_i + \varepsilon_{1,ij}, \qquad (4)$$

with a covariance matrix of the following form:

$$\begin{pmatrix} \varepsilon_{0,i} \\ u_i \\ \varepsilon_{1,ij} \end{pmatrix} \sim N \left[ \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & \rho\sigma_u & 0 \\ \rho\sigma_u & \sigma_u^2 & 0 \\ 0 & 0 & \sigma^2 \end{pmatrix} \right]$$

The sample log-likelihood for this model is conditional on both situations when $h_i$ = 0 and $h_i$ = 1. When the latter is taken into consideration and also conditional on $u_i$, the likelihood ($L$) is:

$$(L_i | h_i = 1, u_i) = \prod_{j=1}^{J} \left\{ 1 - \Phi\left( \frac{\beta x_{ij}' + u_i}{\sigma} \right) \right\}^{I(y_{ij}=0)} \left\{ \frac{1}{\sigma} \phi\left( \frac{y_{ij} - \beta x_{ij}' - u_i}{\sigma} \right) \right\}^{I(y_{ij}>0)} \qquad (5)$$

Also, when $h_i$ = 0 and depending on whether all observations for participant, $i$ are zero or >0, the likelihood is:

$$(L_i | h_i = 0) = 0\ if\ \sum_{j=0}^{J} y_{ij} > 0$$

$$= 1 \; if \; \sum_{j=0}^{J} y_{ij} = 0 \qquad (6)$$

Taking a weighted average of equations 5 and 6, the likelihood for participant, $i$ is obtained conditional on $u_i$, and by integrating the probabilities of outcome from the first hurdle equation 1; the marginal likelihood for each participant is computed where the sample log-likelihood is written as follows with $f(u)$ being the normal $(0, \sigma_u^2)$ density function for $u$ (Engel and Moffatt, 2014):

$$LogL = \sum_{i=1}^{n} \ln\left( \int_{-\infty}^{\infty} (L_i|u)\, f(u) du \right).$$

An advantage of the random-effects double hurdle model over the standard cross-sectional double hurdle model is that the former relaxes the first hurdle dominance assumption where if a participant is a non-adopter in the first stage, then the subsequent outcome will always be zero. The random-effects double hurdle model allows a mixture of zero and positive outcomes for a participant. In our sample, we also have participants who adopted habitual choice strategy and they may or may not be nonpayment participants such that their bids could be zero or positive ($y_{ij} \geq 0$).

Equations 1 and 4 were estimated via simulated maximum likelihood (Train, 2009). We have assumed that the error terms of these equations are uncorrelated such that the two stage equations are independent because we assumed that the habitual choice strategy adopters would have made the decision to buy the same variety from home. However, these adopters could have also made the decision during the BDM experiment since our data revealed that about 17% of them stated the same price for the RMIB variety as the price they expected the local variety to be sold for. Thus, we also estimated equations 1 and 4 with the dependence assumption in order to examine if there is correlation between the error terms in the two hurdles.

# 5. RESULTS

## Urban Consumer WTP for Iron Beans

Participants WTP are presented in Table 5 with comparisons across treatments and wealth terciles. Mean bid submitted by the control group participants is highest for the WIB variety, followed by the local and RMIB varieties respectively, which is in contrast to the results of the overall sensory evaluation scores (Table 2). The mean bids is consistent with the ranking of observed market prices for local varieties (Table 3) in which a white bean variety (Umweru) is the costliest in the market. The disparity could be due to the ceiling effect in the overall sensory scores, thus we did not include this in the regression analysis discussed later. In the treatment group however, while the mean bid is also highest for the WIB variety, the bid for the RMIB variety is higher than that for the local variety, and this is consistent with the overall sensory scores. Compared to the control group, the treatment group participants were willing to pay about 12% less for the local variety and about 6% more for the RMIB variety. The difference in means is not statistically significant for the WIB variety. This result is opposite to those of Oparinde et al. (2015) where it was found that the deeper colored varieties have the highest WTP while the white colored variety have a market discount in the rural areas of Rwanda. Our result reveal differences in taste between urban and rural consumers of beans.

As expected, the mean WTP bid is higher for hypothetical decision adopters (won but no payment participants) compared to non-adopters (won and paid participants). Although the data also show that the mean bids for habitual choice strategy adopters are actually higher than the mean bids submitted by non-adopters, this is only significant for WIB variety. This is consistent with the assertion of Adamowicz and Swait (2012) that full evaluation behavior would push a consumer towards utility maximization instead of the automatic responses exhibited in habitual behavior. Full evaluation of test varieties would allow participants to cognitively calibrate their WTP, which could suggest why WTP for the habitual strategy adopters is higher compared to non-adopters. It is also interesting to find that WTP is positively correlated with wealth tercile: the rich have the highest mean bids for all varieties, followed by the average and poor terciles, respectively. Compared to the participants from rich households, the poor are willing to pay about 15% less for the RMIB variety and about 20% less for WIB variety. This is consistent with our hypothesis that consumers from urban poor households are more likely to be willing to pay less for iron beans compared to their wealthier counterparts due to financial constraint differentials. However, all household categories are willing to pay the highest for the WIB variety irrespective of wealth status.

### Table 5: WTP by Treatment Group and Wealth Tercile

| Variety | Control | Treatment | Mean Difference | t-statistic[A] |
|---|---|---|---|---|
| ***Treatment effect*** | | | | |
| Local | 527.80 | 472.63 | -55.17 | 3.95*** |
| | (130.31) | (131.40) | (1.09) | |
| RMIB | 519.17 | 551.50 | 32.34 | -1.96* |
| | (136.91) | (162.91) | (26.00) | |
| WIB | 539.92 | 574.33 | 34.41 | -1.57 |
| | (175.29) | (219.40) | (44.11) | |
| ***Hypothetical bias*** | | | | |

| | | | | |
|---|---|---|---|---|
| Pooled bid: with nonpayment bids set to zero | 206.57 | 187.56 | -19.01 | 1.07 |
| | (282.00) | (293.51) | (11.50) | |
| Pooled bid: Won and paid (N = 130) | 546.51 | 542.40 | -4.11 | 0.25 |
| | (128.86) | (160.18) | (31.32) | |
| Pooled bid: Won but no payment (N = 76)[a] | 565.38 | 602.20 | 36.82 | -1.40 |
| | (176.79) | (193.47) | (16.68) | |
| Pooled bid: Lost but would not have paid (N = 61)[b] | 523.61 | 534.59 | 10.98 | -0.39 |
| | (131.61) | (213.91) | (82.30) | |
| ***Habitual choice strategy*** | | | | |
| Adopter (N = 185) | | | | |
| Local | 541.05 | 485.94 | -55.12 | 2.52** |
| | (146.23) | (133.24) | (-12.99) | |
| RMIB | 532.98 | 556.25 | 23.27 | -0.99 |
| | (124.24) | (155.86) | (31.62) | |
| WIB | 569.30[c] | 594.09 | 24.79 | -0.73 |
| | (189.34) | (224.93) | (35.59) | |
| Non-adopter (N = 213) | | | | |
| Local | 517.73 | 460.29 | -57.44 | 3.21*** |
| | (116.79) | (128.93) | (12.14) | |
| RMIB | 508.67 | 547.10 | 38.43 | -1.66* |
| | (145.74) | (169.63) | (23.89) | |
| WIB | 517.60 | 556.01 | 38.41 | -1.36 |
| | (161.55) | (213.34) | (51.79) | |
| ***Poverty level*** | | | | |
| | **Poor** | **Average** | **Rich** | **F-statistic[B]** |
| Local | 456.44 | 496.62 | 519.47 | 7.83*** |
| | (125.84) | (139.29) | (128.02) | |
| RMIB | 491.21 | 555.64 | 575.11 | 11.12*** |
| | (143.25) | (144.03) | (166.14) | |
| WIB | 498.43 | 564.29 | 625.56 | 13.38*** |
| | (186.17) | (201.92) | (211.29) | |

Note: ***1% significance level, **5% significance level, *10% significance level (A: one-sided t-test, B: one-way ANOVA test); (): Standard deviation; a: significant at 1% (won and paid vs. won but no payment); b: significantly different at 1% (won but not payment vs. lost but would not have paid); c: significant at 10% (adopter vs. non-adopter).

## Model Selection

Six regression models estimated are presented in Tables 6 and 7. Following equation 4, we first estimated a random-effects general least square (RE GLS) model of WTP via the maximum likelihood (mle) option in STATA in order to explore the data. Model 2 (Table 6) shows that as expected 'hypothetical bias' significantly inflated participant WTP by about 7%. Therefore, our strategy of treating bids submitted by nonpayment participants as zeroes is consistent. Also, in order to explain why some participants adopted the hypothetical decision, we estimated RE probit model 3 (Table 6). Subsequently as shown in Table 7, we first estimated (equations 1 and 4) the basic form of the RE double hurdle model (1a and b) with only dummy variables for iron bean varieties and information included as the explanatory variables for WTP. The dependent variable for the first hurdle is the habitual choice strategy adoption and the dependent variable for the second hurdle is the WTP (with zero bids). Following this, we included all the socio-economic characteristics[7] hypothesized to influence WTP (see Table 1) in the full RE double hurdle model (2a and b) which was estimated with the independence assumption. To test our hypothesis that the two hurdle decisions are made separately, we also estimated the same model with a dependence assumption. The dependence model shows that the correlation coefficient between the two equations is significant ($\rho = -0.47, p - value = \ 0.03$). However, there is no significant difference in model fit parameters for the two models (log-likelihood of the dependence model is -2902.387 while that of the independence model is -2903.750). A likelihood ratio test $[LR = -2(\ln LL_{Independency\ model} - \ln LL_{Dependency\ model})]$ shows that the difference between the two models is not statistically significant at 5%. Thus, we do not reject the null hypothesis that RE double hurdle model with independence assumption is the superior model since the decision to buy the same variety could have been made before participants left home for market. Therefore, we chose model 3 (Table 6) and model 2 (Table 7) for discussions while other models are presented for comparisons.

*Factors influencing nonpayment decision (Hypothetical Bias)*

Factors that influenced the probability of adopting hypothetical decision towards the bidding process are estimated via a RE probit model. The parameter estimates in model 3 (Table 6) shows that on one hand, being from a rich household, being the household's decision maker on beans purchases and association membership have a negative effect on the probability of making the hypothetical decision towards the bidding process. On the other, the positive coefficients on per capita quantity of beans at home shows that the more participants are from a household that have beans at home the more likely they are hypothetical decision makers. This is consistent since a participant might not want to buy more beans when recruited for the experiment. Similarly, the more a participant is from a household that buys beans more frequently, the more likely such participant will make a decision not to pay in the BDM experiment. The positive sign on the coefficients on male and education variables suggests that being a male with more years of education increases the probability of making a hypothetical decision. Although these results may be context-specific, they provide some explanations on the origin of 'hypothetical bias' in auction experiments conducted in the field in a developing country context.

[7] A multicollinearity check (variance inflation factor) was conducted and none of the included explanatory variable is correlated.

**Table 6: Determinants of Hypothetical Decision**

| Variable | *Dep. Variable:* **WTP**<br>Basic RE GLS (mle) | *Dep. Variable:* **WTP**<br>RE GLS (mle) | *Dep. Variable:* **Hypothetical decision adoption**<br>RE Probit |
|---|---|---|---|
| | **1**<br>Coeff.<br>(S.E.) | **2**<br>Coeff.<br>(S.E.) | **3**<br>Coeff.<br>(S.E.) |
| RMIB | 49.85***<br>(7.84) | -1.04<br>(14.22) | - |
| WIB | 71.99***<br>(7.84) | 27.00*<br>(14.22) | - |
| Information | 3.86<br>(15.03) | -49.49***<br>(17.52) | - |
| Info x RMIB | - | 87.71***<br>(16.16) | - |
| Info x WIB | - | 89.98***<br>(16.16) | - |
| Poor | - | -33.74*<br>(18.86) | -0.19<br>(0.14) |
| Rich | - | 28.74<br>(17.51) | -0.42***<br>(0.16) |
| Poor x RMIB | - | -23.33<br>(16.16) | - |
| Poor x WIB | - | -45.68***<br>(16.16) | - |
| Bean purchase decision maker | - | -34.19**<br>(15.67) | -0.63***<br>(0.14) |
| Purchase frequency | - | 26.54<br>(30.15) | 0.54**<br>(0.27) |
| Per capita quantity of beans at home (kg) | - | 0.23<br>(0.48) | 0.01***<br>(0.01) |
| Aware of anemia | - | 5.34<br>(20.72) | - |
| Male | - | -14.68<br>(14.65) | 0.21*<br>(0.13) |
| Age | - | -1.51<br>(0.81) | 0.004<br>(0.006) |
| Education | - | 0.44<br>(1.66) | 0.03**<br>(0.02) |
| Prior knowledge of iron beans | - | -0.33<br>(22.60) | - |
| Association membership | - | -3.00<br>(13.69) | -0.60***<br>(0.12) |
| Participant had a meal close to interview time (Yes = 1, No = 0) | - | -6.58<br>(16.43) | -0.03<br>(0.14) |
| Hypothetical bias | - | 38.48***<br>(14.56) | - |
| Constant | 488.35***<br>(13.10) | 579.40***<br>(41.85) | -0.09<br>(0.31) |
| No. of observations | 1194 | 1194 | 1194 |
| Log-likelihood | -7628.48 | -7577.27 | -182.73 |

Note: ***1% significance level, **5% significance level, *10% significance level; RE: Random-effects; S.E.: Standard error

## Determinants of Habitual Choice Strategy Adoption and WTP

The determinants of participants' adoption of a habitual choice strategy are identified through the RE probit model 2a (Table 7), which is the first hurdle of the random-effects double hurdle model estimated. Probability of adopting the habitual choice strategy is significantly influenced by two variables. First, we found that the adoption is less among those participants who are the main decision maker on bean purchases for household consumption. This is plausible since those participants who do not make the purchase decision would be instructed by the household decision maker and thus may easily adopt repeated purchases. Moreover, the result is interesting as it suggests that when consumers have control over their choices, they are more likely to be able to diversify their options and perhaps exhibit a different purchase behavior away from a habitual choice especially when motivated by a need or an evaluation of changes in product environment (Gronau and Hammermesh, 2008). Second, the result suggests that participants who are from households with association memberships are less likely to adopt a habitual choice strategy when purchasing beans. Associations such as a traders' association could represent an important medium for information sharing about new market products or new varieties of beans. Therefore, members of an association may be more open to exploring new choice options in the market.

The treatment effect of information on participant WTP for iron beans is discussed using model 2b (Table 7) i.e. the second hurdle. As expected, in the absence of information, the varietal effect is not significant for the RMIB variety since it has a similar appearance as the local variety. However, varietal property of the white iron bean variety translates into a significant premium of about 9% over the red mottled local variety. Coefficients on the interaction terms between variety and information show that the presence of information resulted in a positive and significant effect on participant WTP for both iron varieties. Information increases the WTP by 13% for RMIB variety and by 15% for the WIB variety. Also, consistent with expectations, being from a rich household increases participant WTP by 12% while the coefficient on 'poor' variable is negative but not significant. However, the coefficient on the interaction term between 'poor' and WIB variety suggests that participants from poor households were willing to pay about 11% less for the WIB variety. Participants from poor households could have perceived this variety similarly to the white local variety (Umweru), which is the most expensive in the market (Table 3). In contrast, the coefficient on the interaction term between 'poor' and RMIB variety is not significant, which suggests potential affordability for this variety among the urban poor.

We also estimated a standard RE interval censored model (model 3, Table 7) to shed lights onto the role of habitual choice strategy in urban consumer WTP for iron beans where we included interaction terms for the habit variable. We assume that for the nonpayment participants, their true WTP lies between zero and the bid submitted. The coefficient on habitual choice strategy adoption variable in the interval censored model is not significant and this does not change even in the presence of information. This is contrary to the expectation that the opposite of pure habit could occur when changes occur in the product environments such as the presence of brand information or advertisement (Adamowicz and Swait, 2012). This could be due to the fact that beans are a popular common staple among Rwandan consumers. However, as expected habitual choice strategy adopters were not willing to pay more for the RMIB variety relative to the local variety since the coefficient on the interaction term is not significant. A separate regression output was also obtained where a dummy variable representing those habitual choice strategy adopters who usually purchase Mutiki and its interaction with RMIB and information are controlled for in the interval censored regression, however the coefficients remain insignificant. This suggests that habit can constrain participants to state the same amount they normally spend on the habitually consumed product for a new product.

## Table 7: Determinants of WTP for iron beans

| | Basic RE Double hurdle model (independence assumption) | | RE Double hurdle model (independence assumption) | | *Dep. Variable:* WTP (with zeroes for nonpayment) |
|---|---|---|---|---|---|
| | *1st hurdle Dep. Variable*: Habitual choice adoption; *2nd hurdle Dep. Variable*: WTP (with zeroes for nonpayment) | | | | |
| **Variable** | **RE Probit (1st hurdle)** | **Truncated (2nd hurdle)** | **RE Probit (1st hurdle)** | **Truncated (2nd hurdle)** | **RE Interval Censored** |
| | 1a | 1b | 2a | 2b | 3 |
| | Coeff. | Coeff. | Coeff. | Coeff. | Coeff. |
| | (S.E.) | (S.E.) | (S.E.) | (S.E.) | (S.E.) |
| RMIB | - | 64.60*** | - | 25.52 | 29.55 |
| | | (15.68) | | (27.07) | (20.51) |
| WIB | - | 84.01*** | - | 49.72* | 33.89* |
| | | (15.68) | | (27.07) | (18.98) |
| Information | - | 36.77 | - | -11.56 | -19.60 |
| | | (26.78) | | (31.58) | (31.19) |
| Information x RMIB | - | - | - | 76.58** | 63.13*** |
| | | | | (31.96) | (21.70) |
| Information x WIB | - | - | - | 85.28*** | 68.41*** |
| | | | | (31.96) | (21.77) |
| Poor | -0.11 | - | -0.11 | -2.95 | -26.23 |
| | (0.16) | | (0.16) | (35.37) | (26.87) |
| Rich | -0.14 | - | -0.14 | 71.85** | 10.50 |
| | (0.17) | | (0.17) | (32.78) | (26.03) |
| Poor x RMIB | - | - | - | -30.42 | -24.40 |
| | | | | (33.16) | (21.66) |
| Poor x WIB | - | - | - | -63.28* | -49.79** |
| | | | | (33.16) | (21.73) |
| Bean purchase decision maker | -0.43*** | - | -0.43*** | -32.56 | -83.70 |
| | (0.15) | | (0.15) | (30.29) | (22.84) |
| Purchase frequency | 0.46 | - | 0.46 | 92.22* | 75.35* |
| | (0.30) | | (0.30) | (47.15) | (43.92) |
| Per capita quantity of beans at home (kg) | 0.01 | - | 0.01 | -0.03 | 1.01 |
| | (0.01) | | (0.01) | (0.54) | (0.65) |
| Aware of anemia | 0.10 | - | 0.10 | -2.95 | 18.48 |
| | (0.21) | | (0.21) | (39.71) | (30.54) |
| Male | 0.14 | - | 0.14 | -13.77 | 1.14 |
| | (0.15) | | (0.15) | (28.62) | (21.56) |
| Age | -0.01 | - | -0.01 | -1.95 | -2.51** |
| | (0.01) | | (0.01) | (1.55) | (1.18) |
| Education | 0.02 | - | 0.02 | 1.22 | 3.46 |
| | (0.02) | | (0.02) | (3.37) | (2.42) |
| Prior knowledge of iron beans (Yes = 1, No = 0) | -0.34 | - | -0.34 | -46.26 | -46.42 |
| | (0.23) | | (0.23) | (46.21) | (33.78) |
| Association membership | -0.42*** | - | -0.42*** | -33.50 | -56.19*** |
| | (0.13) | | (0.13) | (26.22) | (19.86) |
| Participant had a meal close to interview time (Yes = 1, No = 0) | - | - | - | -15.92 | -5.61 |
| | | | | (29.42) | (24.05) |
| Habitual choice strategy adoption | - | - | - | - | 50.26 |
| | | | | | (35.20) |
| Habit*RMIB | - | - | - | - | -28.59 |
| | | | | | (18.02) |
| Habit*Information | - | - | - | - | -53.84 |
| | | | | | (42.19) |
| Constant | 0.02 | 495.48*** | 0.02 | 582.29*** | 453.68*** |
| | (0.37) | (23.29) | (0.37) | (77.40) | (61.36) |
| No of observations | 1194 | | 1194 | | 1194 |
| Log-likelihood | -2921.28 | | -2903.21 | | -2975.91 |

Note: ***1% significance level, **5% significance level, *10% significance level; RE: Random-effects; S.E.: Standard error

## 6. CONCLUSION

In this paper, we estimated consumer WTP for biofortified iron beans in Rwanda, where iron deficiency is an important public health problem among children under the age of five and women of child bearing age. Iron biofortified crops are a relatively cheap alternative intervention to address global hidden hunger but the premise that rural poor households in developing countries would cultivate and consume the crops can be challenged by the increasing rural-urban migration in the global South. Therefore, the success of biofortification in addressing iron deficiency in the global South depends not only the acceptance of the crops among consumers but also on the success of reaching the poor and undernourished population in the urban areas. Hence, an understanding of the prices for biofortified iron beans among poor and rich households in the urban market place has tremendous implications for promoting adequate access for the urban poor, and in informing large scale dissemination and marketing of these nutritious crops. In this study, we examined the WTP differentials across poverty levels among urban beans consumer in Rwanda. Since promoting such new market products would require an efficient marketing, we also tested the effect of nutrition information and examine the role of habit in WTP.

We show that even without providing the nutrition information, Rwandan urban consumers are willing to pay the same price for the red mottled iron bean (RMIB) variety as the local variety. And they are even willing to pay more for the white iron bean (WIB) variety. Thus, iron beans have the potential to compete favorably well with the local variety in the urban market place. However, since the RMIB variety does not secure a premium in the absence of information, information is important to its promotion. This is particularly important since it has a similar appearance to the local variety and since iron is an invisible trait. We observe a large positive effect of information on consumer WTP. The information resulted in 13 to 15% premium for both iron bean varieties. Thus, the short information used in this study can be adopted for a large-scale promotion of iron beans since it resulted in a significant impact on acceptance.

Our results suggest that relative to the average households, poor households may not be able to afford the WIB variety if it costs 11% more than what they can afford (491 RWF i.e. their mean WTP). Therefore, if a strict market-based approach (with full forces of demand and supply) is mainly applied in promoting biofortified iron beans, our result suggests that it could create an inadequate access for this urban population. Micronutrient malnutrition is usually more prevalent among the poor than among the rich. Thus, the target consumers of biofortified foods may be missed in the urban area if an equitable pricing or other interventionist approach is not applied in marketing biofortified crops in the urban area. Meanwhile, since we found that poverty has no effect on WTP for RMIB variety the result suggests that poor households would be able to afford this variety in respect to the local variety. Thus, a 'multivariety-marketing' approach can be adopted in which certain iron bean varieties are promoted among the poor while other varieties such as the WIB are promoted among the rich. While such an approach could reduce the access gap between the poor and the rich, it can also create an aspiration problem where consumers from poor households would consider RMIB variety as an inferior variety compared to the WIB variety. Therefore, a mix-marketing approach that embraces both equity in pricing and product targeting should be applied in promoting biofortified foods in the urban areas in order to ensure an equitable access for the urban poor.

About 22% of population in the urban areas of Rwanda live below the poverty line of US $1.25 a day (National Institute of Statistics of Rwanda - NISR). With about 2.3% population growth rate, Rwandan population is likely to rise up to about 16 million in 2032 (NISR, 2012). This population growth will have a significant impact on access to agricultural land in the rural areas and thus rural-urban migration is likely to continue to increase in Rwanda. Only 46.3% (1.8 million hectares) of the country's land area is agricultural land. Approximately 11.5% of Rwandan households are landless while about 55% of the agricultural holdings are less than 0.5 hectares. Similar to Rwanda, several countries in the developing world, such as China, India, Nigeria and Uganda are undergoing agglomeration in the urbanization process where a significant proportion of poor rural farm households are moving out of agriculture and migrating to densely populated urban areas. The structural and spatial transformations of food security of a nation are closely nested. This suggests that agricultural-based nutrition interventions like biofortification should incorporate strategies from the onset towards reaching the urban poor especially through integrated value chain approach that emphasizes inclusiveness.

The effect of habitual choice adoption on WTP is not significant. This is contrary to the expectation that habit would be important in consumer demand for staple foods that are consumed very frequently in developing countries, Further, contrary to the results of other studies that have shown that changes in product environment can lead to departure from habitual choice behavior (Adamowicz and Swait, 2012), the combined effect of nutrition information and habit on WTP is also not important. On the other hand, we show that habitual choice adoption can constrain participants to state the same price they normally buy the habitually consumed product for a similar new product since we found that participants who purchase same variety repeatedly stated the same price for both RMIB and local varieties (which are similar in appearance). However, the inability of our data to detect the effect of habit can be attributed to various reasons. First, several other studies that have investigated the impact of habit have utilized panel data with observed dynamic repeated choices while this study only considered static value. Second, scanner data is commonly used in the investigation of habit effects (e.g. Andrews and Srinivasan, 1995) while the use of experimental auction bids as it is done in this study is rare. Therefore, further research is required to explore the role of habits in consumer demand for staple foods in developing countries. Utilization of panel auction data such as auction bids with several rounds could be more appropriate in exploring this ground.

Ethical reasons have been cited for not asking consumers from poor households to pay out of pocket in experimental auctions conducted in Africa (Morawetz et al., 2011). However, our study shows that if the product on offer for sale is a commonly consumed product in which the unit cost constitutes a very small share of household food budget, then consumers from poor households may actually be willing to pay out of pocket. We had a very high participation rate even when an out-of-pocket payment requirement was explicitly mentioned during the participant recruitment process.

One of our objectives was to shed light onto the role of eliminating participatory fees in auction bids as a strategy to identify hypothetical bias. Our study shows that the inclusion of participatory fees in experimental auctions could also mask 'hypothetical bias' since we found a significant proportion of our sample making hypothetical decisions ex ante even before participating in the experiment. Therefore, the provision of participatory fees could mask such bias and bring about distortions in optimal bidding behavior. We found that the 'hypothetical bias' in WTP elicited through a BDM experiment can be up to 7%. Although the magnitude of 'hypothetical bias' in other studies is much higher and can be up to 100% in choice experiments or contingent valuation for instance (Chowdhury et al., 2011), the magnitude revealed by our study suggests that this will be sensitive to the elicitation techniques used and whether or not the experimental setting is real. This result is also indicative of the market reality in which some consumers may be unable to afford products that they prefer in the market due to poverty. Our approach of making auction participants pay out of pocket could be more efficient in representing market realities in the field than giving participatory fees. Therefore, more practical approaches to mimic market realities as close as possible should be maximized to improve the demand revealing property of field auction experiments conducted in developing countries.

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**APPENDIX**

**RADIO MESSAGES**

**<u>Radio Message (Gain Frame)</u>**

*[Mother = Karine]*

*[Karine's neighbor = Female = Marie]*

**Mother:** Good evening, my neighbor Marie, welcome!

**Farmer Neighbor:** Hello, madam Karine. I have news for you. Do you know that when ***you have*** enough iron in your diet *you will have physical strength and endurance* and therefore will become tired less rapidly? **[EMPASIS ON THIS ASPECT OF THE MESSAGE]**

This means you will have optimal strength to undertake heavy physical activities (such as working in the field). When your children have enough iron in their diets they will perform better in school because their minds or brains will be able to focus better and pay more attention to school work.

You should be giving high iron beans to your children. This bean type has about 40 to 70 percent more iron than the local variety. It also grows well like any other popular variety. My family is already growing and consuming high-iron beans.

**Farmer Neighbor:** I am leaving for market now to buy some high-iron beans for my family. Bye-bye, madam Karine.