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Contents

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Demand-Pull Creation, Public Officer's Endorsement, and Consumer Willingness-to-Pay for Nutritious Iron Beans in Rural and Urban Rwanda

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ABSTRACT

Several studies have suggested demand-pull creation in urban areas as a strategy to drive the adoption of novel agricultural products in rural areas. However, questions remain about whether urban consumers have preferences that are similar to those of rural smallholder producers who produce what they consume. This paper compares urban and rural consumers' preferences for novel agricultural products by using the case of biofortified iron beans in Rwanda; tests the effects of two marketing levers in field experiments using the Becker-DeGroot-Marshak mechanism; and examines the effect of a public officer's endorsement on consumer demand for iron beans, along with, and the impact of, information length to inform the design of cost-effective marketing strategies for iron beans. The study results show that with or without information on the nutritional benefits of iron beans, rural and urban consumers have similar preferences for one of the two varieties of iron beans tested, which suggests an avenue for demand-pull creation in the urban area. However, the length of the information and a public officer's endorsement have no significant effect on consumer demand for iron beans. This paper suggests that providing cogent information on the nutritional benefits could alone be effective in branding and marketing iron beans.

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1. INTRODUCTION

Beans (*Phaseolus vulgaris*) are an important grain legume in human diets, as they provide proteins and complex carbohydrates. Although beans originated in Latin America, they are widely consumed in eastern Africa.

Rwanda is the highest consumer of beans in the world, with an average daily consumption of about 164 grams per capita (Ferris 2002). However, micronutrient deficiency is prevalent in the country, which has an overall anemia[1] prevalence of about 30.9 percent among children 6–59 months old (DHS 2010). In a smallholder agriculture population, such as that of Rwanda where households consume what they produce, the introduction of staple crops biofortified to have higher micronutrient content is a strategic, promising, and potentially cost-effective solution to address micronutrient deficiency (Meenakshi et al. 2010).

Biofortification is the process of breeding high-yielding staple crops rich in vitamins and minerals. Recently, the Rwanda Agriculture Board (RAB) in collaboration with HarvestPlus officially released conventionally bred biofortified bean varieties that are about 40 percent richer in iron content than local varieties. This effort is aimed at increasing iron consumption among farming households in Rwanda, with an assumption that the bean varieties will be grown and consumed by these households. However, a recent value-chain analysis (Murekezi and Birol 2012) shows that more than 50 percent of farming households in the country produce less beans than they consume—that is, they are net buyers of beans. Farming households sell beans to meet other household needs during the harvesting season, and later buy them back from the market during periods of scarcity. Small-scale traders and local assemblers acquire grains from farmers during harvest and sell them to urban wholesalers in Kigali, Rwanda's capital city. Once the harvesting period is over, farming households' demand for beans begins to rise. As a result, some of the traders repurchase beans from urban wholesalers, and then resell them to farmers in rural areas for home consumption.

This net-buyer scenario suggests that the urban wholesalers are an important lever for promoting iron bean (IB) consumption in rural areas of Rwanda, since farming households are likely to sell beans immediately after harvest and later depend on the urban wholesale market to resupply beans for home consumption. Meanwhile, the business interests of urban wholesalers would be strongly driven by the preferences of their customers, who include urban consumers. If urban consumers do not prefer the sensory attributes of IBs as much as those of the local varieties, the wholesalers are likely to be uninterested in trading with IBs. This means that the assumption that farming

[1] Less than 110 grams per liter of hemoglobin

households would produce and consume IBs may suffer a setback from the supply–demand imbalance, since farmers may also be less incentivized to produce IBs if the demand from the urban market is lacking. Thus, farming households may continue to produce conventional bean varieties for income and repurchase the same for consumption. The current bean value-chain system in Rwanda would be beneficial to the biofortification strategy if urban and rural consumers have similar preferences for IB varieties. This could mean that farmers would produce varieties that they like to consume and also that wholesalers prefer to sell to the urban consumers.

This tenet forms the basis of this paper to examine both rural and urban consumer preferences for biofortified IBs. The paper has three objectives. First, we investigate consumers' sensory evaluation of IB varieties vis-à-vis a market-popular local variety (*Mutiki*). Using a hedonic rating method adopted from food science literature, we assess consumer preferences for two IB varieties (RWR 2245: IB1 and MAC 44: IB2) that are adaptable to low- to mid-altitude areas in Rwanda, where most of the beans in the Kigali wholesale market of Nyabugogo are sourced. Second, we designed a field experiment using an incentive-compatible Becker-DeGroot-Marschak (BDM) mechanism to examine consumer willingness-to-pay (WTP) for IB varieties, and identify the magnitude of the premium or discount relative to the popular local variety. Third, we examine the role of various marketing levers on consumer WTP. We investigate the effects of the presence of a nutrition information campaign, the length of the information provided, and an endorsement by a popular public official on consumer WTP.

The role of nutrition information in promoting nutrient-dense foods has been well established in the emerging consumer acceptance literature on biofortification (Chowdhury et al. 2011; Meenakshi et al. 2012; Banerji et al. 2013; Oparinde et al. 2014; Birol et al. 2015). Even when nutrition campaigns are an important instrument for engendering demand, however, some policy-relevant questions remain unanswered. These questions centrally refer to how consumer demand may change if nutrition information is designed in different ways—for example, the length of information provided or the incorporation of a social campaign element, such as an endorsement by a celebrity or a popular public official for the purpose of marketing a product and building its brand. These areas are relevant to drawing lessons that can enhance the design of effective marketing strategies to maximize the adoption and consumption of IBs in Rwanda.

The effect of celebrity endorsement on consumer acceptance has been well tested in the marketing literature (Goldsmith, Barbara, and Stephen 2000; Dzisah and Ocloo 2013; Martey and Frempong 2014). However, the influence of public officials as an endorsement agent has not received significant attention in this literature, especially for nutritious food products. This paper aims to fill this gap using the case of biofortified IBs in Rwanda. Celebrity endorsement has the potential to provide a distinct product differentiation in a market where several brands already exist and new ones are emerging (Choi and Rifon 2007). Consumers may associate themselves with a product that an individual who enjoys public recognition certifies, but this will be effective only if the endorser is perceived by the consumers to have the right endorser–product match (McCracken 1989; Escalas and Bettman 2003).

In several developing countries, agricultural innovations are usually introduced to farmers through public institutions. Therefore, understanding the role that a public official's endorsement plays in consumer acceptance could provide insights for innovative crop branding. Public institutions, such as RAB, have played a significant role in developing and introducing biofortified IBs to farming households in Rwanda. Thus, it is crucial to test if a public official's endorsement would increase consumers' demand for IBs. Further, considering the cost of airing a radio message campaign, a short radio message may be cheaper to implement than a long one. However, a short message may also be less effective than a long message, because it may contain less vital information. Therefore, we also tested the effect of information length on consumer WTP.

These objectives were addressed by conducting the study in the rural areas of Karongi District in Rwanda's Western Province, and in the urban bean wholesale market in Kigali Province. The study was conducted in a home-use test (HUT) setting in the rural areas, where 578 participants tested the three bean varieties at home over the course of 7 days. Each participant was visited four times during this period to conduct hedonic rating of the sensory attributes of the bean varieties tested, while also eliciting participants' WTP for the varieties. In the urban area, the study was conducted in a central-location test (CLT) setting within the urban wholesale market in Kigali City, where 261 participants evaluated the sensory attributes of the varieties in the CLT.

The rest of this paper unfolds as follows. Section 2 describes the sampling technique, BDM mechanism, and experimental procedures applied; Section 3 discusses the data and econometric strategy; Section 4 presents, the results; and Section 5 draws the conclusions regarding the potential implications for IB demand-pull creation and product marketing.

2. METHODOLOGY

In the ex ante evaluation of consumer preferences for new food products, various valuation techniques (such as experimental auction and stated choice experiment) have been applied in the consumer acceptance literature (List 2003; Harrison, Harstad, and Ruström 2004; Lusk and Shogren 2007; Corrigan et al. 2009; De Groote, Kimenju, and Morawetz 2011). The BDM mechanism is an auction-like mechanism that has also been widely applied in developing countries—especially because it can easily be implemented on a one-on-one basis, unlike group auctions, which require assembling participants. In remote areas of Africa where transportation logistics can be a challenge, the BDM mechanism is advantageous, since it can be conducted independently with each participant at home or in a central location (Banerji et al. 2013). This advantage informed the choice of the BDM mechanism for this study.

While individual bidders compete against one another in many of the experimental auction techniques, such as the second-price auction, individuals compete against market price in the BDM mechanism. The BDM mechanism provides incentives for individuals to truthfully reveal their values and imposes a cost for untruthful (or inaccurate) value revelation. The BDM mechanism asks each participant to submit the highest price she or he is willing to pay for a fixed quantity of a good. Assume that individual *i* places the value v_i on a good and "wins" in the auction, the individual derives utility $U_i(v_i - p)$, where p is the price and U is an income-dependent utility function. If otherwise, the individual does not "win" in the auction, such that $U(0) = 0$. Price is a random variable when bids are submitted in the auction. Assume that individual *i*'s price expectation is defined by the cumulative distribution function $G_i(p)$ and the associated probability density function $g_i(p)$. The goal of a rational individual is to submit a bid y_i, that maximizes her or his expected utility:

$$E[U_i] = \int_{\underline{p_i}}^{y_i} U_i(v_i - p)dG_i(p) + \int_{y_i}^{\overline{p_i}} U_i(0) = \int_{\underline{p_i}}^{y_i} U_i(v_i - p)g_i(p)dp + \int_{y_i}^{\overline{p_i}} U_i(0) \ , \qquad (1)$$

Thus, the optimal bid is when $y^* - y = 0$.

The decision rule for "winning" in the BDM mechanism is based on a comparison of the bid with a random price (p) drawn from a distribution already established ex ante: the individual "wins" the good if the bid is greater than the random price, and pays price p. If $y < p$, the bidder does not "win"—that is, does not obtain the product or pay a price. Rational behavior under this mechanism is for bidders to place a bid equal to their WTP (Lusk and Shogren 2007).

2.1. Experimental and Sampling Design

2.1.1. Experimental groups

Five experimental groups (T1–T5) were used in conducting this study in the rural areas, while only two experimental groups (T1 and T2) were used in the urban areas for logistical reasons. In the rural areas, T1 is the control group, where participants were given no information about the nutritional benefits of IB varieties. Participants in the T2 group were given a brief (1-minute) radio message about the nutritional benefits of IBs, while participants in T4 were given a longer, more detailed (3-minute) radio message. The effect of endorsement was tested by including the Karongi District head's endorsement information in the message. Participants in T3 received the same short message as T2 participants, but with the endorsement information. Likewise, the T5 group received the same long message as the T4 participants, but with the endorsement information. The definition of treatment groups T1 and T2 is the same across rural and urban areas. The radio messages were in Kinyarwanda (the most popular local language in Rwanda), and were conveyed through MP3 players. (English texts of the messages used are available from the authors.)[2]

2.1.2. Power calculations and total sample size determination

The sample size required was determined by conducting a power calculation exercise based on binary comparisons across treatment groups. At the time of the study design, the market prices of bean grains in rural areas and Kigali markets ranged from 250 to 750 Rwandan francs (RWF) (1 US dollar ≈ 650 RWF). We assume an effect size of 6 percent based on evidence available in the literature on consumer acceptance of nutritious foods in Africa (for example, Birol et al. 2015), which observed an effect size of 6–25 percent of the mean market price, with a standard deviation (SD) of 11 percent. The 6 percent effect size and 11 percent SD correspond to 18 RWF and 33 RWF, respectively. We also assume a roughly double SD of 60 RWF as the maximum expected SD. We randomize into treatments at the individual level. With an effect size-to-SD ratio of 18:60, a significance level of 5 percent, and power of 0.8, the power calculation shows that we require 89 subjects per treatment to be able to detect the minimum detectable effect size. However, to ensure that the sample size is robust, we also used the effect size-to-SD ratio of 15:60 to conduct the power calculation, the result of which shows that we would require 128 subjects per treatment. As shown in Table 1, we apply the sample size when the minimum effect size is assumed to be 15 in most treatment groups. However, given the budget and logistical constraints, we use the sample size when the minimum effect size is assumed to be 18 as well.

[2] Because of space constraints, these messages are not included here, but can be obtained from the authors.

Table 1. Sample size required by experimental group

Rural Western Province (HUT)				
	T1: Control	T2: Treatment	T4: Treatment	Total
	No information	Short information	Long information	
	128	128	128	384
		T3: Treatment	T5: Treatment	
		Short information + endorsement	Long information + endorsement	
	NA	89	89	178
Urban wholesale market (CLT)				
	T1: Control	T2: Treatment		Total
	No information	Short information		
	128	128		256

Note: CLT = central-location test; HUT = home-use test; NA = not applicable.

The sampling methodology used to select farming households interviewed in the rural areas was a combination of purposive and multistage cluster sampling. In the case of the rural areas of Western Province, the study primarily aimed to target locations where the dissemination of IB varieties has not started, to allow for controlled experiment in testing the effect of information. Karongi district was selected in Western Province for two reasons. First, no dissemination of or marketing activities on IBs has taken place in the district. Second, in this district, a majority of farming households typically grows bush beans more than climbing beans. One of the IB varieties and the local variety being tested in this study are bush beans. Bean production data available from the Rwanda National Institute of Statistics show that bush beans accounted for about 75 percent of total bean production in Karongi district in 2012 (DHS 2010).

Karongi district has 13 sectors. As a selection strategy, we grouped these 13 sectors into four quartiles using 2008 population density figures. Seven of these sectors are high-altitude sectors, two are mid- to high-altitude sectors, while four are mid-altitude sectors. Bush beans are mainly grown in the midto low-altitude sectors. Since this study aimed to test mainly bush beans, the four mid-altitude sectors were selected. One of these four sectors falls in the second quartile (Murundi), two in the third quartile (Murambi and Mubuga), and one in the fourth quartile (Bwishyura). Given the logistical considerations, we randomly selected one-fifth of all villages in each sector and then listed all households within the selected villages. Finally, 562 households (in the rural area) were randomly selected from a household list proportionate to size. An additional 16 households were randomly selected for replacement in the event of non-response.

In the case of the urban areas, Nyabugogo market in Kigali Province was chosen to allow for comparison with results from the rural areas. This market was selected because mid- to low-altitude varieties, which are widely grown in Karongi District, are also widely sold in the wholesale bean market. Consumers from all segments of the market were randomly invited to a CLT venue located within the market. A CLT was used in the urban areas instead of an HUT because of the impracticality of, and logistical constraints with, tracking recruited consumers to their homes. Uninvited consumers were not interviewed to avoid a self-selection bias. Across the recruited participants, female and male consumers older than 18 years were invited to the CLT venue. In the rural areas, however, participants were the household members over 18 who are mainly responsible for deciding which bean variety to purchase or cook for home consumption. The study was implemented in both rural and urban areas between October and November 2013—or season A: October to January, which is the off-harvesting period.

Upon securing participants' consent to participate in the study, we randomly allocated them into treatment and control groups. However, this study is limited by the potential selection bias introduced because of the allocation of participants with prior knowledge of IBs into the treatment groups only (T2–T5). While this allocation was not necessary,[3] it was aimed at having a control group void of any information. However, we examine the effect of this potential selection bias in the regression analysis discussed later. Social and economic data on the participant and the participant's household were collected after the random allocation of participants.

2.2 Sensory Evaluation and WTP Elicitation Procedure

2.2.1 Sensory evaluation

[3] The experimental design and the decision to include those participants with prior knowledge in the treatment groups were informed by the need of the team marketing and promoting IBs in Rwanda. The team wanted to know if additional information given to those who had already heard about IBs would significantly increase their demand for the beans. However, we expected the selection effect to be negligible.

Following the sensory evaluation protocols in food science literature (for example, Tomlins et al. 2007), we asked each participant to evaluate the various attributes of raw and cooked bean grains from the three bean varieties. These attributes were selected through focus group discussions with farmers, consumers, and bean traders. Also, urban focus group participants developed a generalized protocol commonly used by consumers in urban areas to cook beans at home, which was followed in cooking beans at the CLT venue. The bean grains were hygienically cooked at the same kitchen by the same staff of the Kigali Institute of Science and Technology. Even though rural participants in the HUT cooked each of the three varieties using their own ways of cooking beans, we assumed that by using a generalized protocol of cooking beans at home established by urban focus group participants, the sensory evaluation would be comparable across the CLT and HUT settings.

Urban wholesale market

In the urban CLT, participants were presented with both cooked and raw grains of each of the three varieties. They evaluated raw bean color and size, and cooked bean size and taste without salt or staples. Prior to this, T2 participants listened to the short radio message. The participants' sensory evaluation of these attributes was captured by asking how much they liked the particular attributes of each bean variety 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).

Rural Western Province

In the rural areas, participants in the HUT cooked and tested grains of the three varieties at home. Each household received 1 kilogram (kg) of each of the three varieties during three visits within 7 days. The order in which the varieties were given is randomized across participants and across visits. Prior to receiving the first bean variety, rural participants in treatment groups T2–T5 listened to the radio message. On the first visit (day 1), all participants were given 1 kg of raw grains of the first variety and were told that they would be revisited on the third day. The 1-day interval is meant for the participants to cook and test the variety overnight with other household members. Enumerators reminded the respondents to consider various attributes of the beans as they test it at home. On the second visit (day 3) respondents evaluated the sensory characteristics of the first variety given. In addition to the sensory characteristics evaluated in the urban area, rural participants evaluated the cooking time after beans become well cooked and the overnight keeping quality. Similar to the urban participants, sensory evaluation of these attributes was also captured on the same 7-point Likert scale. Participants were given the second and third varieties, respectively, on day 3 and day 5. The sensory characteristics of these second and third varieties were also evaluated by participants on day 5 and day 7, respectively.

2.2.2. Economic valuation

Following the sensory evaluation of the three bean varieties, a BDM experiment was conducted where the economic valuation of these varieties was elicited in terms of participants' WTP for each variety. Participants were first asked to submit separate WTP values (bids) for 1 kg of each one of the three bean varieties they evaluated. After submitting bids, they were asked to draw the "binding" variety, by randomly picking a chip from an opaque bag containing three chips corresponding to each of the three varieties. For this binding variety, the participants were asked to draw a sale price by randomly selecting a price strip from a bag containing price strips with a uniform distribution around the prevailing market price of the local variety. For the urban participants, the price strips ranged from 200 to 1250 RWF; for the rural participants, it ranged from 250 to 1,000 RWF. The choice of the price strip range was informed by the range of market prices observed in each study area during the survey. If the participant's stated WTP for the binding variety exceeded the sale price that she or he had drawn, the consumer would "win" 1 kg 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.

Before participants were asked to state their WTP for 1 kg of each variety, they were taken through a practice round with biscuits to familiarize them with the instructions and steps in the BDM experiment. Enumerators explained to the participants that it was optimal to state a bid equal to their true WTP for each of the three bean varieties. In particular, they explained that stating a bid higher than their true WTP could result in participants having to buy at a price higher than what they were willing to pay, whereas stating a bid lower than their WTP could result in participants losing out on a profitable opportunity to buy. Enumerators emphasized the point that the optimal strategy was for participants to state their true WTP.

A special feature of this economic valuation experiment was that participants were not given any participation fee and all payments were effectively collected by enumerators. In the experimental auction literature, such participation fees are usually given to compensate respondents for their time and also to ensure they are not out of pocket when purchasing the good at auction. Since standard theory suggests that initial endowments could distort optimal bidding behavior (Corrigan and Rousu 2006; Oparinde et al. 2014), all participants in this study were informed before starting the survey that they would have the opportunity of purchasing 1 kg of grains of any of the three varieties at the end of the interview, and they would have to pay out of their own pockets. Their time was compensated for with non-monetary gifts at the end of the experiment.

Apart from the immediate out-of-pocket payment, rural participants were also given the option of purchasing on credit at a zero percent interest rate after the BDM experiment was completed, and once they declared their inability to pay out of pocket. All credits were effectively collected through mobile phone money transfers. In the rural areas, 49 percent of the participants declared inability to pay because of financial constraint, as did 20 percent of the participants in the urban area. We did not offer the urban participants the zero percent credit option because of the logistical difficulty in collecting the credit, unlike in the rural areas, where participants were instructed to pay the amount owed to the farmers' leader in their community, who then remitted the money to the study team via mobile phone money transfers. However, since all credits were effectively recovered in the rural areas, we opined that assuming the same credit option was offered to the urban participants, they could have paid as well. This is plausible, since the average market price of the local bean variety at the time of survey was 575 RWF, which is an insignificant share of the average monthly food expenditure (75200 RWF) of the participants' households. By not providing any participation fee and by emphasizing that the bids they state could result in their spending their own money to buy one of the three bean grain varieties, we assume that the bids submitted are a true reflection of participants' WTP.

However, interactions among participants could bias these experiments. Interactions could occur within the village or in meeting places, which could also result in information contamination. This can be minimized in the rural Western Province by using a cluster randomized design, where randomization is done at the village or cell level. However, randomizing at the village level would be limited by the same social interaction bias as randomizing at the household level. This strategy is also limited, since Rwanda is a relatively small country and villages are close to one another; thus, it is practically impossible to avoid social interactions among participants.

Considering this constraint, randomization was done at the household level, where control group interviews were conducted in the first week and treatment group interviews were randomized across four subsequent weeks as a strategy to avoid information contamination from the treatment group. Even though this strategy removes treatment to control information contamination, there is still a possibility for experience sharing from control to treatment groups. Control variables are included in the subsequent regression analysis to determine if this possibility has an impact on our estimations.

3. DATA AND ECONOMIC STRATEGY

3.1. Socioeconomic characteristics of participants

Urban and rural participants' social and economic characteristics by treatment groups are presented in Table 2. These key socioeconomic characteristics are selected based on the results of the preliminary focus group discussions held in both study locations, as well as a similar study on bean varietal adoption in Rwanda (Asare-Marfo et al. 2011). Most of urban (57 percent) and rural (72 percent) participants are males. About 55 percent of the urban participants and 73 percent of rural participants are responsible for deciding which variety of bean grains to buy for home consumption. For the urban participants, the majority (78 percent) of beans consumed at home during the 2013 B season (February-July) before the survey was sourced via market purchases, while rural participants sourced about 53 percent and 36 percent, respectively, from their own production and via market purchases. While about 16 percent of the rural participants were self-sufficient—that is, they sourced all beans consumed at home during this season from their own production—only 1 percent of the urban participants were self-sufficient.

A comparison of key socioeconomic characteristics across treatment groups in both rural and urban settings shows no significant difference for a majority of the characteristics. Thus, the data are comparable across treatments (Table 2). In the urban wholesale market, none of the key participant characteristics is significantly different when compared across T1 and T2. Also for the rural participants, most key consumer characteristics are similar across treatments. However, in the rural study areas, some significant differences appear across treatments for few variables. First, participants in T4 have significantly more years of education compared with participants in T1 (p-value<0.10). Although most of the participants were aware of anemia, more participants in T1 and T2 were aware of anemia than in T4. Also, about 24 percent of the rural participants had beans at home at the time of the survey, and those in T1 and T5 had significantly larger quantities at home than their counterparts (p-value<0.10). This demonstrates that ex ante product endowments could have an effect on their WTP. However, on average, urban participants generally have more beans at home (8 kg) than their rural counterparts (3 kg).

Since farmers are also simultaneously considered as consumers in the rural areas, these participants may have perceptions about the agronomic qualities of the beans tested. Owing to survey time constraints, these data were not collected. However, the information collected on did reveal that only 4 percent of the participants' households cultivated an improved variety in season B.

Although participants with prior knowledge of IBs were allocated to the treatment group, the percentage of these participants with such knowledge is not large, as expected (8 percent in rural and 5 percent in urban areas). We compared the socioeconomic characteristics of these participants with those of participants without prior knowledge, as shown in Table 3, using a t-test that also accounted for the unequal sample size. In the urban area, none of the socioeconomic characteristics is significantly different. However, in the rural areas, the t-test shows a systematic difference, where participants with prior knowledge significantly have more years of education and source more of the beans consumed at home from their own production than those who have no prior knowledge of IBs.

We examine this further by estimating a probit model of prior knowledge of IBs, where all variables listed in Table 3 are the explanatory variables. The probit model for the rural areas suggests that only education significantly contributes to the probability of having prior knowledge of IBs (beta = 0.05, p = 0.053). This suggests a potential interaction between a priori knowledge and education with a potential effect on WTP.

Table 2. Social and economic characteristics, by study location and treatment group

Variable	Definition	T1 – No information	T2 – Short information	T3 – Short information & endorsement	T4 – Long information	T5 – Long information & endorsement	T1 – No information	T2 – Short information
		Rural Western Province					Urban wholesale market	
		N=128	N=134	N=89	N=130	N=97	N=131	N=130
Participant								
Male	1 if participant's gender is male	69%	74%	75%	72%	70%	55%	58%
Aware of anemia [A*]	1 if participant is aware of anemia	73%	71%	75%	59%	68%	84%	84%
Aware of iron beans [A*, B*]	1 if participant has heard of iron bean varieties before survey	0%	13%	9%	7%	11%	0%	10%
Variety decisionmaker	1 if participant is the main decisionmaker on bean variety for home consumption	71%	77%	78%	71%	71%	57%	49%
Listen to radio	1 if participant listens to radio	80%	81%	80%	72%	75%	94%	96%
Age	Participant age in years	45.5 (15.6)	43.4 (15.3)	41.4 (14.0)	43.0 (15.0)	45.5 (16.0)	33.4 (9.0)	32.9 (10.7)
Education [A*]	Participant education in years	3.4 (3.0)	3.9 (3.4)	3.2 (2.9)	4.1 (3.1)	4.1 (3.8)	9.1 (4.4)	9.5 (4.3)
Participant's household								
Household size	Household size	4.8 (2.2)	4.7 (1.9)	4.6 (1.7)	4.8 (1.9)	4.9 (2.2)	5.0 (2.2)	5.1 (2.4)
Plant beans in season B	1 if participant's household planted beans in 2013 season B	86%	91%	90%	82%	84%	-	-
Plant beans in season A	1 if participant's household planted beans in 2014 season A	91%	96%	97%	94%	96%	-	-
Bean area in season B (ha)	Area of land in hectares planted with beans by the participant's household in 2013 season B	0.3 (0.4)	0.2 (0.2)	0.2 (0.3)	0.2 (0.2)	0.3 (0.4)	-	-
Bean area in season A (ha)	Area of land in hectares planted with beans by the participant's household in 2014 season A	0.2 (0.4)	0.2 (0.2)	0.2 (0.3)	0.2 (0.3)	0.2 (0.3)	-	-
Beans status & consumption at home								
Household has beans at home [A*]	1 if participant's household had beans at home at time of survey	34%	19%	18%	19%	27%	55%	61%
Bean consumption frequency (last 24 hours)	No. of times the household consumed beans in the last 24 hours	1.8 (0.5)	1.7 (0.5)	1.8 (0.4)	1.8 (0.4)	1.8 (0.4)	1.1 (0.5)	1.2 (0.4)
Total quantity of beans at home (kg) [A*]	Quantity (kg) of beans participant had at home	5.0 (15.6)	2.0 (7.5)	1.3 (4.4)	1.7 (5.2)	4.1 (14.0)	7.7 (17.5)	8.1 (16.4)
% beans from own production	Percentage of total quantity of beans consumed by the household in 2013 season B that was sourced from own production	57.1 (31.9)	54.1 (31.6)	53.7 (33.8)	50.9 (35.5)	49.2 (35.1)	19.3 (26.1)	18.5 (26.9)
% beans from market purchase	Percentage of total quantity of beans consumed by the household in 2013 season B that was purchased at market	33.5 (27.4)	37.2 (28.2)	36.8 (30.0)	34.1 (29.9)	36.7 (30.3)	75.5 (28.4)	76.8 (29.5)
% of self-sufficient households	Percentage of households that sourced 100% of beans consumed in 2013 season B from own production	17%	15%	15%	18%	16%	0%	2%

Note: *One-sided t-tests and Pearson chi-square tests reveal statistically significant differences in participant/household characteristics across treatment arms; () = standard deviation; A* = rural; B* = urban.

Table 3. Socioeconomic characteristics by prior knowledge of iron beans

Variable	No prior knowledge (control)	No prior knowledge (treatment)	Prior knowledge (treatment)	F-test	Welch-Satterthwaite t-test with unequal variances
Rural Western Province	(1) N=127	(2) N=408	(3) N=37	F statistic	Significance
Aware of anemia	73%	66%	80%	2.48	
Male	69%	72%	83%	1.63	
Age	45.5 (15.6)	43.3 (15.2)	43.7 (15.0)	1.02	
Education (years)	3.4 (3.0)	3.7 (3.3)	5.0 (3.6)	4.12**	(1 vs. 3)***;(2 vs. 3)**
Household size	4.8 (2.2)	4.7 (1.9)	5.1 (2.1)	0.86	
Bean area in season B (ha)	0.3 (0.4)	0.2 (0.2)	0.3 (0.5)	2.64*	
Grow improved beans	9%	2%	4%	5.90	
% beans from own production	57.1 (31.9)	51.0 (33.9)	61.6 (33.2)	3.26**	(2 vs. 3)**; (1 vs. 2)*
Don't buy beans	6%	3%	7%	2.16	
Bean consumption frequency (last 24 hours)	1.8 (0.5)	1.8 (0.4)	1.8 (0.4)	0.21	
Per capita quantity of beans at home (kg)	1.1 (3.2)	0.4 (1.4)	1.0 (2.6)	6.18***	(1 vs. 2)**
Wealth index[a]	0.2 (0.1)	0.2 (0.1)	0.2 (0.2)	3.73**	(2 vs. 3)**

Note: *Significant at 10% level, **significant at 5% level, ***significant at 1% level. [a] The wealth index was computed using a principal component analysis to weight the number of relevant assets owned by participants' households. The wealth index includes the estimated value of a household's land, house, motorcycle, television, cell phone, radio, and goats, among others. This index was standardized to range between 0 and 1.

3.2. Sensory Evaluation Data

Table 4 presents the mean hedonic score for the sensory attributes of the three bean varieties tested (local: *Mutiki*, IB1, and IB2) by location and treatment groups. Most participants in each treatment scored all products 4 or above (that is, 4. "Neither like nor dislike," 5. "Like slightly," 6. "Like moderately," or 7. "Like very much"). Interestingly, in the absence of information, both rural and urban participants in the control group (T1) have similar preferences for the IB2 variety. Except for the taste and cooking time, participants in both rural and urban study areas liked all the sensory attributes of the IB2 variety significantly much more than those of both the local and the IB1 varieties. Meanwhile, rural T1 participants liked the cooking time for the local and IB1 varieties significantly more than for the IB2 variety.

The local variety has an appearance similar to the IB1 variety in terms of raw bean color. This raises concern that both varieties can easily be mixed up along the value chain. The data show that rural and urban T1 participants did not score the local variety significantly differently from IB1 in terms of raw bean color. The data also show that raw bean size and cooked bean size are the sensory attributes that may distinguish the two varieties. T1 participants in the urban areas scored these attributes very differently for the local and IB1 varieties; similarly, the scores of T1 participants in the rural area regarding cooked bean size were significantly different.

The provision of nutrition information does not seem to have an influence on participants' rating of bean sensory attributes, as the ratings by urban T2 participants are consistent with those of their counterparts in T1, except for taste for the IB1 variety, which is significantly rated higher than that for the local variety. Generally, across all treatment groups with information (T2–T5), rural participants' liking for the sensory attributes of the IB1 variety relative to those of the local variety is not significantly different. This may reflect the inherent similarity in the appearance of the two varieties. Consistently across both rural and urban areas, the data show that with or without information, IB2 is the variety most preferred by all participants. However, the cooking time of the local variety is liked the most, followed by that of the IB1 variety, and last the IB2 variety. This reveals similar sensory preferences between urban wholesale market consumers in Kigali City and rural consumers in Western Province.

Table 4. Mean hedonic rating of bean grain varieties and comparison within treatment

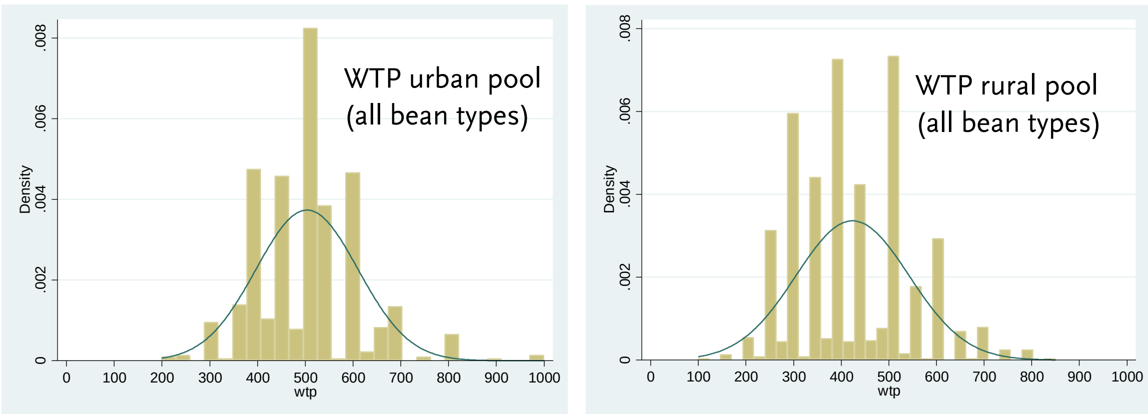
	Bean variety	Raw bean color	Raw bean size	Cooked bean size	Taste+	Cooking time	Overnight keeping quality	Overall	Raw bean color	Raw bean size	Cooked bean size	Taste+	Overall
		Rural Western Province (HUT)							Urban wholesale market (CLT)				
Control (T1): No information (n = 128, 131)	Local	5.93	5.58	5.75	5.47	5.95	5.85	5.73	5.75	5.57	5.94	5.85	5.80
	IB1	6.05	5.48	6.05	5.57	5.70	5.92	6.01	5.63	4.39	5.42	6.03	5.78
	IB2	6.27	6.27	6.58	6.10	5.21	6.16	6.37	6.05	6.52	6.86	5.98	6.36
	Difference in means												
	Local vs. IB1	-0.12	0.11	-0.30**	-0.09	0.26	-0.07	-0.27*	0.12	1.18***	0.52***	-0.18	0.03
	Local vs. IB2	-0.34***	-0.69***	-0.83***	-0.62***	0.74***	-0.32**	-0.63***	-0.31**	-0.95***	-0.92***	-0.13	-0.56***
	IB1 vs. IB2	-0.23*	-0.80***	-0.52***	-0.53***	0.48**	-0.25	-0.36**	-0.43***	-2.14***	-1.44***	0.05	-0.58***
T2: Short information (n = 132, 130)	Local	6.13	5.90	6.07	5.76	5.97	6.20	5.86	5.54	5.37	5.94	5.71	5.70
	IB1	6.04	5.80	6.06	5.74	6.07	6.22	5.95	5.47	4.38	5.46	6.12	5.84
	IB2	6.60	6.63	6.78	6.32	5.84	6.56	6.62	5.90	6.52	6.77	5.90	6.23
	Difference in means												
	Local vs. IB1	0.08	0.09	0.01	0.02	-0.10	-0.02	-0.09	0.07	0.99***	0.48***	-0.41***	-0.15
	Local vs. IB2	-0.48***	-0.74***	-0.72***	-0.56***	0.13	-0.36***	-0.76***	-0.36**	-1.15***	-0.83***	-0.19	-0.53***
	IB1 vs. IB2	-0.56***	-0.83***	-0.72***	-0.58***	0.23	-0.34***	-0.67***	-0.43**	-2.14***	-1.31***	0.22	-0.38***
T3: Short information + endorsement (n = 89)	Local	6.07	5.94	5.97	5.63	6.11	6.10	5.90					
	IB1	6.19	5.77	5.98	5.72	6.25	6.27	6.02					
	IB2	6.49	6.63	6.87	6.30	5.89	6.65	6.69					
	Difference in means												
	Local vs. IB1	-0.12	0.17	-0.01	-0.08	-0.13	-0.17	-0.12					
	Local vs. IB2	-0.43***	-0.69***	-0.90***	-0.67***	0.22	-0.55***	-0.79***					
	IB1 vs. IB2	-0.30*	-0.86***	-0.89***	-0.58***	0.36**	-0.38***	-0.66***					
T4: Long information (n = 131)	Local	6.19	5.93	6.10	5.88	5.97	6.19	6.00					
	IB1	6.02	5.70	6.03	5.81	5.92	6.11	5.85					
	IB2	6.56	6.55	6.78	6.33	5.69	6.63	6.65					
	Difference in means												
	Local vs. IB1	0.17	0.23**	0.07	0.07	0.05	0.08	0.15					
	Local vs. IB2	-0.37***	-0.62***	-0.68***	-0.45***	0.28*	-0.44***	-0.65***					
	IB1 vs. IB2	-0.54***	-0.85***	-0.75***	-0.52***	0.22	-0.52***	-0.80***					
T5: Long information + endorsement (n = 98)	Local	6.24	5.95	6.16	6.03	6.09	6.33	6.18					
	IB1	6.09	5.84	5.99	5.86	6.01	6.11	6.00					
	IB2	6.58	6.53	6.68	6.49	5.82	6.61	6.67					
	Difference in means												
	Local vs. IB1	0.14	0.11	0.17	0.17	0.08	0.23*	0.18					
	Local vs. IB2	-0.34***	-0.58***	-0.52***	-0.46***	0.27	-0.28***	-0.49***					
	IB1 vs. IB2	-0.48***	-0.70***	-0.69***	-0.63***	0.19	-0.50***	-0.67***					

Notes: *** Significant at 1%, ** Significant at 5%, *Significant at 10% (one-sided t-test). +After beans are well cooked without salt or ingredients. Standard deviation and comparison across treatments are unreported due to space constraints. The proportions are also available from the authors. CLT = central-location test; HUT = home-use test.

3.3. WTP Data and Empirical Model

Bean grain prices were collected daily throughout the survey period—randomly from sales points in the markets nearest to the study villages and in the urban wholesale market. In the rural areas, the observed market price for the local variety per kg ranged from 200 to 700 RWF and averaged 521 RWF, while in the urban area, the price ranged from 480 to 1200 RWF and averaged 575 RWF. Frequency distributions of WTP data presented in Figure 1 show that participants' bids are widespread, ranging from 200 to 1000 RWF for urban participants and ranging from 100 to 850 RWF for rural participants. Bids submitted for the local variety are also within a similar wide range, but some participants' bids are outside the observed market price range (that is, bids for the local variety range from 250 to 1,200 RWF for urban participants, and from 100 to 800 RWF for rural participants). This is surprising, since it would be expected that consumers should at least bid the price at which they can buy the local variety in the market.

Figure 1. Frequency distribution of WTP for 1 kg of beans (in RWF)



In the rural areas, 3 participants (0.5 percent) submitted bids lower than 200 RWF, while 8 participants (1.4 percent) submitted bids higher than 700 RWF. This finding is more significant in the urban area, where about 49 percent submitted lower than below 480 RWF. As a result of this finding, our estimations focus on the difference in WTP. Even though these urban participants' bids could be assumed to be lower, censored at the minimum observable market price, this study is particularly interested in understanding how much premium (*P*) consumers are willing to pay for IB1 and IB2 varieties compared with the local variety. Therefore, we computed premium as the difference between WTP for each IB variety and WTP for the local variety, as shown in Table 5.

This premium is assumed to be influenced by those participants' social and economic characteristics; *Z*, previously discussed; and other factors, including the product characteristics.

Thus, we assume that participant *i*'s premium (*P*) for a particular product, *j*, is determined by his or her sensory liking (*L*) for the product, and whether the participant receives treatment, T_i, such that:

$$P_i = \alpha + \beta' T_i + \theta' L_i + \gamma' Z_i + e_i \, , \qquad (2)$$

where e_i represents the normally distributed error term and $\beta, \theta,$ and γ are parameters of interest.

A random effect estimation would be have been appropriate to account for the individual-specific effects across the three products. However, since we model the premium, the difference in bids eliminates the need to control for the individual-specific effect. Thus, an ordinary least squares (OLS) regression is appropriate to estimate the treatment effect on participants' premium for IBs. Equation 2 was estimated for each IB variety. The robustness of the identification strategy was investigated using further analysis where measurement issues previously discussed are examined. The density functions of the premium for IB1 and IB2 are not skewed (in both the urban and the rural cases); thus, no data transformation was necessary.

4. RESULTS

4.1. Urban and Rural Participants' WTP for Iron Beans

Table 5 reports average WTP for each bean variety as well as the results of t-tests within each treatment group. Mean bids observed are within the market price range (200 to 1200 RWF/kg). Based on the pooled sample, rural participants' WTP is about 407 RWF/kg for the local variety, about 409 RWF/kg for the IB1 variety, and about 456 RWF/kg for the IB2 variety. Within each treatment group, rural participants are willing to pay the most for the IB2 variety, whereas their WTP bids for the local and IB1 varieties are similar. Similarly, using the pooled sample, urban participants on average are also willing to pay the highest for the IB2 variety (534 RWF/kg), followed by the IB1 variety (494 RWF/kg), and then the local variety (477 RWF/kg). This finding reflects participants' hedonic rating for the sensory attributes of the three varieties where, for example, they liked almost all the sensory attributes of the IB2 variety the most (Table 4).

In the absence of nutrition information, the difference in mean WTP between the local and IB1 varieties is not statistically significant for both rural and urban participants. However, even in the absence of information, there is a significant premium for the IB2 variety relative to the local variety, where the rural participants were willing to pay about 8 percent more and the urban participants were willing to pay about 10 percent more.

In the presence of information, rural participants in treatment groups T2–T5 were willing to pay about 9–13 percent more for the IB2 variety compared with either the local or the IB1 variety. These bids are higher than the premium (8 percent) submitted by those rural participants in the control group without nutrition information, which suggests that information may have a positive effect on rural participants' premium for the IB2 variety. Likewise, urban T2 participants who received the same nutrition information as the rural T2 participants were willing to pay the same premium (13 percent) as their rural counterparts for the IB2 variety relative to the local one. Unfortunately, the provision of nutrition information does not seem to increase rural T2 participants' WTP for the IB1 variety, since the difference in mean WTP between local and IB1 varieties is not statistically significant for treatment groups T2–T5, while it is statistically significant for the urban T2 participants, who are willing to pay about 6 percent more for the IB1 variety than for the local variety. This finding also suggests that with or without information, urban and rural participants have similar preferences for the IB2 variety.

Compared with other treatment groups, rural and urban T1 participants submitted the highest bids for each of the three varieties. This could be the result of the social interaction bias within the village or market. It is possible to assume that some participants who won (and were asked to make out-of-pocket payment) in the control and treatment groups could have interacted with other treatment group participants by informing them that if they win, they have to pay, which may have influenced the informed participants to lower their bids in the BDM experiment. In the rural areas, data were collected on whether participants had a conversation about the study with anyone within their social network (within or outside their villages). We assumed that the responses obtained are a true proxy for interactions among participants.

About 60 percent (346) of participants reported to have had a conversation about the study (20 percent of these participants are in the control group and 80 percent are in the treatment groups). Each rural participant spoke about the study with three people on average. Of this 60 percent, 42 percent won in the BDM experiment. As a strategy to identify whether there is a potential for a social interaction effect on WTP, the bid difference of rural participants "with interaction" was compared with the bid difference of rural participants "without interaction." Unfortunately, only data on association memberships were collected for the urban participants; thus, we assume that urban participants who are members of a market association are more likely to interact with others about the study.

The results of the t-tests conducted (for the rural areas) show that there is no statistical difference between those who interacted and those who did not interact with others about the study in terms of their premium for IBs. In the urban area, there are only a few comparison cases where there is a statistical difference in premium for IBs when compared with those who are members of a market association and those who are not. Thus, the fact that control group participants stated higher WTP for all varieties is less likely the result of a social interaction effect. Nevertheless, a dummy variable was included to control for social interactions or association memberships in the regression analysis discussed later.

Further, probit models[4] were estimated, where whether a participant interacted with others (for the rural areas) or belonged to a market association (for the urban area) is the dependent variable, while participant characteristics are explanatory variables. The probit regression for the urban area shows that planning to buy beans on the day of the interview (beta: 0.44, p: 0.023) is positively correlated with association membership. In the case of the rural areas, age (beta: –0.12, p: 0.003) and wealth

[4]Not reported because of space constraints.

index (beta: 0.92, p: 0.039) are significant, which show that wealthier and younger participants are more likely to have interacted with others during the survey. Thus, their interaction terms could have an effect on the WTP premium. Again, it can also be expected that the further the survey progressed, the greater the potential for rural participants to interact with one another. Therefore, cross terms between the later weeks' dummy variables (week 4 and week 5) and the social interaction variable were included in the regression analysis.

Table 5: Consumer willingness-to-pay for 1 kg of iron beans by study location

Information and endorsement	Average	Mean WTP (std dev)		Mean diff in WTP (std dev): WTP for traits (RWF/kg)						
		(1) Local	(2) IB1	(3) IB2	(4) IB1–Local	(5) %	(6) IB2–Local	(7) %	(8) IB2–IB1	(9) %
Rural Western Province										
T1: No information	Group average (N=128)	444.5	444.6	480.8	0.1	0.02	36.3**	7.5	36.2***	7.5
		(121.0)	(122.7)	(124.4)	(98.7)		(100.1)		(93.9)	
T2: Short information	Group average (N=134)	401.9	408.7	460.6	6.8	1.7	58.6***	12.7	51.9***	11.3
		(121.1)	(119.8)	(117.8)	(97.9)		(96.1)		(97.9)	
T3: Short information + endorsement	Group average (N=89)	379.8	389.8	436.2	10.0	2.6	56.4***	12.9	46.4***	10.6
		(106.6)	(115.6)	(115.2)	(96.6)		(94.4)		(100.0)	
T4: Long information	Group average (N=130)	393.7	385.6	444.0	-8.1	-2.1	50.3***	11.3	58.4***	13.1
		(116.3)	(102.4)	(113.7)	(104.2)		(85.5)		(93.3)	
T5: Long information + endorsement	Group average (N=97)	408.1	409.1	448.7	1.0	0.2	40.5***	9.0	39.5***	8.8
		(109.5)	(103.2)	(107.1)	(82.1)		(91.1)		(98.9)	
Overall	Full sample (N=578)	407.1	408.6	455.6	1.5	0.4	48.4***	10.6	47.0***	10.3
		(117.6)	(115.1)	(116.9)	(96.7)		(93.7)		(96.5)	
Urban wholesale market										
T1: No information	Group average (N=131)	494.4	496.7	547.9	2.3	0.5	53.4***	9.8	51.1***	9.3
		(104.0)	(102.2)	(125.6)	(88.5)		(116.7)		(105.9)	
T2: Short information	Group average (N=130)	461.3	491.9	529.2	30.6***	6.2	67.8***	12.8	37.2***	7.0
		(70.5)	(96.6)	(113.6)	(79.7)		(104.9)		(112.3)	
Overall	Full sample (N=261)	477.9	494.3	538.5	16.4***	3.3	60.6***	11.3	44.2***	8.2
		(90.3)	(99.3)	(119.9)	(85.2)		(111.0)		(109.1)	

Note: ***1% significance level, **5% significance level, *10% significance level (one-sided t-test); () = standard deviation. T_y & T_x are the corresponding comparison groups.

Table 6. Parameter estimates from OLS models for the IB1 variety

***Dependent variable**: Difference in WTP for the IB1 variety relative to the local variety*

Variable	Rural Western Province			Urban wholesale market			All study areas
	Basic model	Full model	Full model *with social interaction variables*	Basic model	Full model	Full model *with social interaction variables*	Pooled sample
	1	2	3	4	5	6	7
Information							15.44**
							(6.63)
T2 – Short Information	6.71	10.77	12.57	28.33***	25.57***	25.70***	–
	(12.15)	(10.78)	(11.22)	(10.42)	(9.67)	(9.67)	
T3 – Short Information + endorsement	9.94	14.93	17.65	–	–	–	–
	(13.44)	(12.05)	(12.30)				
T4 – Long information	-8.12	8.54	10.80	–	–	–	–
	(12.64)	(11.05)	(11.22)				
T5 – Long information + endorsement	0.92	13.41	16.22	–	–	–	–
	(12.06)	(11.05)	(11.55)				
Per capita quantity of beans at home (kg)	–	0.02	0.08	–	0.74	0.71	0.75
		(2.56)	(2.63)		(1.68)	(1.66)	(1.42)
Participant's household is self-sufficient (Yes = 1, No = 0)	–	4.70	4.05	–	–	–	–
		(11.38)	(11.51)				
Participant planned to buy beans on the day of BDM experiment (Yes = 1, No = 0)	–	-11.90	-11.57	–	-9.61	-6.74	-11.84*
		(8.26)	(8.28)		(10.03)	(14.38)	(6.23)
Aware of anemia	–	7.93	8.50	–	17.45	18.84	10.88
		(7.79)	(7.87)		(12.96)	(13.06)	(6.71)
Male	–	-9.95	-9.80	–	0.80	1.44	-5.41
		(8.29)	(8.33)		(9.44)	(9.48)	(6.19)
Age	–	0.45*	0.41	–	0.20	0.31	0.49**
		(0.25)	(0.25)		(0.47)	(0.47)	(0.21)
Education	–	1.03	0.96	–	2.45**	2.34**	1.64*
		(1.27)	(1.27)		(1.09)	(1.11)	(0.87)
Sensory liking relative to local (difference between sensory liking for IB1 and local) variety	–	39.04***	39.14***	–	26.90***	26.27***	35.29***
		(2.81)	(2.80)		(3.43)	(3.48)	(2.19)
Grow improved variety (Yes = 1, No = 0)	–	1.24	-0.44	–	–	–	–
		(14.97)	(15.31)				
Prior knowledge of iron beans (Yes = 1, No = 0)	–	21.16*	21.46*	–	-20.45*	-16.24	11.79
		(11.31)	(11.43)		(12.21)	(12.23)	(9.47)
Wealth index		-8.51	-5.07	–	73.75	79.71	-0.30
		(26.55)	(26.68)		(51.04)	(48.46)	(24.57)
Socially interacted with other participants (Yes = 1, No = 0)	–	–	-6.80	–	–	–	–
			(8.12)				
Week 4, times socially interacted with others	–	–	-9.00	–	–	–	–
			(10.23)				
Week 5, times socially interacted with others	–	–	0.86	–	–	–	–
			(15.95)				
Association membership (Yes = 1, No = 0)	–	–	–	–	–	-21.01*	–
						(11.18)	
Association, times planned to buy beans	–	–	–	–	–	1.55	–
						(21.03)	
Participant had a meal before interview	–	–	–	–	–	0.01	–
Rural (Yes = 1, No = 0)						(10.53)	
Urban (Yes = 1, No = 0)	–	–	–	–	–	–	11.61
							(9.09)
Constant	0.06	-29.46	-24.49	2.29	-44.39*	-41.51	-41.98***
	(8.73)	(18.03)	(17.92)	(7.73)	(25.30)	(25.27)	(14.73)
No. of observations	578	576	576	261	261	261	837
F-statistic	0.55	13.88	11.78	7.39	8.61	7.15	24.96

Prob > F	0.70	0.00	0.00	0.01	0.00	0.00	0.00
R-square	0.004	0.31	0.31	0.03	0.27	0.28	0.29
Root mean square error	96.88	81.59	81.64	84.22	74.19	73.96	79.49

Notes: ***1% significance level, **5% significance level, *10% significance level; () = robust standard error.

Table 7. Parameter estimates from OLS models for the IB2 variety

Dependent variable*: Difference in WTP for the IB2 variety relative to the local variety*

Variable	Rural Western Province			Urban wholesale market			All study areas
	Basic model	Full model	Full model *with social interaction variables*	Basic model	Full model	Full model *with social interaction variables*	Pooled sample
	1	2	3	4	5	6	7
Information							14.22**
							(7.32)
T2 – Short information	22.39*	18.65*	22.15*	14.41	11.14	10.82	–
	(12.14)	(10.89)	(11.26)	(13.73)	(12.43)	(12.50)	
T3 – Short information + endorsement	20.15	15.37	19.23	–	–	–	–
	(13.35)	(11.86)	(12.00)				
T4 – Long information	14.07	16.29	20.90*	–	–	–	–
	(11.60)	(10.41)	(10.76)				
T5 – Long information + endorsement	4.258	10.11	15.41	–	–	–	–
	(12.79)	(11.28)	(11.48)				
Per capita quantity of beans at home (kg)	–	-0.45	-0.33	–	-1.88	-1.86	-0.42
		(1.70)	(1.73)		(1.39)	(1.45)	(1.10)
Participant's household is self-sufficient (Yes = 1, No = 0)	–	19.69**	18.36*	–	–	–	–
		(10.00)	(10.06)				
Participant planned to buy beans on the day of BDM experiment (Yes = 1, No = 0)	–	-17.09**	-16.41**	–	-8.46	-3.29	-16.48**
		(8.22)	(8.26)		(11.94)	(16.49)	(6.65)
Aware of anemia	–	7.68	8.27	–	32.12*	32.53*	14.12**
		(7.22)	(7.21)		(17.11)	(17.29)	(6.78)
Male	–	-9.84	-9.84	–	15.00	15.57	-0.12
		(8.07)	(8.08)		(11.95)	(11.97)	(6.65)
Age	–	0.09	0.05	–	1.33**	1.37**	0.44*
		(0.27)	(0.27)		(0.58)	(0.58)	(0.24)
Education	–	0.17	0.11	–	3.24**	3.42**	1.88**
		(1.09)	(1.08)		(1.47)	(1.55)	(0.90)
Sensory liking relative to local (difference between sensory liking for IB2 and local)	–	40.28***	40.30***	–	34.91***	34.91***	38.82***
		(3.14)	(3.16)		(4.87)	(4.87)	(2.69)
Grow improved variety (Yes = 1, No = 0)	–	17.24	16.78	–	–	–	–
		(13.30)	(13.64)				
Prior knowledge of iron beans (Yes = 1, No = 0)	–	-10.20	-11.02	–	32.24	34.44	-2.59
		(10.68)	(10.83)		(22.51)	(22.81)	(9.91)
Wealth index		-2.44	0.72	–	-59.47	-59.13	-17.40
		(28.85)	(29.11)		(75.00)	(75.56)	(26.10)
Socially interacted with other participants (Yes = 1, No = 0)	–	–	0.46	–	–	–	–
			(7.63)				
Week 4, times socially interacted with others	–	–	-16.40	–	–	–	–
			(10.48)				
Week 5, times socially interacted with others	–	–	-10.07	–	–	–	–
			(13.46)				
Association membership (Yes = 1, No = 0)	–	–	–	–	–	-6.59	–
						(14.70)	
Association, times planned to buy beans	–	–	–	–	–	-6.27	–
						(23.96)	
Participant had a meal before interview	–	–	–	–	–	-6.28	–
Rural (Yes = 1, No = 0)						(13.93)	

Urban (Yes = 1, No = 0)	–	–	–	–	–	–	11.06 (10.44)
Constant	36.26*** (8.85)	8.30 (18.54)	8.95 (19.25)	53.44*** (10.20)	-67.51** (31.66)	-64.62** (31.59)	-17.22 (16.21)
No. of observations	578	576	576	261	261	261	837
F-statistic	1.21	13.59	11.39	1.1	8.44	7.15	21.38
Prob > F	0.31	0.00	0.00	0.29	0.00	0.00	0.00
R-square	0.01	0.32	0.33	0.00	0.27	0.28	0.29
Root mean square error	93.63	78.28	78.27	110.97	96.60	73.96	84.76

Notes: ***1% significance level, **5% significance level, *10% significance level; () = robust standard error.

Table 8. F-tests comparing coefficients in model 3 (rural areas only)

Comparison	Definition	P-value	
		IB1	IB2
T2 vs. T4	Effect of information length (both with no endorsement)	0.8599	0.8003
T3 vs. T5	Effect of information length (both with endorsement)	0.9006	0.6393
T2 vs. T3	Effect of endorsement (both short information)	0.6517	0.7595
T4 vs. T5	Effect of endorsement (both long information)	0.5945	0.5294

4.2. Impacts of Nutrition Information, Length of the Information, and the District Head's Endorsement

The study hypothesizes that the presence of nutrition information, length of the information, and a district head's endorsement will positively and significantly influence participants' WTP premium for IBs. Tables 6 and 7 present results from the OLS models estimated for the IB1 and IB2 varieties, respectively. To clearly identify the treatment effect via comparison across treatments, equation (2) was expanded in a stepwise manner by first including only dummy variables controlling for the treatment in basic models 1 and 4. Socioeconomic variables hypothesized to influence participants' premium are further included in full models 2 and 5, while proxy variables for social interactions are included in models 3 and 6. Socioeconomic variables and cross terms are only included in cases where these variables are not strongly correlated, to avoid potential multicollinearity issues. As a result, cross terms between prior knowledge, age, and wealth index variables are not included because of collinearity. Robust standard error[5] is reported for all models. Also, the models are compared using R^2 as a measure of goodness of fit.

As shown in Tables 7 and 8, the R^2 values suggest that the inclusion of socioeconomic variables significantly improved the robustness of the regression models. However, there is no marked difference when the R^2 values of the full model and the full model with social interaction variables are compared. Also, there is no marked difference in coefficients across the two models. Therefore, we select the full model with social interaction variables for discussion, and present other models for comparison only. Contrary to the expectation that participants' premium for the IB varieties would be driven by social interactions during the survey, the coefficients on the social interaction variable and its cross terms with week 4 or week 5 are not significant for both IB varieties in the rural areas. However, in the case of the urban area (Table 6, model 6) this coefficient is significant, where the result suggests that participants who are members of a market association are willing to pay a significantly lower premium for the IB1 variety. Again, a priori knowledge of IBs positively influenced the premium for the IB1 variety in the rural areas only.

The magnitude of the effect of information on participants' premium for IB1 in the urban area is similar to that for IB2 in the rural areas. For rural participants, the effect of information on the premium is not

[5] The Breusch-Pagan/Cook-Weisberg test for heteroskedasticity is significant.

significant for the IB1 variety; in contrast, it is positive and significant for the IB2 variety, where the short information has a premium of about 22 RWF and long information has a similar premium of about 21 RWF (equivalent to about 5 percent of the average WTP for IB2 without information—461 RWF or 5 percent of the average market price (521 RWF) of beans in the rural area. In the urban area, however, the effect of the short information on the IB2 variety is not significant, but is significant on the IB1 variety. The short information increases urban participants' premium for the IB1 variety by 26 RWF (equivalent to about 5 percent of the average WTP for IB1 without information—492 RWF or 5 percent (575 RWF) of the average market price of beans in the urban area. Also, when the data are pooled (model 7), information is significant for both IB varieties.

To examine whether the length of information and endorsement have a significant effect on rural participants' premium for IBs, hypothesis testing was conducted where the coefficients on the treatment variables are compared, as shown in Table 8. The F-tests show that there is no significant difference in coefficients for short versus long information; likewise, there is no significance difference in coefficients when an endorsement from a district head is included in the nutrition information given. This result is surprising, as it would be expected that more detailed information would increase acceptance. However, long information may have also resulted in poor comprehensibility or loss of attention to details among rural participants.

Overall, the results discussed above have demonstrated that, without information, rural and urban participants have similar preferences for the IB2 variety (about an 8–10 percent premium, shown in Table 5), while the presence of information influences their WTP for the same variety differently. Further, in the pooled sample (model 7), the coefficient on the dummy variable representing urban participants is not significant, which corroborates the fact that urban and rural participants have similar preferences for the IB varieties.

4.3. Other Covariates

In both the rural and the urban study areas, the per capita quantity of beans that participants had at home does not have a significant effect on their premium for IBs. The results show that participants' liking for the attributes of each of the IB varieties significantly increases their premium, which is consistent with expectation. Further, participants in the rural areas from households where 100 percent of their bean consumption comes from their own production were willing to pay about 18 RWF more for the IB2 variety. While this is contrary to expectation, the results suggest that such participants may also be considering the seed value of the variety in addition to its consumptive value. Also, rural participants who were planning to buy beans on the day of the experiment were willing to pay about 16 RWF less for the IB2 variety. This is also contrary to expectation, since one would expect participants to value the transaction cost of accessing the same variety outside the experiment. However, in the urban area, participants' prior awareness of anemia, age, and education level positively and significantly influenced their premium for the IB2 variety, while only education level significantly and positively influenced their premium for the IB1 variety.

5. CONCLUSION

This paper compares urban and rural consumer acceptance of two biofortified IB varieties (IB1 and IB2) relative to a popular local variety (*Mutiki*) using the two cases of rural areas of Western Province and an urban wholesale market in Rwanda. We examine participants' evaluation of bean sensory attributes using hedonic rating and their WTP for the varieties using the BDM incentive-compatible mechanism. In the rural areas, the sensory evaluation was conducted in a home-use setting, where participants have the opportunity to cook and try each bean variety at home before stating their WTP. In the urban area, however, participants were invited to a central location within the market to evaluate raw and cooked bean grains from these varieties. We aim to inform the development of cost-effective marketing strategies for promoting IB varieties in Rwanda by testing the effects of the length of nutrition information provided and a public officer's endorsement on participants' premium for these varieties. Also, by comparing WTP across rural and urban areas, we attempt to examine the potential for a demand-pull mechanism. Within this context, we hope to contribute to the emerging literature on consumer acceptance of biofortified crops, which has not yet tested the effect of these experimental variables on consumer demand.

Without an information campaign, both rural and urban participants have no premium for the IB1 variety, because of its similarity in appearance to the local variety. On one hand, this variety was valued similarly to the local variety. On the other hand, while the presence of information does not increase rural consumers' valuation for the variety, it does increase urban consumers' valuation—and potentially demand—for the variety. The similar appearance of both IB1 and local bean varieties signals challenges in branding the IB1 variety. There may be a need to provide product-specific information to differentiate the IB1 variety from the local variety in both rural and urban areas. We found participants' ratings of the two varieties' raw bean size and cooked bean size are significantly different. Thus, nutrition information that positively brands these different attributes may assist in promoting the IB1 variety. Therefore, variety-differentiated marketing strategies would be required to engender demand for IBs across both urban and rural areas. A broader implication of this result is that market entry for products that already have several brands in the existing market may be difficult without clearly identifying and promoting their unique nonfunctional attributes.

However, both rural and urban participants have similar preferences for the IB2 variety. In the absence of information, the IB2 variety has a large premium of about 8 percent in the rural areas and about 10 percent in the urban area. Information significantly increases consumer valuation for this variety in the rural areas, while it does not increase valuation for the variety in the urban area. Regarding cost-effectively marketing IBs, our results suggest that promoting the IB2 variety with short information can increase its acceptance in the rural areas, while promoting it without information in the urban area may be cost-effective.

We also found that the short (brief) 1-minute message has the same impact on consumer demand as the long (detailed) 3-minute message. Thus, since the short message would be more economical for marketing purposes, it may be cost-effective to apply such information in promoting IBs. Further, we found no effect of a district head's endorsement on consumer demand for IBs; thus, other forms of endorsement should be tested for marketing IBs. The fact that the endorsement does not have a significant effect on the premium is surprising, since one would expect local farmers to be positive about interventions endorsed by their local authority. This could be due to the type of the endorsing authority used, where participants may have found the endorser–product match unacceptable. Since political officers may also suffer from public trust issues, testing other endorsing authorities, such as local celebrities, may yield a different demand path for IB varieties. Also, further research is warranted in testing other types of endorsing authority–product matches.

The similar preferences found for both rural and urban participants suggest the potential for a demand–pull mechanism in promoting the adoption and consumption of IBs in Rwanda. The fact that the provision of nutrition information has the potential to increase demand for the IB1 variety in urban areas also provides an opportunity for a market-led approach in promoting the adoption and consumption of this variety in rural areas. Generating demand pull from the urban wholesale market in Kigali is important, because a majority of beans collected by local assemblers in rural areas ends up in this market (Murekezi and Birol 2012). Implementation of technology-push mechanisms is very common in the development arena, with the assumption that the consumers could not access a product because of its unavailability. Also, pull mechanisms have been widely adopted, with the assumption that consumers need the product. This study suggests that such an assumption should always be tested given that, in Rwanda's case, rural consumers push the product to the market and also pull the same product from the market.

This paper has demonstrated that a diagnostic study such as the one presented here could be useful in understanding the direction of marketing investment strategy. One caveat of this study is that a CLT approach was used in the urban area, while an HUT approach was used in the rural areas, because of the impracticality of tracking recruited consumers in the urban market to their homes. Thus, further research is required to apply the CLT approach in both rural and urban areas.

REFERENCES

Asare-Marfo, D., E. Birol, L. Katsvairo, J. D. Manirere, F. Maniriho, and D. Roy. 2011. "Farmer Choice of Bean Varieties in Rwanda: Lessons Learnt for HarvestPlus Delivery and Marketing

Strategies." Unpublished project report. Washington, DC: International Food Policy Research Institute, HarvestPlus.

Banerji, A., S. Chowdhury, H. De Groote, J. V. Meenakshi, J. Haleegoah, and M. Ewool. 2013. *Using Elicitation Mechanisms to Estimate the Demand for Nutritious Maize: Evidence from Experiments in Rural Ghana.* HarvestPlus Working Paper No. 10. Washington, DC: International Food Policy Research Institute, HarvestPlus.

Birol, E., A. J. V. Meenakshi, A. Oparinde, S. Perez, and K. Tomlins. 2015. "Developing Country Consumers' Acceptance of Biofortified Foods: A Synthesis." *Food Security* 7: 555–568.

Choi, S. M., and N. J. Rifon. 2007. "Who Is the Celebrity in Advertising? Understanding Dimensions of Celebrity Image." *Journal of Popular Culture* 40 (2).

Chowdhury, S., J. V. Meenakshi, K. Tomlins, and C. Owori. 2011. "Are Consumers Willing to Pay More for Biofortified Foods? Evidence from a Field Experiment in Uganda." *American Journal of Agricultural Economics* 93: 83–97.Corrigan, J. R., D. T. Depositario, R. M. Nayga, X. Wu and T. P. Laude. 2009. "Comparing open-ended choice experiments and experimental auctions: an application to golden rice"., *American Journal of Agricultural Economics,* 91(3): 837-853.

Corrigan, J. R., and M. Rousu. 2006. "The Effect of Initial Endowments in Experimental Auctions." *American Journal of Agricultural Economics* 88 (2): 448–457.

De Groote, H., S. C. Kimenju, and U. B. Morawetz. 2011. "Estimating Consumer Willingness to Pay for Food Quality with Experimental Auctions: The Case of Yellow versus Fortified Maize Meal in Kenya." *Agricultural Economics* 42: 1–16.

DHS (Demographic Health Survey). 2010. *Rwanda Demographic and Health Survey, Final Report.* Kigali: National Institute of Statistics of Rwanda. Accessed January 27, 2015. http://dhsprogram.com/pubs/pdf/fr259/fr259.pdf.

Dzisah, W. E., and C. E. Ocloo. 2013. "Celebrity Endorsement and Consumer Buying Behaviour; Enhancing the Promotion Function of Marketing in the Central Business Area of Accra, Ghana." *European Journal of Business and Management* 5 (25).

Escalas, J. E., and J. R. Bettman. 2003. "You Are What They Eat: The Influence of Reference Groups on Consumer Connections to Brands." *Journal of Consumer Psychology* 13 (3): 339–348.

Ferris, R. S. B. 2002. "Bean Sub-sector Market Survey: Rwanda." ATDT-CIAT/ISAR/IITA-FOODNET and PEARL Project—Rwanda.

Goldsmith, R. E., A. L. Barbara, and J. N. Stephen. 2000. "The Impact of Corporate Credibility and Celebrity Credibility on Consumer Reaction to Advertisements and Brands." *Journal of Advertising* 29 (Fall): 43–54.

Harrison, G. W., R. Harstad, and E. Ruström. 2004. “Experimental Methods and Elicitation of Values.” *Experimental Economics* 7: 123–140.

List, J. A. 2003. “Does Market Experience Eliminate Market Anomalies?” *Quarterly Journal of Economics* 118: 41–71.

Lusk, J. L., and J. F. Shogren. 2007. *Experimental Auctions: Methods and Applications in Economics and Marketing Research*. Cambridge, UK: Cambridge University Press.

Martey, E. M., and J. Frempong. 2014. “The Impact of Celebrities’ Endorsement on Brand Positioning on Mobile Telecommunication Users in the Eastern Region of Ghana.” *International Journal of Education and Research* 2 (7).

McCracken, G. 1989. “Who Is the Celebrity Endorser? Cultural Foundation of the Endorsement Process.” *Journal of Consumer Research* 16: 310–321.

Meenakshi, J. V., A. Banerji, V. Manyong, K. Tomlins, N. Mittal, and P. Hamukwala. 2012. “Using a Discrete Choice Experiment to Elicit the Demand for a Nutritious Food: Willingness to Pay for Orange Maize in Rural Zambia.” *Journal of Health Economics* 31: 62–71.

Meenakshi, J. V., N. L. Johnson, V. M. Manyong, H. DeGroote, J. Javeosa, D. R. Yanggen, F. Naher, C. Gonzalez, J. Garcia, and E. Meng. 2010. “How Cost-Effective Is Biofortification in Combating Micronutrient Malnutrition? An ex-ante Assessment.” *World Development* 38 (1): 64–75.

Murekezi, A., and E. Birol. 2012. “Bean Seed and Grain Value Chains in Rwanda.” Unpublished Project Report. Washington DC: International Food Policy Research Institute, HarvestPlus.

Oparinde, A., A. Banerji, E. Birol, and P. Ilona. 2014. *Information and Consumer Willingness to Pay for Biofortified Yellow Cassava: Evidence from Experimental Auctions in Nigeria.* HarvestPlus Working Paper No. 13. Washington, DC: International Food Policy Research Institute, HarvestPlus.

Tomlins, K. I., J. Manful, J. Gayin, B. Kudjawu, and I. Tamakloe. 2007. “Study of Sensory Evaluation, Consumer Acceptability, Affordability and Market Price of Rice.” *Journal of the Science of Food and Agriculture* 87: 1564–1575.