Available online at www.centmapess.org

INTERNATIONAL JOURNAL ON FOOD SYSTEM DYNAMICS

Int. J. Food System Dynamics 8 (3), 2017, 222-235

DOI:http://dx.doi.org/10.18461/ijfsd.v8i3.834

Identifying Socioeconomic Characteristics Defining Consumers' Acceptance for Main Organoleptic Attributes of an Iron-biofortified Bean Variety in Guatemala

Salomón Pérez[a], Alexander Buritica[b], Adewale Oparinde[c], Ekin Birol[c], Carolina Gonzalez[a], and Manfred Zeller[d]

[a]*International Center for Tropical Agriculture (CIAT-HarvestPlus) Palmira, Colombia.*
[b] *International Center for Tropical Agriculture (CIAT-HarvestPlus) and University of Los Andes, Bogota, Colombia.*
[c] *International Food Policy Research Institute (IFPRI-HarvestPlus) Washington, DC, USA*
[d]*International Food Policy Research Institute (IFPRI-HarvestPlus), Washington DC, USA and University of Hohenheim.*

s.p.suarez@cgiar.org; a.buritica@uniandes.edu.co; a.oparinde@cgiar.org; e.birol@cgiar.org; c.gonzalez@cgiar.org; m.zeller@cgiar.org

Received October 2016, accepted April 2017, available online June 2017

ABSTRACT

The success of biofortification, the process of generating new staple crops varieties with higher micronutrient content, depends on whether those biofortified cultivars are accepted by target populations. Consumer behavior economics argues that socioeconomic, cultural and biological characteristics define consumer preferences for specific product attribute. This study aims to establish which socio-demographic characteristics predict respondents' preferences for the main sensory attributes of an iron bean variety. A home use testing approach and sensory evaluation was applied to 360 families in northwest Guatemala. We found that revealed preferences are mostly culturally formed and market related, more than influenced by socio-demographic characteristics.

Keywords: biofortification; iron; bean; sensory evaluation; consumer acceptance; cluster analysis

1 Introduction

At the global level more than 30 percent of the population, i.e. 2 billion people are anemic mainly due to iron deficiency. This is the most common and widespread nutritional disorder in the world constituting a public health condition of epidemic proportions (WHO, 2014). Although many strategies including food fortification, dietary diversification, and supplementation have been developed to address this disorder as well as other micronutrient deficiencies of importance, biofortification has emerged as the most promising complementary strategy that attempts to overcome mostly micronutrient deficiencies without changing dietary habits (Banerji et al., 2013).

Biofortification is the process of breeding and delivering staple food crops with higher micronutrient content (Saltzman et al., 2013). It is an important cost-effective strategy used mostly for rural areas in developing countries where high levels of micronutrient deficiencies coexists with high production and consumption of staple crops such as beans, rice, maize, and cassava (Meenakshi et al., 2010; Asare-Marfo et al., 2013; Saltzman at al., 2013).

Guatemala has one of the highest prevalence of iron deficiency in Latin America, i.e. in rural areas 24 percent of the children and 20.1 percent of the women are affected (MSPS, 2012). This country also has one of the highest rates of bean consumption per capita in the world, i.e. 12.4 kilograms/person/year (FAOSTAT, 2011). Therefore, iron-biofortified bean cultivars appear to be an alternative to tackle this nutritional disorder in this country.

The success of biofortification depends on whether the biofortified cultivars are accepted and consumed by target populations (Meenakshi et al., 2010). Acceptance and consumption is mainly based on consumer preferences which depend among others on various organoleptic or sensory characteristics such as taste, color, and texture, among others (Costell et al., 2010). Previously, as part of this study a market survey was carried out in Guatemala City and in the west region asking bean consumers and retailers about their preferences when purchasing, cooking and eating beans. Characteristics as color, cooking time, flavor and cooked bean thickness were stated as the most important characteristics for a bean variety to be accepted and consumed at home. Regarding bean color, darker and brighter colored grains are preferred. These two attributes are pointed out as synonymous of freshness. Less cooking time means that the grains are fresher, and consequently less wood for cooking is required; thus, their higher acceptance and consumption. Flavor and cooked bean thickness are important especially for children´s acceptability. Mainly in rural Guatemala children are fed with bean broth and children's acceptance plays a relevant role in the society´s nutritional status.

Although some studies have analyzed consumer acceptance of biofortified crops in Africa using sensory evaluations (Stevens at al., 2008; Meenakshi et al., 2010; Pillay at al., 2011; Talsma at al., 2013; Oparinde et al., 2014; Oparinde et al., 2015), such a study has not yet been carried out in Latin America where the commercial use of biofortified crops is in an early stage. On the other hand, no study evaluating consumer acceptance of biofortified crops has established socioeconomic and demographic characteristics predicting each respondent's acceptance, i.e. hedonic score for each of the iron bean variety´s attributes evaluated. According to consumer behavior economics, consumer's preferences for specific product characteristics are determined by socioeconomic, cultural and biological aspects as gender, level of education, wealth, knowledge, and even neurons (Triplett 1995; Troemel et al. 1997; Moerbeek & Casimir, 2005). These factors are identified in consumer decision models as external variables influencing consumers' decision process (Bray 2008). Identifying these factors will help to understand much better consumers' preferences and behavior through the identification of an accepter profile according to each organoleptic attribute evaluated. This information will be useful for breeders and other specialist related with crop biofortification development and dissemination to present new and improved crops to consumers with higher acceptance potential.

Through the exploration and use of a database designed and built to analyze the consumer acceptance towards an iron bean variety, this study attempts to fill the literature gaps on consumer acceptance of biofortified crops by evaluating the main factors defining consumer acceptance for main organoleptic characteristic of an iron-fortified bean variety named *Super Chiva* (74 ppm of iron) over a traditional one named *Parramos* (50 ppm of iron) in rural west Guatemala.

The main objectives of this paper are to (1) make a novelty use of a consumer acceptance study database to try to extract new information never analyzed before; (2) assess consumer preferences regarding the main organoleptic characteristics of a high-iron bean (HIB) cultivar compared to those of a traditional one; (3) establish the main socioeconomic and demographic characteristics predicting these preferences; and (4) segment consumers into groups based on their characteristics, preferences, and attitudes toward iron-fortified beans.

This paper is organized as follows: Section 2 gives further details on the study design, methodology used for data collection and analysis, section 3 discusses the results obtained, and section 4 provides main conclusions and discussion.

2 Methodology

This study was conducted under the ethical approval provided by the Ministry of Health and Education of Guatemala.

2.1 Study Sites and Sampling Design

The sensory evaluation experiment along with the socioeconomic survey was carried out in August 2013 in 12 communities of the San Sebastian Huehuetenango municipality northwest Guatemala. This study was part of a broader study carried out by the HarvestPlus project which attempts to elicit the willingness to pay (WTP) for each variety included in this study, and these results will be analyzed in another paper.

This municipality was chosen due to its high chronic malnutrition prevalence (72.2 percent) (Gobierno de Guatemala, 2012), and finding high levels of iron deficiency affecting more than 30 percent of the children and pregnant women (MSPS, 2012). Moreover, people in the region have high levels of bean consumption and production along with suitable agroecological conditions for the production of a HIB variety according to validation tests carried out by the Science and Institute of Agricultural Science and Technology (ICTA)[*] of Guatemala.

As the main goal of the experiment was to elicit the WTP for these varieties power calculations were conducted to determine the optimal respondent number to be surveyed. Bean price in northwest Guatemala varies by color. Red and white varieties are the most expensive ones and are cooked on special occasions, whereas black varieties are the cheapest and are consumed daily. In July 2013 the average market price for these bean varieties was 5 quetzals[†] per pound. Based on the average market price a treatment effect of 10 percent (0.5 quetzals) and a standard deviation in the market price per pound of 2.5 quetzals were anticipated. Using a 5 percent significance level and a power of 0.8 a sample size of 120 households for each treatment was established.

In total, 360 respondents or rural bean consumers were surveyed. The treatments were randomly assigned to all participants and each received a pound sample of the iron-biofortified bean variety and one of a local variety to cook, eat and evaluate at home according to their appointed treatment.

The bean varieties used in this study were both black varieties. One is a high iron-fortified bean (HIB) variety (*super chiva*) with 75 parts per million (ppm) of iron, and the other is the local variety (*parramos*) with 50 ppm of iron. The iron-biofortified variety used in this study was provided by ICTA and had been cultivated in the first season of 2013, and the traditional variety was obtained from a local farmer who cultivated it in the same season under similar conditions.

The objective of our sampling strategy was to draw a sample of 360 households from different communities of the San Sebastián Huehuetenango municipality. Unfortunately there were no reliable secondary data from recent censuses to determine the total number of people or households in the municipality. Likewise, no official data that could reliably give an estimate of the current population in each community existed. Therefore, local experts and community leaders in San Sebastián Huehuetenango were asked to estimate approximately the current population size in the municipality and in each of the communities mentioned.

Data collection took place during the rainy season which made transportation of the enumerator teams to some communities very difficult, if not impossible. Moreover, remote communities had higher security risks and locals were somewhat reluctant to participate in any kind of study. As a result, a list of 20 accessible and less remote communities was drawn from which 12 were randomly chosen. Within these communities enumerators randomly selected the households to participate in the study, selecting every fifth or seventh household they found in the road depending on the size of the community. To prevent contamination or leakage of the nutrition information through social networks the control treatment, i.e. without information was established during the first week, and the other two treatments were established in the following two weeks.

2.2 Sensory Evaluation and Survey Procedure

In this study we used the home-use testing (HUT) approach in which selected households received 1-pound of grain of both bean varieties (one variety each day in a random order) to cook and eat at home. Based on an average household size, demographics and information on quantity of beans consumed per person in the region, 1-pound was calculated to be sufficient for an average breakfast and lunch consumption per household. Each sample was packed in transparent plastic bags looking similar externally. However, these were differentiated using geometrical shapes on the plastic bags: a triangle for the iron-biofortified variety and a square for the local variety. Only those in treatments 2 and 3 were informed about how to distinguish between the iron-biofortified and the traditional varieties. Each consumer had a chance to experience and to evaluate the following sensory and cooking attributes: raw bean color, raw bean size, bean taste, cooking time and cooked bean thickness. They were also given the opportunity to review the overall evaluation. Each of these attributes was evaluated on a 7-point Likert scale ranging from 1 (dislike very much) to 7 (like very much), with other levels being 2 (dislike), 3 (dislike a little), 4 (neither like nor dislike), 5 (like a little), and 6 (like).

[*] Personal communication with ICTA's bean breeder team.

[†] US$1 = 7.67 quetzals in July 2013 (http://www.oanda.com/currency/historical-rates/)

The evaluation lasted three days and was carried out as follows:

Day 1: Before describing the study and asking their consent to participate the subjects were asked about their knowledge regarding iron-biofortified bean varieties. Those who revealed any knowledge were not included to avoid bias in their answers based on their previous experience or information. Following this, they were asked about their knowledge on food purchasing and cooking at home, and only those with knowledge of any of these aspects were surveyed. After signing a consent form they were randomly assigned to one of the treatments and received 1-pound of the bean sample they had been appointed to receive. They were then requested to cook the sample following their usual cooking practices[‡] and without mixing it with any other bean varieties they may already have at home. The households were visited early in the afternoon as households usually cook their beans in the evening to consume at breakfast and lunch the following day. Each household was given one day to cook and consume the variety as one day was thought to be sufficient time to generate an opinion about the variety, while reducing the risk of information contamination through social networks.

Day 2 (after lunch): The enumerator visited the same household again to conduct the sensory evaluation of the delivered variety on day 1 and to provide a sample of the other variety according to the treatment they were appointed to.

Day 3 (after lunch): The sensory evaluation for the second sample was carried out on the third day.

2.3 Survey and other Tools used

A survey tool was designed in collaboration with local experts and was pretested prior to data collection. Because of its length the survey was divided into three parts and each part was completed per day. In treatment arms the information about nutrition and other characteristics of the iron-biofortified bean variety was given through a recorded (simulated) radio message that the respondents listened to on individual MP3 devices. Qualitative background studies and the literature review carried out prior revealed that simulated radio messaging was the most effective mean to transmit information in rural Guatemala, where illiteracy is traditionally high especially in indigenous communities, and where radio ownership and use is high, i.e. close to 90 percent (Avila Pinto, 2010). This nutrition message was recorded in Spanish using local vocabulary and phrases. The content of the message was developed and validated by nutritionists as well as by local leaders. This message includes topics related to agronomic and nutritional characteristics of the HIB variety and its potential benefits for children and women's health. This message was mainly heard by participants to avoid information leakage or contamination.

2.4 Data Analysis

2.4.1 Ordinal Probit Regression

Unlike previous studies that evaluated hedonic attributes (Meenakshi et al., 2010), in this study scores for the main organoleptic characteristics were not highly correlated (see Table 1). This allowed the use of an ordinal probabilistic regression to analyze the socioeconomic and demographic factors determining the premium/discount acceptability hedonic scores for all the attributes evaluated. As a discrete ordinal scale was used to measure consumer liking, the data was of an ordinal nature as their order is meaningful and therefore an ordinal probabilistic regression must be used (Meullenet at al., 2007). In a probabilistic regression model for an ordinal categorical response the response variable (Y) can be represented as a latent, continuous, and unobservable variable (Z). We cannot observe Z but we can observe the difference in "Y" between the scores consumers give to the same attribute for the iron-fortified and traditional bean varieties.

[‡] Most of the families boil the beans without any other ingredient. However, when available some traditional culinary weeds are used.

The relationship between Y and Z can be described as follows:

$Y = 1$ = dislike very much if $-\infty < Z \leq \alpha_1$

$Y = 2$ = dislike if $\alpha_1 < Z \leq \alpha_2$

$Y = 3$ = dislike a little if $\alpha_2 < Z \leq \alpha_3$

$Y = 4$ = neither like nor dislike if $\alpha_3 < Z \leq \alpha_4$

$Y = 5$ = like a little if $\alpha_4 < Z \leq \alpha_5$

$Y = 6$ = like if $\alpha_5 < Z \leq \alpha_6$

$Y = 7$ = like very much if $\alpha_6 < Z < \infty$

Where α_is are the acceptability thresholds that cannot be observed but can be estimated.

Table 1.
Correlation matrix among some bean attributes

Attribute	**Color**	**Size**	**Flavor**	**Cooking Time**	**General**
Color	1				
Size	0.6123	1			
Flavor	0.4752	0.2977	1		
Cooking Time	0.2817	0.2865	0.0851	1	
General	0.5082	0.3588	0.4696	0.0488	1

The model can be specified as:

$$Z_i = X'_i\beta + \mu_i \quad (1)$$

$$Y_i = j \text{ if } \alpha_{j-1} < Z_i < \alpha_j \quad (2)$$

Where Z is a continuous latent variable for consumer *i* varying from $-\infty$ to ∞ corresponding to the observed response Y_i^*, and X'_I is a vector of covariates for consumer *I*; β is a vector of regression coefficients; and μ_i is the i^{th} random error. Y_i is the observed difference between the hedonic score for the iron-fortified variety and the traditional one.

The probability that the response of the i^{th} consumer will fall in the j^{th} category or below (denoted by p_{ij}), given X_i, is given by:

$$p_{ij} = p(y_i = j) = p(\alpha_{j-1} < y_i^* \leq \alpha_j) = F(\alpha_j - X'_i\beta) - F(\alpha_{j-1} - X'_i\beta) \quad (3)$$

Where F is the cumulative distribution of ε: $F(\varepsilon) = \frac{e^{\varepsilon}}{1+e^{\varepsilon}}$ (4)

The marginal effects can be computed as follows:

$$\partial p_{ij} / \partial x_{rj} = \{ F'(\alpha_{j-1} - X'_i\beta) - F'(\alpha_j - X'_i\beta) \} \beta_r \quad (5)$$

2.4.2 Cluster Analysis

Cluster analysis is a technique that allows the segmentation of observations by how well they align with a chosen set of explanatory variables (Hair et al., 1998). Groups of related variables can be formed as in a factor analysis. In a cluster analysis assumptions about the underlying distribution of data are not required as they are used for factor analyses and regressions. A common criticism of the cluster analysis is that it is not a robust statistical method and is highly dependent on the choice of the explanatory variables and the clustering method. It is also more difficult to extend the results of a cluster analysis to a larger population than it is for other statistical techniques such as a regression analysis. However, a cluster analysis is appealing because it allows the sorting of observations into distinct groups (Gifford and Bernard, 2008).

Hierarchical clustering procedures must be used when there is a small data set and you want to easily examine solutions with increasing numbers of clusters. For hierarchical clustering a statistical method that quantifies similarities or dissimilarities between two cases must be chosen before forming groups, and finally the number of clusters required for the representation of the data must be determined (Norusis, 2011). As we have a mixture of categorical and continuous variables a similar method is used as a criterion to form similar groups. None of the distance measures in hierarchical clustering is suitable for use with both types of variables (Norusis, 2011). Therefore, a factor analysis of mixed data (FAMD) is used to group all in a sole index. Then a hierarchical clustering on principal components is used. This makes an agglomerative hierarchical grouping using results from a factorial analysis.

2.5 Independent Variables

The independent variables included in the models are shown in Table 2. Those variables were selected based on previous literature review about the factors defining consumer preferences towards organoleptic characteristics for different types of products.

Table 2.
Independent variables included in different models

Variables	**Description**
HHmembers	Continuous variable indicating the number of persons living in the respondent's household
Children	Households with children or babies less than 4 years old
Women	Households with pregnant women or breastfeeding women
Beancons	Continuous variable indicating the weekly amount of beans consumed by the household
Nopurchase	= 1 if the household does not purchase beans; 0 otherwise
Agriculture	= 1 if agriculture is the main household income
Progress out of Poverty Index (PPI)	Grameen Foundation's PPI accounts for head of household's education, assets and income (calculated by the authors from survey data; explained below)
Age	Continuous variable indicating the respondent´s age
Gender	= 1 if the respondent is male; 0 otherwise
Quiencompra3	= 1 if a man is the person who purchases beans in the household
Education	= 1 if the education level is higher than the medium level
Household planting	= 1 if the household plant´s beans every year
Varorder	= 1 if the iron-fortified variety was received first; 0 otherwise
Talk4	= 1 if the respondent talked with somebody else about this study in the last 4 days; 0 otherwise
Treatment 2	= 1 if the respondent was in treatment 2; 0 otherwise
Treatment 3	= 1 if the respondent was in treatment 3; 0 otherwise
Genderxtreat2	Interaction between gender and treatment 2
Genderxtreat3	Interaction between gender and treatment 3

2.5.1 The Progress out of Poverty Index® (PPI)

The PPI is a poverty measurement tool developed by Grameen Foundation (Grameen Foundation, 2015). The index is computed using the answers to 10 questions on household characteristics and asset ownership to determine the likelihood that the household is living below the poverty line (US$1.25/day 2005 purchasing power parity). The country-specific PPI consists of a set of 10 specific questions for 45 countries. In this study country-specific questions for Guatemala were asked. When the PPI was higher the likelihood of a household to be below the poverty line was lower.

2.5.2 Interaction Variables

Interactions between treatment variables and gender and education were also included. Interaction with gender (genderxtreat2 and genderxtreat3) looks for any gender implication in a possible information and repetition on consumer acceptance effect of the iron-fortified varieties. For example, women are perhaps more susceptible to attend to nutrition information than men. In the same direction the interaction of these treatment variables with education was included (edutreat2 and edutreat3). Thus, a higher information effect on participants with higher education was expected. Moreover, interactions with receiving the iron-fortified variety (varorder variable) were also included, expecting that those receiving information and the iron-fortified variety the second day were willing to pay a higher price for this one.

3 Results

3.1. Participant and Household Characteristics

Table 3 presents key socioeconomic characteristics of respondents and their households by treatment arm, and reports further the results of the ANOVA analysis for median homogeneity across the three groups. The characteristics listed are those hypothesized to affect respondent WTP.

Table 3.
Socioeconomic characteristics by treatment group (ANOVA test)

Variable	**Mean (S.D.)**			
	Treatment 1 N=120	Treatment 2 N=120	Treatment 3 N=119	Prob. > F
HH members**	6.32 (2.53)	6.06 (2.67)	5.46 (2.10)	0.02
Children	0.90	0.75	0.73	0.32
Women	0.28	0.26	0.16	0.16
Beancons	3.46 (2.02)	2.97 (1.63)	2.77 (1.22)	0.13
Nopurchase	0.025 (0.50)	0.033 (0.60)	0.033 (0.42)	0.90
Agriculture	0.66	0.59	0.58	0.98
Poverty Index	60.93% (0.32)	66.47% (0.28)	65.45% (0.28)	0.31
Age	36.24 (11.40)	35.82 (11.41)	34.96 (34.96)	0.73
Gender***	0.45	0.23	0.37	0.00
Quiencompra3	0.25	0.17	0.11	0.13
Education	0.01	0.03	0.04	0.51
beanproducer	0.63	0.56	0.54	0.36
varorder	0.49	0.66	0.31	0.15
Talk4	0.28	0.39	0.35	0.20

*** = statistically different at 1% significance level; ** = statistically different at 5% significance level; * = statistically different at 10% significance level.

Most of the key participant's social and economic household level characteristics are similar across treatments revealing that randomization in treatments worked well. Statistical differences are observed for gender between treatment 3 and other groups, for the number of members per household between treatments 2 and 3, and for the percentage of households with small children between treatment 3 and the other two. Variables such as initial knowledge regarding iron deficiency and anemia and the quantity of beans they had at home were not significantly different across treatments. This showed similar iron deficiency and anemia awareness endowment and levels of product ownership among groups.

3.2 Consumer Acceptance for the Main Organoleptic Characteristics

Table 4 shows mean hedonic ratings for the two bean varieties. According to these results more than 80 percent of the participants scored both varieties above 6, i.e. between like and like very much. Those results are similar for both varieties in the three treatments being marginally higher for the HIB variety for all the characteristics evaluated, except for cooked bean toughness in treatments 2 and 3. Those mean scores are statistically different for cooking time, cooked bean thickness, and the overall evaluation in treatment 1, as well as for raw bean color, raw bean size, bean taste, and cooking time in treatments 2 and 3. In the overall evaluation the HIB variety scored higher but this difference is only statistically different in treatment 1. Color, flavor, size, and cooking time are included in the analysis because of their significant differences in most of the cases in at least two of the three treatments. The overall evaluation is included because of its relevance in the analysis.

Table 4.
Home testing mean hedonic rating of bean varieties from northwest Guatemala

	Bean variety	Raw bean color	Raw bean size	Bean taste	Cooking time	Cooked bean thickness	Cooked bean toughness	Overall rating
Control (T1): No Information	Local (*Parramos*)	6.55±0.59	6.57±0.72	6.59±0.75	6.10±1.35	6.17±1.29	1.85±2.95	6.47±1.00
	HIB (*Super chiva*)	6.63±0.72	6.61±0.67	6.75±0.74	6.58±0.74	6.66±0.66	1.95±3.07	6.66±0.66
	Difference in means							
	HIB vs. local	0.75	0.042	0.16	0.47***	0.49***	0.11	0.19*
T2: Information presented	Local (*Parramos*)	6.53±0.46	6.50 ±0.56	6.63±0.52	6.37±1.09	6.40±0.93	1.42±2.73	6.59±0.63
	HIB (*Super chiva*)	6.77±0.65	6.74±0.46	6.85±0.42	6.64±0.76	6.60 ±0.91	1.21±2.63	6.60±0.91
	Difference in means							
	HIB vs. local	0.24***	0.24***	0.21***	0.26**	0.19	-0.21	0.01
T3: Information presented	Local (*Parramos*)	6.55±0.57	6.54±0.55	6.63±0.53	6.39±0.67	6.53±0.54	1.34±2.63	6.59±0.59
	HIB (*Super chiva*)	6.76±0.51	6.77±0.51	6.84±0.46	6.57±0.77	6.64±0.96	1.15±2.51	6.64±0.96
	Difference in means							
	HIB vs. local	0.21***	0.23***	0.20***	0.17*	0.11	-0.19	0.06

*** = statistically different at 1% significance level; ** = statistically different at 5% significance level; * = statistically different at 10% significance level.

Table 5 presents comparisons of hedonic ratings across treatments. For the local variety statistically significant differences were found for cooking time between treatment 1 and treatments 2 and 3, and for cooked bean thickness between treatments 1 and 3. When estimating consumers' preferences for the HIB variety across the different scenarios, significant differences were found for raw size and cooked bean toughness between treatment 1 and the other treatments. This shows that consumers preferred those attributes when information is provided. When evaluating the impact of the information frequency comparing treatments 2 and 3 no significant differences were found.

Table 5.
Mean hedonic rating of bean varieties across treatments (difference in means)

Treatment group	Raw bean color	Raw bean size	Bean taste	Cooking time	Cooked bean thickness	Cooked bean toughness	Overall rating
Local: T1 vs. T2	0.025	0.075	-0.041	-0.266*	-0.233	0.425	-0.116
Local: T1 vs. T3	0.003	0.037	-0.046	-0.286**	-0.362***	0.505	-0.113
Local: T2 vs. T3	-0.021	-0.037	-0.005	-0.019	-0.129	0.080	0.003
HIB: T1 vs. T2	-0.14*	-0.125*	-0.091	-0.058	0.066	0.75**	0.066
HIB: T1 vs. T3	-0.13	-0.156**	-0.082	0.011	0.019	0.80**	0.019
HIB: T2 vs. T3	0.010	-0.031	0.009	0.070	-0.047	0.057	-0.047

* = statistically different at 1% significance level; ** = statistically different at 5% significance level; *** = statistically different at 10% significance level.

3.3 Socioeconomic and Demographic Characteristics Determining Consumers' Preferences

The results from the ordinal probit regression for each of the attributes included in the analysis appear in Table 6. According to those results color of the HIB variety is more likely to be accepted by those consumers in households in which agriculture is the main source of income with high bean consumption per week. On the other hand, the likelihood of being accepted will decrease in male consumers or in households with children less than 3 to 5 years of age, in traditional bean producer households or in those in which bean purchase is a male duty. Based on that, color of the HIB variety is less likely accepted by those consumers with market orientation since men in rural communities are in charge of bean marketing and traditional bean producers tends to be market orientated and most of them in fact sell some of their surplus in markets. In the other side of the spectrum, color is more likely accepted by less wealthier consumers since a high proportion of their income comes from agriculture and have higher bean consumption or have less diversified diets. The fact that households with children under 3 years of age are less likely to accept color is because wealthier families do not use to feed their young children with beans, therefore the nutritional fact is not relevant. According to the variable gendertreat3, receiving the information trice increases the likelihood of acceptance by men showing some information effect.

Table 6.

Coefficients of the ordinal probabilistic regression[§]

Variables	Color	Size	Flavor	Cooking time	Cooked bean thickness	General
HHMembers	-0.019	-0.061**	-0.022	0.007	-0.024	-0.005
Children (0 to 3 years old))	-0.148*	0.072	0.069	-0.004	-0.059	-0.017
Women (Pregnant or breastfeeding)	0.188	0.225*	0.236*	0.171	0.014	0.248*
Bean consumption at home	0.071*	0.048	0.058	0.056	0.04	0.054
Nopurchase	-0.393	-0.399	-0.878**	-0.401	0.013	-1.081***
Agriculture main income	0.324**	0.084	-0.154	0.161	-0.064	0.240*
Progress out of Poverty index (PPI)	0.265	0.1	0.062	0.144	-0.093	0.139
Age (Respondent's age in years)	-0.003	0	0.002	0.001	-0.005	0.003
Gender (=1 if respondent is male)	-0.491**	-0.036	-0.136	-0.435**	-0.05	-0.562***
Quiencompra3	-0.286*	-0.252	-0.228	-0.247*	0.145	-0.453***
Genderxtreat2	0.412	0.111	0.101	0.144	0.113	0.339
Genderxtreat3	0.714**	0.29	0.741**	0.534*	0.057	0.829***
Education (=1 if higher than medium level)	0.569	-0.157	0.336	0.416	-0.393	0.649*
HH planting beans every year	-0.235*	-0.087	-0.061	-0.03	-0.06	0.005
Treatment2	-0.026	0.283	0.108	-0.269	0.167	-0.176
Treatment3	-0.173	0.176	-0.182	-0.332*	0.008	-0.272
Varorder	-0.059	-0.042	-0.048	0.086	-0.653***	-0.025
Talk4	-0.124	-0.056	-0.353***	-0.052	0.064	-0.196
Obs.	359	359	359	359	359	359
Pseudo R-squared	0.043	0.028	0.043	0.02	0.039	0.048
**** p<0.01, ** p<0.05, * p<0.1*						

[§] All variables were described in table 2.

Regarding size: when the number of household members is higher the probability of acceptance is lower. This result reflects some bean producer opinions mentioning that *Super Chiva´*s grain is a bit smaller than the traditional variety´s grain, and in the region it is traditionally believed that bigger grains generate more hunger reduction. In other words, one pound of big grained beans is preferred over one pound with smaller grains. This fact increases the likelihood of acceptance among pregnant and lactating women since bigger grains sometimes are related with more stomach gases during pregnancy.

The HIB variety´s flavor is less likely accepted by self-sufficient households and those in which the respondent had talked about this study with somebody else in the last four days before the sensory evaluation, reflecting some bias due to information contamination. The likelihood of acceptance increases in men receiving information trice and in households with pregnant or lactating women, reflecting some potential information effect.

Cooking time is less likely accepted by men mostly as male respondents in households are in charge of bean purchasing. However, in the case of information it seems there is an information effect since men receiving information trice increase their acceptance for this attribute.

In the case of cooked bean thickness there are no socio-demographic characteristics defining preferences for this attribute. But this is the only attribute in which the variety´s sample order distribution has an effect. In this case receiving the HIB variety first decreased the acceptance likelihood of the cooked bean thickness attribute for this variety.

Men and households not purchasing beans are less likely to accept the HIB variety for its organoleptic characteristics, and bean producers' households and those with higher education tend to accept the iron-fortified variety.

3.4 Cluster Analysis

As we are working based on a factorial analysis, the traditional test using in cluster methodologies is not possible because these are based only in qualitative variables. In this case, in order to have an optimal number of clusters the inertia sum inside each cluster was estimated. This inertia depends on the ratio in-between the groups and the total variance of the dispersion analysis (See appendix I). Based on that, three different clusters were defined using the agglomerative hierarchical cluster analysis (Figure 1).

Although most of the respondents showed a slightly higher preference for most of the iron-fortified variety´s organoleptic attributes, three clusters can be identified: "fully accepters", "slightly accepters" and "indifferent". Cluster number 3, i.e. the "fully accepters" are those preferring most of the organoleptic attributes of the iron-biofortified variety; cluster 2 presents a lower level of preference and cluster 1 gathered those indifferent among the attributes of both varieties. According to this cluster more than 50 percent of the respondents accept the traditional variety or are indifferent to any, and more than 35 percent accept the HIB variety.

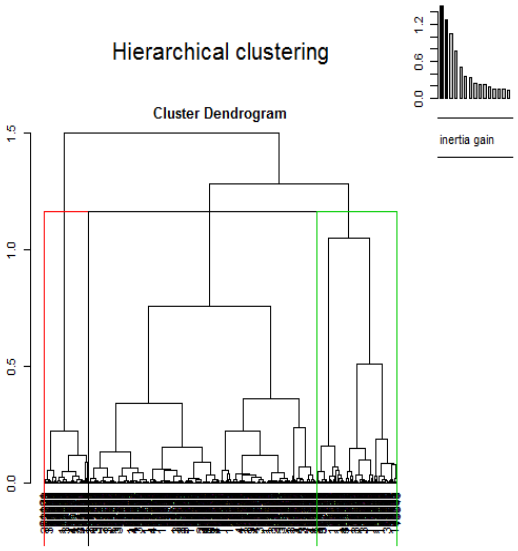

Figure 1. Results from the agglomerative hierarchical cluster analysis

Figure 2 shows the main cluster characteristics based on participants' acceptance of the most important organoleptic characteristics evaluated. According to this figure cluster 3 "fully accepters" includes respondents with a higher acceptance for the color, size, cooking time and flavor of the HIB variety than in the other clusters. Cluster 1 shows slight preference for all the attributes and cluster 2 is similar to cluster 3 in their preferences but shows a higher acceptance for the cooked bean thickness of the iron-fortified variety but a much smaller with cooking time.

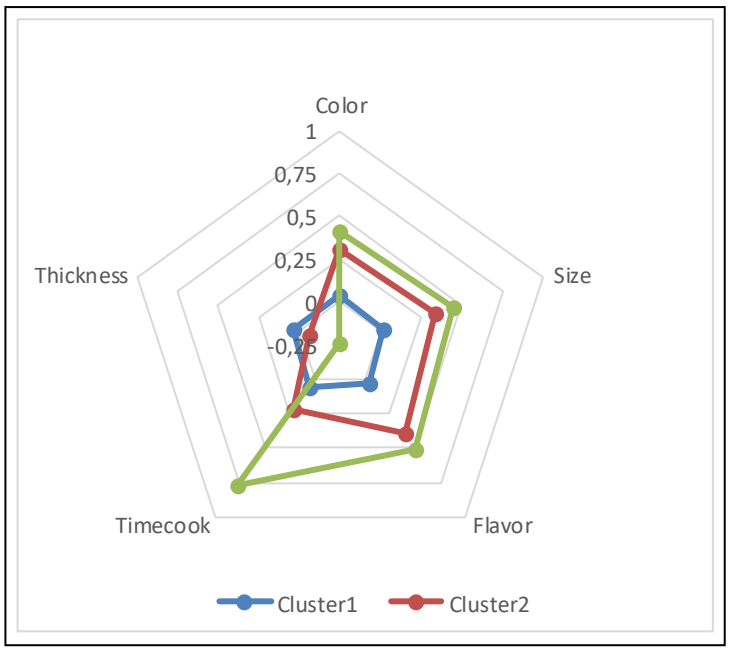

Figure 2. Sensory evaluation of the HIB variety by cluster

Table 7 shows the main socio-demographic characteristics defining each cluster. Cluster 3 "fully accepters" is characterized by women with an average age of 35 years with lower bean consumption, bean purchase in market, lower probability of being under the poverty line and lower proportion of bean producers. Cluster 3 "slightly acceptance" is characterized by men with an average age of 39 years, no purchase of beans in market and higher education compared with the other clusters. Cluster 3 "indifferent" is characterized by bigger households with higher bean consumption, higher income from agricultural activities and being a bean producer.

Table 7.
Main socio-demographic characteristics defining acceptance clusters (Media)

Variable	Fully acceptance	slightly acceptance	Indifferent
HH members	5	6	8
Children	0.6	0.7	1.2
Women	0.1	0.2	0.6
Beanconsume	2.60	2.73	4.29
Nopurchase (%)	1.4	6.7	5.2
Agriculture	46.1	71.1	83.5
Poverty Index	0.58	0.67	0.78
Age	35	39	39
Gender	16.6	100	48.5
Quiencompra3	19.4	11.1	19.6
Education	3.2	4.4	2.1
Bean producer	50.7	64.4	72.2
Varorder	48.4	31.1	58.8
Talk4	32.3	37.8	37.1
Gender*treat2	2.8	0	22.7
Gender*treat3	0	100	0

4 Discussion and Conclusions

This paper tries to use a consumer acceptance database to explore novelty alternatives to examine unanalyzed topics especially in the literature concerning the study towards the acceptance of biofortified crops varieties. This paper investigates the main socioeconomic characteristics defining consumers' preferences for the main organoleptic attributes of a bean variety with higher iron content compared with a traditional variety. The role of nutrition information and its repetition was also analyzed. The organoleptic attributes evaluated were color, size, flavor, cooking time and cooked bean thickness. Respondents were also given the opportunity to review the general evaluation.

As a result, a slightly higher but not statistically significant preference for the HIB variety was estimated especially for attributes as color, size, flavor, and cooking time, depending on nutrition information and how frequently it is received. Preferences for these attributes are defined in most of the cases by socioeconomic characteristics related with bean production status and market orientation of the respondents or households. In this direction, aspects as no purchase of beans in the market, to be a bean producer or a bean consumer determines some of the preferences for these attributes.

Most of the socioeconomic characteristics explaining respondents preferences for most of these organoleptic attributes are related with the preferences stated by bean consumers during a marked survey carried out prior to this study, showing that there is a high relation between the revealed and the stated preferences. Characteristics as age, education level, and poverty level do not influence those preferences, indicating that the beliefs and revealed preferences are mostly culturally formed and market related more than influenced by socio-demographic characteristics.

Cluster analysis shows three clusters, i.e. fully accepters, slightly accepters and indifferent. Fully accepters are mainly wealthier women less related with bean activities as consumption, purchase and production. Slightly accepters are mainly men with higher education and traditionally not purchasing beans in the market. The indifferent are bean consumers and producers with less education and a higher probability of being under the poverty line.

Nutritional information does not seem to play an important role in consumer preference formation in contrast to what other studies had found. Repetition could however improve their acceptance of some of the iron-fortified variety attributes, especially when information is delivered trice to men.

For further analysis, less accessible communities should be included. Although traditionally people leaving on these communities don't have any access to markets, their specific socioeconomic characteristics might have some relevance on consumers' preferences.

6 References

Asare-Marfo, D., Birol, E., Gonzalez, C., Moursi, M., Pérez, S., Shwarz, J. and Zeller, M. (2013). Prioritizing Countries for Biofortification Interventions Using Country Level Data. *HarvestPlus Working Paper No. 11*. Washington, DC, USA: International Food Policy Research Institute.

Avila Pinto, R. (2010). "Country Report: Guatemala." In *Financially Viable Media in Emerging and Developing Markets*. Paris: World Association of Newspapers and News Publishers: 65–75.

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

Bray, JP. (2008). *Consumer behavior theory: Approaches and models*. Bournemouth: Bournemouth University. Discussion paper.

Costell, E., Tárrega, A., and Bayarri, S. (2010). "Food acceptance: the role of consumer perception and attitudes", *Chemosensory Perception*, Vol. **3** No. 1: 42-50.

Food and Agriculture Organization of the United Nations Statistic (FAOSTAT) (2011). Available at http://faostat.fao.org/site/609/DesktopDefault.aspx?PageID=609#ancor (Accessed on 10/04/ 2014).

Gifford, K., Bernard, J. C. (2008). "Factor and Cluster Analysis of Willingness to Pay for Organic and Non-GM Food." *Journal of Food Distribution Research,* **39** (2).

Gobierno de Guatemala. (2012). *Plan Hambre Cero*. Guatemala City, Guatemala.

Grameen Foundation (2015). Progress Out of Poverty Index. Available at: http://www.progressoutofpoverty.org/ (Accessed 04/11/2014)

Hair, J. F., Jr., Black, W. C. (1998). "Cluster Analysis." In *Reading and Understanding More Multivariate Statistics*, edited by L. G. Grimm and P. R. Yarnold. Washington, DC, USA: American Psychological Association: 147−205.

Meenakshi, J. V., A. Banerji, Manyong, V., Tomlins, K., Hamukwala, P., Zulu, R., and Mungoma, C. (2010). Consumer Acceptance of Provitamin A Orange Maize in Rural Zambia. *HarvestPlus Working Paper No. 4*. Washington, DC, USA: International Food Policy Research Institute.

Meenakshi, J. V., Banerji, A.,. Manyong, V., Tomlins, K , Mittal, N., and Hamukwala, P. (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.

Meullenet, J. F., Xiong, R.,and Findlay C. (2007). *Multivariate and Probabilistic Analyses of Sensory Science Problems. Oxford*, England: Blackwell Publishing.

Moerbeek, H., Casimir. G. (2005). Gender differences in consumer's acceptance of genetically modified foods. *International Journal of Consumer Studies*, **29**, 4: 308-318.

MSPS (Ministerio de Salud Pública y Asistencia Social. (2012). *Encuesta Nacional de Micronutrientes 2009–2010*. Guatemala City, Guatemala.

Norusis, M. J. (2011). "Cluster Analysis." Chapter 18 in *IBM. SPSS. Statistics 19 Statistical Procedures Companion*. Rancho Cordova, CA, USA: Pearson Education, Inc. ISBN-13:978-0-321-74842-3.

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

Oparinde, A., Birol, E., Murekezi, A., Katsvairo, L., Diressie, M., Nkundiman, J., and Butare, L. (2015). "Consumer Acceptance of Biofortified Iron Beans in Rural Rwanda: Experimental Evidence". *HarvestPlus Working Paper No. 18*. Washington, DC, USA: International Food Policy Research Institute.

Pillay, K., Derera, J. Siwela, M., and Veldman, F. J (2011). "Consumer Acceptance of Yellow, Provitamin A-Biofortified Maize in KwaZulu-Natal." *South African Journal of Clinical Nutrition,* **24** (4): 186−191.

Saltzman, A., Birol, E., Bouis, H., Boy, E., De Moura, F., Islam, Y., and Pfeiffer, W. (2013). "Biofortification: Progress toward a More Nourishing Future." *Global Food Security,* **2** (1): 9−17.

Stevens, R., A. Winter-Nelson. (2008). "Consumer Acceptance of Provitamin A-Biofortified Maize in Maputo, Mozambique." *Food Policy* **33**: 341–351.