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# Consumer market segments for biofortified iron beans in Rwanda: Evidence from a hedonic testing study

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ABSTRACT

An understanding of consumer market segments is important for efficient and effective targeting of new technologies, such as biofortified foods. In this paper, we use cluster analysis to identify distinct consumer segments in Rwanda for four biofortified iron bean varieties. Data on consumer liking of various sensory attributes of beans was collected by using a 7-point hedonic scale through the application of home-use and central location tests implemented in two rural and two urban locations. Cluster analysis reveals the existence of several distinct consumer segments in each one of the four study locations. Further analysis is conducted by using multinomial probit and logit models to predict consumer segment membership based on the consumer characteristics. Results reveal that, depending on the location, consumer's source of income and whether or not they received information about nutritional benefits of the iron bean varieties have a bearing on their preference of these varieties. The paper presents a profile of each one of the consumer market segments identified to assist targeting of various iron bean delivery, marketing and promotion efforts in Rwanda.



## 1. Introduction

Micronutrient malnutrition, also known as hidden hunger, is an important public health problem in Rwanda. According to the latest Rwanda Demographic and Health Survey (DHS 2014–15), 37% of children age 6–59 months and 19% of women of childbearing age (15–49 year olds) suffer from anemia (NISR et al., 2015), about half of which is caused by iron deficiency (de Benoist et al., 2008). At the same time Rwandans exhibit some of the highest per capita consumption of beans in the world, with beans being consumed almost every day of the week, while the frequency and amount of animal source foods consumption remain low (Asare-Marfo et al., 2011; Berti et al., 2012). Historically coined as the "meat of the poor" (CIAT, 1995), and "vegetable meat for the wealthy" (Valdemiro and Whitaker, 1982), households tend to rely on the market to provide their bean needs. Even in the rural areas, where 85% of rural households grow beans (Asare-Marfo et al., 2011), and majority of household bean consumption comes from own production (79–88%, depending on the season, National Agricultural Survey [NAS], 2008), almost half of all rural households are net bean buyers (Murekezi et al., 2013).

Recent evidence from clinical nutrition studies reveal that beans are an effective vehicle for iron biofortification (Petry et al., 2015), and regular consumption of iron beans improves the iron status of target populations, i.e., children (Luna et al., 2012) and women (Haas et al., 2016). Given significant levels of anemia and high consumption of beans in Rwanda, iron-enriched, i.e., biofortified, bean varieties could be an effective and targeted public health intervention to alleviate iron deficiency in this country. In fact, according to the Biofortification Priority Index (BPI), which ranks developing countries based on their production and consumption of seven priority crops and the rate of micronutrient deficiency among the target population (Asare-Marfo et al., 2013), among the 81 countries ranked for investment in iron beans in Africa, Asia, and Latin America and the Caribbean, Rwanda ranks as number one.

As with other biofortified crops, the success of iron bean varieties in tackling micronutrient deficiency depends on whether or not they are liked and accepted by target consumers. There is an ever-growing literature on consumer acceptance of biofortified foods, using either food science methods (e.g., sensory evaluation and hedonic testing) (see e.g., Tomlins et al., 2007a, 2007b; Muzinghi et al., 2008; Padrón et al. 2011; Garcia Montecinos et al., 2011; Vergara et al., 2011; Tofiño et al., 2011; Carrillo Centeno et al., 2011; Pillay et al., 2011; Laurie and Van Heerden, 2012; Talsma et al., 2013) or economic methods (e.g., revealed

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and stated preference willingness to pay [WTP] studies) (see e.g., Stevens and Winter-Nelson, 2008; Naico and Lusk, 2010; De Groote et al., 2011; Chowdhury et al., 2011; Banerji et al., 2013; Waldman et al., 2014), or both (e.g., Meenakshi et al., 2012; Banerji et al., 2016; Oparinde et al., 2016, in press). Majority of this literature is synthesized in Birol et al. (2015). The current paper contributes to this ever-growing literature on consumer acceptance of biofortified foods, with an in-depth analysis of the identification and profiling of the segments within the target consumer market. Such an understanding of the consumer segments for iron beans would help inform the development of targeted and cost-effective breeding, delivery, marketing and promotion strategies.

Hedonic tests are conducted on a total of 1809 consumers in two rural and two urban locations, using home use testing and central location testing methods, respectively, to measure consumer liking of various bean attributes (e.g., taste, size, color, etc.) on a 7 point hedonic scale for two iron bean varieties, and a local, i.e., control, bean variety. Following the literature on market segmentation based on consumer purchasing behavior of inputs (Gloy and Akridge, 1999; Alexander et al., 2005; Reimer et al., 2009; Feeney and Berardi, 2013), cluster analyses are conducted first, to identify the unique consumer segments for each one of the bean varieties tested in each one of the study locations. Given that consumer segments may differ in their various characteristics that may facilitate or hinder their consumption of iron beans, each distinct segment is expected to respond differently to different marketing strategies such as pricing or promotion (Alexander et al., 2005). Therefore, multinomial probit and logit models are estimated to understand the various consumer and consumer's household level factors that are expected to influence membership in a particular consumer segment.

The rest of this paper is organized as follows. In the next section, we present the study methodology, description of the data and the results of descriptive analysis. Section three presents and discusses the cluster analyses and multinomial probit and logit estimation results. The final section concludes the paper by discussing the implications of the study findings for the development of targeted and cost-effective breeding, delivery, marketing and promotion strategies for biofortified, iron bean varieties in Rwanda.

## 2. Methodology

### 2.1. Study areas and sampling design

The study was conducted from October to December 2013 in two rural districts and two urban bean markets. An investigation of consumer preferences and segments in both rural and urban markets, was expected to enable us to (a) identify similarities/differences between the preferences of urban consumers vs rural producer-consumers; (b) understand whether or not urban consumers could act as "demand pull" mechanism and thereby generate higher rates of adoption of iron beans in rural areas, and (c) estimate any price differentials between rural areas and urban markets.

The rural districts selected were Gakenke in the Northern Province and Karongi in the Western Province. These districts were selected among a list of districts in which e iron beans had not been delivered extensively at the time the study was conducted, and also to represent different agro-ecological conditions where bean varieties adapted to high and mild altitudes, respectively, could be tested. In each district, a multi-stage cluster sampling approach was used to randomly select the study respondents. The selection of the sectors within each of the two chosen districts constituted the first stage of cluster sampling. Sectors were grouped into four quartiles based on the 2008 population density and one sector was randomly selected from each quartile. In the second stage, one fifth of all villages in each chosen sector was randomly selected and all households living in the selected villages were listed. The third stage involved the random sampling of households from these lists. The number of households sampled varied across villages based on the size of the village. Each one of the households sampled was asked to participate in the home use testing of beans, and was subsequently provided with the two iron bean varieties and the local bean variety. Within each household, the person who is mainly responsible for deciding which bean variety to buy for home consumption was chosen to partake in the study survey.

The two urban bean markets selected were the Kigali bean wholesale and retail markets. The wholesale bean market is where consumers make bulk purchases, relatively infrequently; whereas in the retail bean market the quantities purchased are smaller though consumer transactions are more frequent. In each one of the markets, respondents were randomly selected and invited to the central location for bean testing and participation in the study survey. To avoid self-selection bias, those who showed up without being invited were not interviewed. Table 1 presents the local and iron bean varieties tested in each one of the study locations.

In each study location, respondents were randomly allocated into treatment and control groups, as per the experimental design presented in Table 2 below. Control group respondents were not given any information about the nutritional benefits of iron bean varieties. Treatment group respondents received information about the nutritional benefits of iron bean varieties using various communication strategies. These strategies included (a) providing short or long messages, (b) "gain frame" wording (information about the health benefits of consuming iron bean varieties) vs. "loss frame" wording (information about the consequences of not having enough iron in the diet), (c) providing the information once vs thrice, and (d) the presence vs absence of endorsement of the nutritional benefits of iron beans by a public officer. In this current paper, treatment groups were pooled together and were compared with the control group in each study location in order to understand the effects of providing information on market segmentation.

### 2.2. Data collection

Data were collected through face to face interviews either at the respondents' home (in rural areas) or in a central location in the market (in urban areas). Total number of respondents interviewed was 572 in the Northern Province, 578 in the Western Province, 261 in the wholesale market and 398 in the retail market.

Once the respondents were identified, the enumerators first briefly summarized the objectives of the study and obtained informed consent. Respondents were then asked various questions pertaining to their and their households' various demographic characteristics; household assets; household bean purchase and consumption patterns; respondent use of media and their main sources of information; respondent knowledge about anemia and iron deficiency, and respondent knowledge and level of trust in agricultural delivery institutions. Respondents were also asked about their access to and participation in various social networks, as well as about the diversity of their diets and their food security indicators. Following these questions, testing methods from food science literature were used to evaluate consumer liking of sensory attributes of the grains of the three bean varieties. The home-use testing (HUT) approach used in rural areas availed respondents' households to cook bean grains of the three varieties and eat them with all the members of the household. Each variety was given to each household with a day interval in order to allow them to have sufficient time to cook and eat the variety, and the order in which the three bean varieties were given was randomized across