

**PASHFARM COUNTRY CASE STUDY**

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**PROJECT NAME: CONSUMER ACCEPTANCE OF BIOFORTIFIED IRON BEANS IN KENYA: A WILLINGNESS TO PAY AND CHOICE EXPERIMENT APPROACH**

**Draft Manuscript 2: Consumer Preferences for Biofortified Iron Beans: Results from a Willingness to Pay and Choice Experiment in Kenya**

By

Forah Obebo, Josiah Ateka, Joseph Muniu, Juliana Kiio, Christine Mwangi and Amanda Kinya

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# Abstract

Micronutrient deficiencies are a major global health problem affecting an estimated two billion people. Iron deficiency is a public health issue in many developing countries including Kenya, particularly among women, children, and other vulnerable populations. Integrating Biofortified iron beans (BIBS) into the diets could bridge public health burden in the population. Despite the release and promotion of BIBs in the country, their adoption has been slow with varied uptake in both production and consumption. Our study applies the willingness to pay (WTP) and choice experiments to assess preferences for BIB attributes among consumers. Using a dataset of 561 respondents, we compare the WTP among consumers in a large urban city (Nairobi) with those in a rural area (Bomet) where BIBs have been promoted. In the eliciting WTP, we test whether message framing (gain vs loss framed) has varied effects among in the rural-urban context. The study further utilises choice experiments to distil the most important bean attributes among rural-urban and men and women consumers. In view of BIBs being similar looking to the conventional varieties, we test the extent to which biofortification attribute is important for bean preferences. Our descriptive analysis shows that nine in every ten consumers considered flatulence as key attribute when choosing the bean variety. Cooking time, taste, and price were also important attributes for more than half of the consumers. However, biofortification attribute was not an important attribute for most consumers (33.5%). Consumers are willing to pay (WTP) a premium of 38.5% for the BIBs above the price of their preferred conventional beans (KES 165.7). Consumers` WTP was more under gain-framed messaging (KES 65.77) than loss-framed messaging (KES 62.72). Unlike urban consumers, rural counterparts had a higher WTP KES 86.40 under gain frame-messaging compared to KES 63.56 under loss framed messaging. At the same gain-framed WTP (KES 66.99) was higher among females than loss framing (KES 61.47). In addition, wealth index positively influences WTP and more significantly among urban consumers. Unlike the rural sample where the coefficients of the index are not significant, wealth index positively influences WTP among female consumers. Interestingly, awareness on nutrient enriched foods was negatively influenced WTP, likely that some consumers associated biofortification with genetically modified foods, and other negative views on the science. Perceived behavioral control (PBC) indicated a significant and positive effect WTP in the sample as well as male and female respondents. Results from the conditional logit model indicate that yellow and sugar beans are more likely to be chosen by consumers compared to the red colour of the BIBs. The model also indicates that biofortification coefficient was positive and statistically significant (p < 0.10) for urban consumers and female-headed households. Overall, the biofortification is not considered as important attribute for the study sample. This may be associated with the low awareness on the benefits of biofortification among the population. However, considering that flatulence, cooking time and taste are main preferred attributes of the BIBs, promotional messages including these attributes could be used to accompany the biofortification messages to catalyze the adoption of BIBs. Based on the findings, we recommend the need for targeted nutrition education programming to increase the adoption BIBs especially among rural and consumers.

# 1.0 Introduction

Micronutrient deficiencies are aggravating factors for health status and quality of life especially in developing countries. In Kenya, the triple burden of malnutrition and food insecurity is characterized by the coexistence of child stunting, micronutrient deficiencies especially among women and, overweight and obesity in the population (KNBS and ICF, 2023). With the increasing focus on nutrition as part of Sustainable Development Goals (SDGs), attention is shifting to healthy dietary patterns as a mechanism for combating malnutrition as well as a range of non-communicable diseases (FAO, 2016). Biofortification is a proven and cost-effective intervention for addressing micronutrient deficiencies by improving the nutritional quality of the food in the population (Meenakshi et al., 2009; Foley et al., 2021). Under this strategy, Biofortified Iron Beans (BIB) varieties that contain significantly higher amounts of iron and zinc than the conventional varieties were released in the country in 2017. While the conventional beans have about 5 mg of iron per 100 grams, BIBs varieties can contain as much as 90 percent more iron (HarvestPlus, 2022). As one of the most widely legumes, BIBs can potentially address these deficiencies, contributing the Sustainable Development Goals of zero hunger and, good health and wellbeing.

Despite their release and promotion, BIB adoption has been slow with disparities in both production and consumption. Consumption of beans was 13kg/per person per year (Republic of Kenya, 2022) compared to a global consumption target of 18kg/per person per year (50 g/day) (Yanni, et al., 2023). Iron is one of the micronutrients of public health concern, together with Vitamin A, Zinc, and Iodine. Iron deficiency stands at 21.8 percent for pre-school children, 36.1 percent for pregnant women, 21.3 percent for not pregnant women (KNBS, 2011). The consumption of BIBs in Kenya is a promising option for addressing micronutrient deficiencies especially among women and children under five years.

In introducing novel products such as BIBs, there is need to evaluate consumer decision-making processes on food choice. Studies on consumer behavior suggest that food choice requires knowledge in different areas such as, marketing, psychology and economy. Past studies have found that different factors affect bean preferences, including BIBs. Varietal attributes (color, grain size, cooking time and gravy quality) and non-varietal factors such as income and information can influence consumption (Vaiknoras and Larochelle,2021; Oparinde, Biro and Murekezi, 2018; Swema and Mwinuka, 2021). Additionally, the efficacy of the ongoing promotional efforts in creating widespread acceptance of the BIBs is also uncertain in the case for the Base of the Pyramid (BOP) consumers - who are mainly targeted. This is in the context of many competing tradeoffs in preferences for bean attributes (price, nutrition, cooking time, convenience, color, flatulence, size, soup properties) and evidence showing that mixed beans which are often sold at discounted prices could be more popular among the urban poor consumers (Dalberg, 2019). More recently, there is a growing body of research on acceptance and WTP for biofortified foods. In the case of Sub-Saharan Africa (SSA), the existing studies on WTP for BIBs have mainly been based in Rwanda (Asare-Marfo, et. al., 2016; Oparinde, Biro and Murekezim 2018); Vaiknoras and Larochelle, 2021; Oparinde, et al., 2017).

Against this background, the paper makes three contributions to literature. First, we incorporate the role of context specific influences such as gender and residence (rural-urban), a contribution that has received limited attention in the literature. Adequate consideration of such tradeoffs and role of gender and other context specific variables such as residence has seldom featured in acceptance studies of biofortified foods. Gender dynamics play an important role in the consumption of beans given evidence showing that varietal and trait preferences in beans differ by gender (Nchanji et al., 2021; Siri et al., 2020).) Further, women and men and likely to place different value of the health benefits associated with BIBs (Samuel et al., 2023; Talsma et al., 2017). We also compare acceptance and preferences among consumers in a large urban city with those in a rural area where BIBs have been promoted. We also test the hypothesis whether proximity to BIB production area influences the acceptance and preferences for BIBs.

Secondly, many studies assessing the consumers` acceptance of food products have often adopted the willingness to pay (WTP) approach, which involves asking consumers if they would pay a certain amount of money for an assumed change in a good or service (Ateka et al., 2021; Arrow, Solow, Portney & Leaner,1993; Cameron & Quiggin, 1994). "In this study, we applied a modified version of the Willingness to Pay (WTP) framework, which enabled us to integrate message framing effects into our analysis. We specifically tested the effect of the framing of nutrition messages (positive vs negative) on BIB consumption. This approach allowed us to better capture the influence of different framing effects on respondents' decision-making, providing a more comprehensive understanding of how positive and negative messages impact individuals' WTP (Bosone and Martinez, 2017). This integration allows better understanding on how different types of messaging or information framing influences decision-making, and it can also help generate more accurate, reliable, and nuanced estimates of WTP (Oparinde et al., 2015, 2017 and 2018). The approach also provides insights that can be used to influence marketing, and communication strategies effectively.

Thirdly, the study proposes to use a combination of methodologies (choice experiment and double bonded WTP analysis) to uncover preferences for varietal bean attributes and assess WTP among urban poor consumers. The approach will allow for a more robust approach and shed better light on the consumer acceptance of food products of biofortified crops and on the factors that affect this acceptance. The application of choice experiments enabled us to distil the most important bean attributes among rural-urban and men and women consumers. Particularly, we assess extent to which biofortification trait is important for bean choice. This is because BIB varieties are similar looking to the common varieties making it difficult for consumers to observe the biofortification trait (Rubyogo et. al., 2019).

From the foregoing, the overarching question addressed in this study is, “how do the preferences of varietal bean attributes vary by region and gender? We focus on (i) willingness to pay for biofortified iron beans and (ii) choice experiment on important bean attributes. Understanding these attributes is important for scaling up BIB consumption.

# 2.0 Materials and Methods

## 2.1 Study design for willingness to pay for biofortification attributes

The study employed a consumer demand theory to develop a framework for assessing consumer preferences for bean attributes among consumers (Cameron and Trivedi 2005). Based on the theory, we assume that a consumer willing to purchase beans faces a choice between many alternative bean products in the market. The products have different attributes which in turn are associated with varying levels of utility. In making a choice, the consumer, based on his/her preferences, will compare the attributes offered by the available products and select the alternative that yields the highest utility (McFadden, 2000). The consumer is assumed to make trade-offs by agreeing to buy a product at the offered price if the utility from the proposed change is greater than the utility without the change (Chelang’a, Obare, Kimenju, 2013).

In this study, we specifically consider BIBs which is an attribute associated with increased iron content in beans, through conventional breeding practices. Biofortified beans have better agronomic characteristics and offer higher micronutrient content compared to conventional beans. We therefore consider two maximal (optimal) utility regimes associated with the consumption of BIBs and common beans. Equation 1 shows that the household or consumer will purchase BIBs if the maximal utility associated with BIBs is at least greater or equal to the expected utility from the consumption of common beans (CB).

(1)

The approach involves asking respondents if they would accept to pay a specified cash amount (bid) to obtain a change in quality of a good (Johnston et al., (2017). We asked respondents to indicate whether they would be willing to pay a stated premium (by using initial bids to be determined following initial fieldwork) to obtain a kilogram of BIB. We utilized the double bounded format of WTP which asks if the household would be willing to accept to pay some initial bid amount, and then a follow up question with a higher or lower bid, depending on the response to the first bid. If the respondent answers yes to the initial bid, they are presented with a higher bid and vice versa. The follow-up questions improve precision of WTP, which makes the double bounded approach to yield less biased estimates (Johnston et al., 2017; Perman et. al., 2003).

The general econometric model for the bounded WTP model is specified as

(2)

Where is a latent variable observed through the household acceptance or rejection of a certain bid to pay for BIB, represents bid amount that was presented to the respondent, is a vector of covariates likely to influence a household’s WTP, while and are parameters which were estimated while represents the standard error term (Verbeek, 2012)[[1]](#footnote-1). Under the double bounded WTP, respondents are asked respond to a follow-up bid that is lower if the initial bid is rejected or a higher one if in the initial bid is accepted, such that

. (3)

Based on the responses to the follow-up bid, four scenarios simulated from equation (3) are possible (see Khainga, Obare & Nyangena, 2018).

Answers yes to the first bid and no to the second bid C1: (4)

Answers yes to both bids offered C2: (5)

Answers no to the first bid and yes to the second bid C3: (6)

Answers no to both bids offered C4: (7)

Where,

C1: (8)

(9)

(10)

(11)

The mean WTP is estimated using a likelihood function constructed to allow and to be directly estimated using maximum likelihood estimation (Lopez-Feldman, 2012) as shown in Equation 12.

(12)

Where take the value of zero or one depending on the respective case of the target BIB consumer. Each consumer only contributes one of the four parts in the equation. represents the standard normal cumulative distribution function resulting in an ordered probit model.

From equation 12, the empirical mean WTP can be estimated, as

(13)

Where includes sample means of household, demographic and institutional characteristics, is a vector of estimated coefficients and is the coefficient on the bid.

## 2.2 Study design for choice experiment

Our assessment is based on the utility maximization framework, where households make consumption decisions with an objective of maximizing their utility (Singh et al., 1986). We use an extended utility maximization model which assumes that goods are not the immediate objects of preference but have associated attributes which are directly relevant to consumers (Lancaster,1966). Therefore, the demand for products is based on the product characteristics, or attributes, rather than the product itself. Following, Swema and Mwinuka (2021), the utility may be defined as;

(14)

Where, *Uij* is the is the utility of the *ith* individual derived from *jth* type of bean, *attj* is the specific bean attribute, is the specific individual attribute and is the error term for the ith individual. From the equation (14) we hypothesize that individuals can rank the choices based on perceived satisfaction derived from each type of bean variety.

To uncover the preferences both the descriptive and choice experiment approaches were used. The descriptive approach involved asking consumers to rank the preferences given a set of pre-selected preferences - following literature review and Focus Group Discussions (FGDs). The choice experiment is used to measure stated preferences and to measure the marginal value of product attributes (Lancaster, 1966). This is particularly important where certain traits such as biofortification are new and not widely traded in market (Lusk & Shogren 2007; Mwangi, 2022).

The choice experiment was constructed using six attributes; color, cooking time, bio-fortification, flatulence, taste and price. These attributes varied in levels (Table 1.1).

**Table 1.1: Attributes and attribute levels considered in the choice experiment design**

|  |  |  |
| --- | --- | --- |
| Attribute | Description | Levels |
| Color | Color represents the skin color of the bean before cooking. The attribute was included since it may affect the purchase depending on preference, market segment and use. Beans have multiple skin colors and therefore the study considered the most common bean colors in Kenyan markets which are red, yellow and sugar. | * Red * Yellow * Sugar |
| Cooking time | Cooking time represents the amount of time it takes to cook beans. The study considered time taken to boil beans, cooked without use of pressure. Cooking time is an important attribute as it affects the amount of fuel used and time used in meal preparation. Cooking time may range from 0.9 - 3 hours depending on variety, storage and source of cooking energy. | * 1 hour * 1.5 hours * 2 hours |
| Bio-fortification | Biofortification enhances the nutritional value of crops through conventional plant breeding practices. Biofortified beans are high in iron compared to conventional beans hence nutritionally important especially to children and women of reproductive age. | * Biofortified * Non-biofortified |
| Flatulence (Gas) | Flatulence is the accumulation of intestinal gas. Consumption of beans may lead to high to low levels of flatulence. Presence of flatulence may therefore discourage the consumption of some bean varieties. | * No Gas * Has no gas |
| Taste | Taste is one of the most important influencers of food choice. Taste of beans may range from sweet taste to a more ‘beany/earthy’ taste. It is therefore important to know whether taste affects choice of bean variety to consume. | * Less Tasty * Neutral * Tasty |
| Price per KG | Price reflects the amount of money that consumers pay for 1 kilogram of raw beans. This study considered a range that reflects the common bean prices in local Kenyan markets. | * KES.125 * KES. 150 * KES. 175 * KES. 200 |

Using the STATA software, we generated an efficient design with three blocks and each block containing six choice sets. A total of 18 choice sets were used in the experiment. The block design was used to avoid possible fatigue effects that may have result from administration of all the choice sets. Each consumer was randomly assigned one block. Consumers were therefore expected to compare 2 alternatives and a no purchase option for each choice question and then select their most preferred alternative.

In order to determine utility for each consumer, from alternative in each scenario , the utility can be denoted by:

(2)

Where represents the vector of coefficients for the different bean attributes for consumer and is the random error term.

A conditional logit model was used for estimation. In order to calculate the marginal effects for each of the attributes.

## 2.3 Data collection methods

This study employed a mixed-methods approach to assess the acceptance of BIBs among consumers. A cross-sectional survey of 561 households from Nairobi, largest urban city and Bomet, a rural County with relatively high production of BIBs, but with a relatively high malnutrition rates among pregnant women and children under five years (Figure 2). The choice of these two study areas allowed us to compare the rural-urban differences in acceptance of BIBs

|  |  |
| --- | --- |
| D:\PASHFARM\download.jpg | D:\PASHFARM\Map-of-Bomet-County-showing-study-area-Source-Kenya-Independent-Electoral-and-Boundaries_Q320.jpg  **Bomet County** |
| **D:\PASHFARM\download.png**  **Nairobi County** |

**Figure 2.3: Survey sites**

The sampling of survey respondents followed a three-step process. The first step involved a purposive selection of sub-counties within each region, taking into consideration the geography of the county, income status as well as BIB concentration (for the case of Bomet). The second step was to purposively select 1-2 low income to form an enumeration area. In the third, stage, we worked with community health promoters (CHVs) and randomly selected 20 – 40 respondents proportionate to the population in each enumeration area. Each CHV has a list of their households within a given area.

Information from the survey was complemented with qualitative data from KIIs and FGDs. Prior to the survey, two FGDs were conducted in (Kasarani Sub-County) to provide an understanding of key consumer choice and product attributes. Each FGD had 10 participants identified with the help of community health promoters (CHP). Each FGD had six women and four male participants. The key attributes identified included color, flatulence, cooking time, taste, price and form of presentation (loose verses packaged). This information was used to revise the questionnaire for administration.

**3.0 Results and Discussions**

We present results around five domains; (i) descriptive statistics of the sample, (ii) bean attributes and preferences (iii) willingness to pay for biofortified attributes and (iv) choice experiment. The results are organized around region and gender dimensions.

**3.1 Socio-demographic characteristics of bean consumers**

Our analysis is based on 561 households interviewed in Nairobi (309 households) and Bomet (252 households). Majority (71.7%) of the households were male-headed with their mean age being 38 years. Nearly two thirds of household heads had completed secondary level of education, with more males having completed university level of education. The study had more female respondents (66.7%) than male respondents (33.3%). The study adopted a design where at least one female member was interviewed as either a primary or secondary respondent to ensure gender perspectives and aspects of nutrition were addressed.

**Table 3.1:** **Sociodemographic** **characteristics of the respondents**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Variable | Metric | Total Sample | Region | | | Gender of head | | |
| **Urban** | **Rural** | **p-value** | **Female** | **Male** | **p-value** |
|  |  | N=561 | N=309 | N=252 |  | N=159 | N=402 |  |
| Age household head | Mean years | 38.0 (11.9) | 39.5 (11.3) | 36.2 (12.4) | 0.001 | 38.4 (12.4) | 37.8 (11.7) | 0.60 |
| Gender of household head | Female (%) | 28.3 | 31.1 | 25.0 | 0.11 |  |  |  |
| Male (%) | 71.7 | 68.9 | 75.0 |  |  |  |  |
| Gender of the primary respondent | Female (%) | 66.7 | 79.6 | 50.8 | <0.001 | 97.5 | 54.5 | <0.001 |
| Male (%) | 33.3 | 20.4 | 49.2 |  | 2.5 | 45.5 |  |
| Education level of head | Informal (%) | 9.1 | 10.0 | 7.9 | 0.013 | 15.7 | 6.5 | <0.001 |
| Primary (%) | 30.8 | 31.7 | 29.8 |  | 37.7 | 28.1 |  |
| Secondary (%) | 35.7 | 39.5 | 31.0 |  | 25.2 | 39.8 |  |
| Vocational (%) | 12.8 | 10.0 | 16.3 |  | 16.4 | 11.4 |  |
| University (%) | 11.6 | 8.7 | 15.1 |  | 5.0 | 14.2 |  |
| Total years of schooling of head | Years | 11.4 (3.5) | 11.2 (3.4) | 11.7 (3.5) | 0.096 | 10.5 (3.9) | 11.8 (3.2) | <0.001 |
| Marital status of head | Single (never married) (%) | 21.2 | 19.4 | 23.4 | 0.67 | 45.9 | 11.4 | <0.001 |
| Married (%) | 64.7 | 65.7 | 63.5 |  | 10.1 | 86.3 |  |
| Divorced/ separated (%) | 9.6 | 10.4 | 8.7 |  | 29.6 | 1.7 |  |
| Widowed (%) | 4.5 | 4.5 | 4.4 |  | 14.5 | 0.5 |  |
| Household size | Number | 3.6 (1.6) | 3.8 (1.5) | 3.4 (1.7) | 0.014 | 3.5 (1.8) | 3.7 (1.7) | 0.14 |
| Children below 5 years | Number | 0.5 (0.6) | 0.5 (0.6) | 0.5 (0.6) | 0.26 | 0.4 (0.5) | 0.5 (0.7) | 0.002 |
| Wealth index | Lowest income (%) | 33.3 | 18.1 | 52.0 | <0.001 | 37.1 | 31.8 | 0.47 |
| Middle income (%) | 34.4 | 40.1 | 27.4 | 33.3 | 34.8 |
| High income (%) | 32.3 | 41.7 | 20.6 | 29.6 | 33.3 |

**Consumer survey (June 2024): Standard deviation in brackets, where applicable**

The study sample had varying wealth levels. The wealth index is a composite measure of a household’s cumulative living standard and incorporates productive assets, non-productive assets and household utilities (World Food Program, 2017). Using the Principal Component Analysis (PCA) method, we estimated a composite index and divided into lowest, middle- and high-income levels. Households in the urban areas had a higher wealth index than those in the rural areas. In addition, there appeared no differences in the index between female- and male-headed households.

## 3.2 Bean attributes and preferences in Kenya

Various bean varieties with varying attributes exist in the market. Table 3.2 shows that the yellow variety was most preferred among urban consumers, due to lower flatulence, better taste, shorter cooking time, and an appealing look after cooking. On the other hand, Rose coco (a sugar bean) was more preferred by the rural consumers owing to availability in the production sites, lower flatulence and good taste. Nyayo varieties (red speckled) and Wairimu (red haricot) are also favored by some consumers due to their affordability (favourable price) and thick souping characteristics.

**Table 3.2: Bean preferences and other attributes in Kenya**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Indicator | Metric | Pool | Urban | Rural | P value | Gender head=Male | Gender head=Female | P value |
| Most preferred variety | Yellow | 48.30% | 75.70% | 14.70% | 0.001 | 56.00% | 45.30% | 0.13 |
| Nyayo | 6.80% | 6.80% | 6.70% |  | 5.70% | 7.20% |  |
| Wairimu | 6.10% | 7.80% | 4.00% |  | 6.90% | 5.70% |  |
| Rosecoco | 31.70% | 4.20% | 65.50% |  | 22.00% | 35.60% |  |
| Mwitemania | 0.70% | 1.30% | 0.00% |  | 0.60% | 0.70% |  |
| Main source of cooking energy for beans | Charcoal | 65.20% | 76.40% | 51.60% | 0.001 | 79.20% | 59.70% | 0.001 |
| Firewood | 17.80% | 1.30% | 38.10% |  | 11.90% | 20.10% |  |
| Gas | 12.70% | 15.90% | 8.70% |  | 3.80% | 16.20% |  |
| Electricity | 1.60% | 1.90% | 1.20% |  | 3.10% | 1.00% |  |
| Biogas | 0.20% | 0.30% | 0.00% |  | 0.00% | 0.20% |  |
| Kerosene | 2.50% | 4.20% | 0.40% |  | 1.90% | 2.70% |  |
| Cooking time | Minutes | 94.5 | 90.5 | 99.3 | 0.056 | 99.4 | 92.5 | 0.18 |
| Price of 1kg of beans in last purchase |  | 163.6 | 166.4 | 160.3 | 0.059 | 163.1 | 163.9 | 0.83 |
| Frequency of sourcing beans | Weekly | 53.10% | 65.40% | 38.10% | 0.001 | 49.10% | 54.70% | 0.51 |
| Twice a month | 20.70% | 19.70% | 21.80% |  | 23.90% | 19.40% |  |
| Monthly | 19.80% | 12.60% | 28.60% |  | 21.40% | 19.20% |  |
| Quarterly | 6.40% | 2.30% | 11.50% |  | 5.70% | 6.70% |  |
| Main decision maker on bean consumption | Head (Male) | 14.10% | 9.40% | 19.80% | 0.001 | 0.00% | 19.70% | 0.001 |
| Head (Female) | 32.10% | 36.20% | 27.00% |  | 89.90% | 9.20% |  |
| Spouse (Male) | 0.40% | 0.00% | 0.80% |  | 0.00% | 0.50% |  |
| Spouse (Female) | 42.20% | 45.30% | 38.50% |  | 3.10% | 57.70% |  |
| Whether household planted beans | Yes (n=252) | 54.8% | 0% | 54.8% |  | 46.00% | 57.70% | 0.11 |
| Variety of beans planted | Common bean (n=138) | 95.70% |  | 95.70% |  | 96.60% | 95.40% | 0.79 |
| BIB (n=138) | 10.10% |  | 10.10% |  | 20.70% | 7.30% | 0.034 |

**Consumer survey (June 2024): Standard deviation in brackets, where applicable**

Cooking time for beans depends on many factors, such as storage duration, storage condition and variety. We asked respondents to state their average cooking time. Our results (Table 3.2) suggest that beans were cooked for 94.5 minutes for the total sample, with rural consumers (99.3 minutes) taking longer than urban consumers (90.5 minutes). Majority of consumers used charcoal (65.20%) compared with firewood (17.80%) and gas (12.70%). The choice of source of cooking energy demonstrates the economic status of the respondents, with most of them being able to afford charcoal and firewood compared to other energy sources. Cooking time is considered a constraining factor to bean consumption especially for the urban consumers who have less access to cheaper sources of fuel or just lack the technology to address the constraint. FGDs revealed that consumers are currently using various mechanisms to reduce cooking time (soaking, cooking using a pressure cooker and, cooking with soda ash), reducing the value attached to cooking time. Ready to cook options especially in urban areas are also diminishing the value of shorter cooking time. Women influence the choice of beans due to the cooking time attached to the preference and choice of beans.

Table 3.2 shows the frequency at which a household purchases beans on average for home consumption. At least half of all respondents purchase their beans weekly, with urban consumers` weekly purchase being more dominant (65.40%) than their rural counterparts (38.10%). Rural consumers have longer purchase frequencies owing to the ease of getting beans from local markets or need to purchase more beans at the time prices are lower. Similarly, urban consumers face a higher price per kg (KES 166.4) of their beans than rural consumers (KES160.3).

Decision making on what is to be consumed has implications on the household’s nutrient mix. Female members (whether head or spouse) are the main decision makers on bean consumption. Yet female-headed households had lower income of KES 6000 compared to men headed households (KES 10,000). Moreover, female respondents exhibited moderate autonomy over income and expenditure decisions. For instance, 59 percent of all female respondents (n=361) reported using income the way their family or community expect. Lower income and agency compound the ease with which female household members can influence consumption of BIBs, especially if they are sold at a premium.

Our assessment further asked respondents about the value of different bean attributes using a five-point Likert scale, ranging from “not important at all” to “very important’’ (Figure 3.1). The results show that flatulence is a key factor influencing the choice of beans among consumers. Nearly 9 in 10 consumers consider flatulence as key attribute when choosing their variety. Consumers can avoid eating beans because they believe its consumption will cause them to have intestinal gas (Winham and Hutchins, 2011). This largely the reason why the yellow variety is widely accepted (Descrochers and Brauer, 2001). Further, cooking time, taste, and price were also important attributes (for more than half of the consumers) influencing consumer decisions on choice of varieties. The price component signifies the importance of the economic aspect in the choice of bean varieties.

Most consumers did not give a lot of regard to the biofortification attribute. The relatively low ranking could be associated with the fact that the micronutrient attribute is not readily identifiable or visible and awareness levels could be low. Often, consumers are more likely to be influenced by sensory attributes such as taste and texture compared to nutritional attributes (El-Nakhel et. al., 2020). Discussions with consumers revealed that increasing the consumption of BIBs could be achieved through awareness creation and behavior change communication. Promoting BIBs as having low flatulence, good taste, and faster cooking time would be a good entry point.

**Figure 3.1: Factors to consider when selecting beans for consumption (n=561)**

## 3.3 Willingness to pay for the biofortification attribute

Respondents were asked how much more they were willing to pay for bio-fortified iron beans over and above what they pay for the ordinary beans they currently purchase. For each, consumer, we randomly treated them with either gain-framed or loss-framed messaging. Gain-frame messaging reinforces the positive outcome associated with biofortification while loss-frame messaging emphasizes the nutritional consequences associated with not consuming BIBs. 46 percent of sample were treated with gain framed-messaging and the rest on loss-framed messaging.

We utilized the double bounded format of WTP which asks if the household would be willing to accept to pay some initial bid amount, and then a follow up question with a higher or lower bid, depending on the response to the first bid. If the respondent answers yes to the initial bid, they were presented with a higher bid and vice versa. The follow-up questions improve precision of WTP, which makes the double bounded approach to yield less biased estimates (Johnston et al., 2017; Taylor, 2006). In order to elicit responses, the study considered five treatments (bids) which were randomly assigned to the respondents (Table 3.3).

**Table 3.3: Distribution of responses across the treatment groups**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Treatment | Yes | Yes-Yes | Yes-No | No-Yes | No-No |
| 1.(20, 25, 15) | 94.0% | 93.28% | 0.75% | 0.75% | 5.22% |
| 2.(30, 35, 25) | 89.5% | 86.6% | 3.0% | 0.75% | 9.70% |
| 3.(40, 45, 35) | 80.6% | 76.26% | 4.32% | 3.60% | 15.83% |
| 4.(50, 55, 45) | 67.1% | 59.87% | 7.24% | 3.29% | 29.61% |

We first report results based on the mean willingness to pay by region and gender of respondent. Table 3.4 shows that the sampled consumer would be willing to pay a premium of KES 63.9 to obtain a kilogram of BIB. The mean price of the preferred bean variety in June 2024 was KES 165.7 suggesting that consumers are willing to pay a premium of 38.5% above the price of the preferred conventional beans. This premium is higher than the one estimated by Rubyogo et al (2019) who found that the price rural consumers in Tanzania were willing to pay to obtain one kilogram of HIB was 25 percent above the average market price for conventional beans. The difference in WTP is expected since in our study, we have a component of urban consumers who have a higher purchasing power than their rural counter parts. Our results further show that consumers are willing to pay slightly more under gain-framed messaging (KES 65.77) than loss-framed messaging (KES 62.72). Thus, positive messaging of the nutritional value of BIBs is a plausible strategy for demand creation activities.

**Table 3.4: WTP for Bio-fortified Iron Beans (KES)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Pool | Urban | Rural | Gender of respondent = male | Gender of respondent = female |
| Total sample | 63.87 | 60.81 | 71.06 | 64.15 | 63.61 |
| Gain framed messaging | 65.77 | 58.51 | 86.40 | 59.71 | 66.99 |
| Loss framed messaging | 62.72 | 62.57 | 63.56 | 66.91 | 61.47 |

Disaggregation by region reveals that among urban consumers, the loss-framed messaging outperformed the gain framed messaging. In contrast, the rural consumers were willing to pay KES 86.40 under gain framed messaging compared to KES 63.56 under loss framed messaging. We suggest that rural respondents consume beans more regularly making it easier to appreciate it`s nutritional value. This may have been driven by the fact that rural respondents reported higher levels of awareness of BIBs (14.68%) than the urban respondents (7.12%). These differences are associated with efforts by organizations to promote BIBs in the rural county (CIAT, 2020). Understanding the level of awareness and information on BIBs ins a prerequisite for carting the right messages for its promotion.

Across gender, there was observed higher WTP under gain framed messaging (KES 66.99) than loss framing (KES 61.47). This may as well be driven by the finding that more female respondents had heard about BIBs (and their varieties) than male respondents. Further, there is evidence to suggest that men especially in developing countries are often unwilling and lack the motivation to engage with health-related information (Stefan, 2015). Therefore, their WTP response to loss-framed consequence is higher.

In our second result, we assessed determinants of WTP using an ordered probit model. We report eight models across the full sample, residence and gender, disaggregated by gain or loss treatment. Table 3.5 shows varied results across the models. Wealth index is positively associated with WTP in the full sample and as well as among urban consumers. Unlike the rural sample where the coefficients of the index are not significant, wealth index positively influences WTP among female consumers. As suggested earlier, empowering female consumers is critical in uptake of BIBs, as they have large control over food choices in the household. Further, higher household expenditure reduces WTP. The results suggest that higher household expenditure is associated with lower income levels, implying lower purchasing power. This is because the monthly median income of the sample was KES 9,000, with female headed household earning KES 6000 compared to men headed households (KES 10,000). This would also explain the similar effect on WTP among female consumers.

**Table 3.5 Determinants of WTP for BIBs using ordered probit model**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Model | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Total sample  Gain framed | Total sample  Loss framed | Urban  Gain framed | Urban  Loss framed | Rural  Gain framed | Rural  Loss framed | Gender respondent= Male | Gender respondent=  Female |
| Gender head Male=1 | -14.47\*\* | -4.275 | -9.379 | -0.506 | -38.31 | -17.47\*\* | -110.0 | -4.209 |
| (6.520) | (4.498) | (5.842) | (5.868) | (25.31) | (7.949) | (6722.3) | (4.124) |
| Age of head | -0.0909 | -0.151 | 0.0847 | -0.346 | -0.327 | 0.111 | -0.459 | -0.0848 |
| (0.269) | (0.205) | (0.268) | (0.292) | (0.800) | (0.297) | (0.376) | (0.193) |
| Household size | 1.800 | 4.727\*\*\* | 1.284 | 2.353 | -0.00634 | 5.668\*\* | 4.498\* | 2.381 |
| (2.238) | (1.802) | (2.221) | (2.512) | (6.590) | (2.603) | (2.598) | (1.687) |
| Wealth index | 3.504\* | 2.921\*\* | 4.787\*\* | 4.848\*\* | 1.814 | 2.084 | 2.292 | 2.528\* |
| (1.818) | (1.490) | (1.933) | (2.453) | (4.859) | (1.839) | (2.013) | (1.384) |
| Total food expenditure | 0.000226 | 0.00340 | -0.00521 | -0.00254 | -0.00852 | 0.00621\*\* | 0.00114 | 0.000214 |
| (0.00276) | (0.00220) | (0.00283) | (0.00335) | (0.00837) | (0.00312) | (0.00316) | (0.00207) |
| Group membership | -9.130 | 1.350 | -8.787 | 13.49\*\* | -3.100 | -19.31\*\* | -15.09\*\* | -0.744 |
| (5.611) | (4.337) | (5.511) | (6.098) | (16.52) | (8.462) | (7.548) | (4.020) |
| Children <5 years | 2.230 | -5.536 | 3.219 | -2.667 | -3.872 | -0.446 | 7.345 | -5.558\* |
| (4.607) | (3.574) | (4.451) | (4.883) | (13.79) | (5.529) | (5.922) | (3.336) |
| Total years of schooling head | 0.706 | -0.804 | 0.698 | -1.077 | 1.290 | -1.422 | 0.816 | -0.563 |
| (0.832) | (0.703) | (0.759) | (0.935) | (2.484) | (0.999) | (1.107) | (0.603) |
| Total household expenditure | -0.00322 | -0.0768\*\*\* | -0.00743 | 0.00424 | 0.000123 | -0.00141\*\* | 0.00808 | -0.00641\*\* |
| (0.0601) | (0.0295) | (0.00635) | (0.00750) | (0.0215) | (0.00652) | (0.000939) | (0.00281) |
| Planted beans | 9.420 | 5.964 | 0 | 0 | 19.24 | 12.43\*\* | 14.24\* | 4.098 |
| (6.855) | (5.351) | (.) | (.) | (17.36) | (6.236) | (7.517) | (5.569) |
| Awareness on nutrient enriched foods | -2.438 | -10.86\*\* | -3.597 | -5.356 | 30.81 | -11.70\* | -3.988 | -3.784 |
| (6.325) | (4.664) | (5.824) | (5.705) | (24.92) | (6.675) | (7.467) | (4.306) |
| Awareness of Anaemia | -1.010 | 6.664 | -0.250 | -2.753 | -6.141 | 11.20 | 16.05 | 12.24\*\* |
| (7.110) | (5.725) | (6.878) | (7.519) | (19.31) | (9.657) | (10.09) | (5.350) |
| Awareness on BIBs | -13.11 | 4.682 | 5.535 | 109.5 | -67.88\* | -2.449 | -11.30 | -3.953 |
| (9.642) | (7.245) | (12.99) | (5534.4) | (37.21) | (8.256) | (11.31) | (6.775) |
| Attitude index | 0.801 | 0.220 | 1.088\* | 0.956 | 0.629 | 0.390 | 0.168 | 0.562 |
| (0.568) | (0.437) | (0.614) | (0.636) | (1.486) | (0.643) | (0.648) | (0.419) |
| Subjective norms index | -1.451 | 0.742 | -0.389 | 1.052 | -4.890 | 1.578 | -0.632 | -0.491 |
| (1.171) | (0.868) | (0.990) | (1.076) | (4.196) | (1.553) | (1.373) | (0.831) |
| PBC index | 4.763\*\*\* | 2.884\*\* | 1.506 | 2.797 | 14.75 | 0.581 | 8.805\*\*\* | 2.679\*\* |
| (1.776) | (1.288) | (1.570) | (1.793) | (7.847) | (1.711) | (3.040) | (1.136) |
| Estimated WTP | 64.05 | 62.65 | 55.14 | 72.52 | 84.44 | 61.56 | 91.90 | 63.63 |
| Observations | 258 | 293 | 148 | 157 | 110 | 136 | 182 | 369 |

Marginal effects; Standard errors in parentheses (d) for discrete change of dummy variable from 0 to 1 \* *p* < 0.10, \*\* *p* < 0.05, \*\*\* *p* < 0.0

Awareness on nutrient enriched foods exhibited negative influence on WTP, implying that higher the greater the awareness, the lower the WTP. Findings from FGDs suggest that some consumers confused biofortification with genetically modified foods, and products containing artificial chemicals. This underscores the need for enhanced awareness campaigns to educate consumers about the benefits of fortification and clarify misconceptions. This was observed in the case rural consumer model, where awareness of BIBs negatively influenced WTP.

Perceived behavioral control (PBC) had a positive effect on WTP in the sample as well as male and female respondents. PBC is the perceived ease or difficulty of carrying out a behavior. (Ajzen,1991; Ajzen, 2015). PBC was measured using three (3) statements around; decision power over to buying and consuming BIBs, financial capability to buy BIBs and complete information and awareness regarding where to get BIBs. Collectively, consumers who had a higher PBC were likely to pay more for the BIBs. FGDs with consumers revealed that female consumers had a lower PBC especially the financial capability to buy BIBs and information, regardless of their higher willingness to consume BIBs than male consumers.

## 3.4 Choice experiment results

To assess the preferences for bean attributes, we first calculated the mean scores based on rating the consumers gave each attribute. The rating was on scale of 1(never considered) to 5 (always considered). Table 3.6 presents the mean scores indicating how often attributes were taken into account during the choice experiment. Flatulence was rated as the most critical attribute to consumers, with the highest mean score. This was followed closely by taste and bio-fortification, indicating their significant influence on consumer decision-making. Biofortification was rated higher by rural consumers than urban consumers. This points to differences in information gaps and need for programmes that promote access to nutritional informational to consumers. Cooking time, price and color were also considered important bean attributes factors but to a lesser extent compared to flatulence.

**Table 3.6: Mean values of bean attributes used in the beans**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Total sample | Gender of respondent= Female | Gender of respondent= Male | p-value | Urban | Rural | p-value |
| Color | 2.9 | 2.9 | 3.0 | 0.35 | 2.8 | 3.1 | 0.032 |
| Cooking Time | 3.0 | 3.0 | 3.0 | 0.55 | 3.2 | 2.7 | 0.001 |
| Flatulence | 4.5 | 4.5 | 4.5 | 0.7 | 4.5 | 4.6 | 0.032 |
| Bio-fortification | 3.3 | 3.3 | 3.4 | 0.48 | 3.1 | 3.6 | 0.001 |
| Taste | 3.6 | 3.7 | 3.6 | 0.29 | 3.7 | 3.6 | 0.14 |
| Price | 3.2 | 3.2 | 3.2 | 0.94 | 3.3 | 3.1 | 0.014 |

The choice experiment was further analysed using a conditional logit model. Results from the conditional model results are presented in Table 3.7. The model is used to determine the relationship between each level of an attribute and the choice that the respondent made. The results show that, in relation to red colour, yellow and sugar beans are more likely to be chosen by consumers. Particularly, the yellow variety is linked with low flatulence compared to red varieties. Similarly, the results show that beans with no flatulence were the more preferred across gender and residence. This suggests that the BIB promotion strategy for must demonstrate this attribute for it to gain acceptance.

The acceptance of biofortified attribute had mixed results. For the whole sample, the biofortification coefficients was not significant, implying that in the face of trade-offs, the biofortification attribute was not important for the sample consumers. This is associated with low awareness of the biofortification intervention among the population. However, for urban consumers and female-headed households, the biofortification coefficient was positive and statistically significant. FGDs affirmed that urban respondents had a better understanding of biofortification than the rural consumers. Also, female headed households were more sensitive to nutritional information than their male counterparts. Leveraging on urban and female consumers is a good entry for promoting uptake of BIBs. Also intensifying awareness programmes is key for encouraging choice of BIBs especially among rural consumers.

**Table 3.7: Conditional logit regression of the choice experiment attributes**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|  |  | Total sample | Gender head= Male | Gender head= Female | Gender respondent= Male | Gender respondent= Female | Urban | Rural |
| Color | Yellow | 0.892\*\*\* | 0.898\*\*\* | 0.889\*\*\* | 1.027\*\*\* | 0.842\*\*\* | 0.738\*\*\* | 1.124\*\*\* |
| (0.0614) | (0.0726) | (0.117) | (0.114) | (0.0736) | (0.0806) | (0.0980) |
| Sugar | 1.193\*\*\* | 1.300\*\*\* | 0.938\*\*\* | 1.519\*\*\* | 1.056\*\*\* | 0.915\*\*\* | 1.613\*\*\* |
| (0.0671) | (0.0795) | (0.128) | (0.123) | (0.0810) | (0.0886) | (0.108) |
| Cooking time |  | 0.494\*\*\* | 0.523\*\*\* | 0.459\*\*\* | 0.542\*\*\* | 0.483\*\*\* | 0.779\*\*\* | 0.0952 |
|  | (0.0690) | (0.0812) | (0.133) | (0.123) | (0.0837) | (0.0923) | (0.108) |
| Bio fortification |  | 0.0450 | 0.00345 | 0.157\* | 0.0918 | 0.0291 | 0.155\*\* | -0.0732 |
|  | (0.0473) | (0.0554) | (0.0924) | (0.0842) | (0.0576) | (0.0637) | (0.0722) |
| Flatulence |  | 1.472\*\*\* | 1.482\*\*\* | 1.475\*\*\* | 1.637\*\*\* | 1.420\*\*\* | 1.300\*\*\* | 1.792\*\*\* |
|  | (0.0527) | (0.0624) | (0.101) | (0.0971) | (0.0636) | (0.0677) | (0.0890) |
| Taste | Tasty | -0.175\*\*\* | -0.147\*\* | -0.267\*\* | -0.178 | -0.190\*\* | -0.205\*\* | -0.146 |
| (0.0628) | (0.0745) | (0.118) | (0.114) | (0.0760) | (0.0837) | (0.0966) |
| About right | 0.452\*\*\* | 0.498\*\*\* | 0.352\*\*\* | 0.520\*\*\* | 0.425\*\*\* | 0.573\*\*\* | 0.303\*\*\* |
| (0.0656) | (0.0775) | (0.125) | (0.117) | (0.0798) | (0.0864) | (0.103) |
| Price |  | 0.0120\*\*\* | 0.954\*\*\* | 0.0179\*\*\* | 0.00623\*\*\* | 0.0145\*\*\* | 0.0124\*\*\* | 0.0126\*\*\* |
| (0.00109) | (0.0013) | (0.002) | (0.002) | (0.0013) | (0.00143) | (0.0017) |
| Observations | | 9792 | 7020 | 2772 | 3258 | 6534 | 5346 | 4446 |

**Reference category for colour=red; taste=tasty**

Marginal effects; Standard errors in parentheses; (d) for discrete change of dummy variable from 0 to 1; \* *p* < 0.10, \*\* *p* < 0.05, \*\*\* *p* < 0.01

The coefficient for cooking time was positive suggesting that consumers could forgo the attribute (beans with shorter cooking time) to obtain the most preferred attribute in that choice set. FGDs revealed that consumers are currently using various mechanisms to reduce cooking time (soaking, pressure cooker and, cooking with soda ash). This may explain why this attribute is fungible for a specific consumer segment.

Surprisingly, the price coefficients were negative and statistically significant in all models, implying that options with higher prices were more likely to be chosen compared with options with lower prices. We suggest that consumers consider other options too important that they are willing to pay more to have these options. This view may be supported by a high WTP that was discussed in the previous section. A similar argument may be given for taste, which show surprising results. Consumers often associate bean color and flatulence with a certain taste, result in a mixed result.

# 4.0 Conclusions and recommendations

This study assessed consumer preferences for BIBs, which possesses nutritional benefits, relative to the conventional beans in Kenya. Data from a willingness to pay and choice experiments were used to estimate ordered probit and conditional logit models, which provides estimates of the WTP for BIBs and consumers’ attribute-based utility functions under different scenarios across residence and gender differentiated experiences. We found that consumers are willing to pay a premium 38.5% above the price of the preferred conventional beans. We further found that consumers, particularly females are willing to pay slightly more under gain-frame messaging than loss-frame messaging, pointing to the value of positive messaging of the nutritional value of BIBs in demand creation activities. Assessment of determinants of WTP showed that wealth index positively influenced higher WTP in the study sample and as well as among urban sampled consumers revealing the importance of economic factors. Awareness on nutrient enriched foods exhibited negative influence on WTP, implying the need for enhanced awareness campaigns to educate consumers about the benefits of fortification and clarify misconceptions.

The results of the choice experiment affirm that flatulence is a critical attribute to consumers together with yellow and sugar varieties which are associated with low gas. However, biofortification attribute is more important for urban as well as female consumers. The results suggest gaps in information regarding biofortification. Further, in the face of tradeoffs, consumers are willing to pay more or select the longer cooking attribute.

From the foregoing, consumer acceptance strategies must account for residence, gender differentiated experiences and preferences. Leveraging on urban and female consumers is a good entry for promoting uptake of BIBs. Also intensifying awareness programmes is key for encouraging choice of BIBs especially among rural consumers. A mix of loss and gain framed messages are important for diverse audiences, with emphasis given to attributes of low flatulence, taste and shorter cooking time.

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