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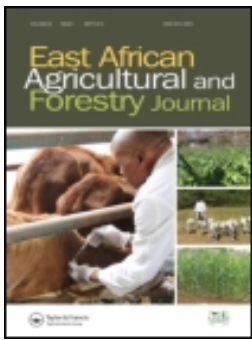
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## Determinants of Consumers' Choice and Willingness to Pay for Biofortified Pearl Millet in Kenya

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### ABSTRACT

Globally, micronutrient deficiency is a major health concern as more than two billion people suffer from iron deficiency, 1.75 billion are at risk of low zinc intake, while 127 million pre-school children suffer from vitamin A deficiency. Consumption of iron biofortified pearl millet is one optimal strategy for reducing micronutrient deficiencies, which is a major health concern. However, its consumption is unclear due to changes in product traits (appearance, aroma and flavour) from biofortification. Therefore, we centred on the hypothetical introduction of a biofortified pearl millet variety in Mbeere District, Kenya, where most staple crops record poor yields. We used a contingent valuation method in estimating consumer willingness to pay (WTP), on a sample of 100 biofortified pearl millet consumers. Our findings indicate that consumers were willing to pay an average premium of 42 percent above the prevailing market price of finger millet varieties. Factors directly influencing WTP were: frequency of consuming finger millet; whether consumer is a household decision maker or otherwise; household income and consumer's previous experience; and level of awareness concerning the benefit of consuming biofortified pearl millet products. These results suggest the need for market segmentation with more attention given to high-income households with good knowledge of pearl millet in promoting biofortified pearl millet products.

### KEYWORDS

Biofortification; consumer choice; malnutrition; micronutrient; pearl millet; willingness to pay

## Introduction

Micronutrient deficiency (especially vitamin A and iron deficiency) is a global health concern as it compromises the quality of life. Globally, more than two billion people in rural areas suffer from iron deficiency while 127 million preschool children suffer from vitamin A deficiency (FAO, 2012). In Kenya, for instance, more than 3.8 million pre-school children suffer from vitamin A deficiency (MI, 2004; UN, 2004). Most of these are from low-income households in rural areas, and may increase their vitamin A levels by increasing the consumption of processed staples such as pearl millet. However, the commonly available pearl millet variety in Kenya contains low levels of micronutrients (iron and vitamin A).

Biofortification (increasing a crop's nutrient content through breeding) is considered a cost effective method of targeting rural areas (Saltzman *et al.*, 2013). It ranks fifth out of

the ten ways of curbing malnutrition in the Copenhagen Consensus report (Biol *et al.*, 2015). The idea behind biofortification is that most rural households are poor and cannot afford diets rich in fruits, vegetables and animal products, therefore scientists research affordable crops and improve their nutrient levels. Successful biofortification requires three conditions: finding marker lines with increased micronutrient content; establishing the nutritional worth of biofortified crops; and consumer acceptance of biofortified varieties as part of household purchases (Saltzman *et al.*, 2013). Although successes have been reported in the first two conditions (van Jaarsveld *et al.*, 2005; Jaim and Hossain, 2007; Low *et al.*, 2007; Chowdhury *et al.*, 2009), limited information exists on consumer acceptance of biofortified pearl millet. This study sought to bridge this gap.

### **Pearl millet development and utilization**

The history of pearl millet (*Pennisetum glaucum* (L.) R. Br.) consumption dates back over 40,000 years in the Sahel region of Africa (National Research Council, 1996). It is ranked third (together with sorghum and finger millet) amongst East African staples in terms of production. In Kenya, pearl millet products are recommended for children, the elderly and convalescents due to their high levels of zinc, iron and protein. However, because of poor infrastructure, overreliance on government maize subsidies and the widespread poverty common in Kenya's rural areas, access to commercially fortified products is limited. Households are therefore forced to rely on diets of sweet potatoes and white maize, which are iron deficient or less iron rich. In 2010, pearl millet received an endorsement from the Association for Strengthening Agricultural Research in Eastern and Southern Africa as a desert 'king' while Biodiversity International endorsed pearl millet products as alternatives for curbing childhood malnutrition (ASARECA, 2014; Mueni *et al.*, 2014).

To provide the recommended dietary iron, magnesium and phosphorus, new biofortified varieties of pearl millet (KAT PM1, KAT PM2, ICVM and KAT PM3) were developed by the International Crops Research Institute for the Semi-Arid Tropics in collaboration with partners (Egerton University and the University of Nairobi). These improved pearl millet varieties contain higher iron concentrations, equivalent to between 7.5 mg/100 g and 1.9 mg/100 g better than traditional varieties (Nambiar *et al.*, 2011). This means that if biofortified pearl millet products are promoted, micronutrient (especially iron) deficiency levels might be alleviated among pearl millet consuming populations. However, as biofortification changes product traits (appearance, aroma and flavour) in ways likely to influence acceptance, knowledge of consumer acceptability and willingness to pay (WTP) is important. Even though empirical evidence on consumers' willingness to pay for biofortified staple crops in Africa exists (De Groote and Kimenju, 2008; Stevens and Winter-Nelson, 2008; Chowdhury *et al.*, 2009; De Groote *et al.*, 2010), few studies have focused on consumers' WTP for biofortified pearl millet products common in the Arid and Semi-Arid Lands of Kenya.

### **Determinants of willingness to pay**

In determining the market potential of hypothetical products, consumer WTP studies are commonly used. In such studies, socio-demographic, perceptual, psychological and

institutional factors that may influence consumer WTP are hypothesised. In Kenya, for example, Bett *et al.* (2013) showed that consumers were willing to pay a premium of 23.6 percent per kilogram and 41.5 percent to obtain indigenous chicken meat and eggs respectively. Important factors affecting WTP in that study included age of consumers, income levels, education, family size, price of substitute products and taste/flavour (Bett *et al.*, 2013). Kimenju and De Groote (2005) found that Kenyan consumers were willing to pay 13.7 percent more for genetically modified maize meal over their favourite brand's mean price. Household monthly income, education levels and trust positively influenced consumers' WTP estimates. Ngigi *et al.* (2010) showed that Kenya's consumers were willing to pay 39 percent more for leafy vegetables with healthy attributes in open-air markets. Presence of children in a household, safety concerns, income and consistency of consumption determined a household's WTP.

Regarding how much consumers were willing to pay, De Groote *et al.* (2011) found Kenyan consumers willing to pay a 24 percent premium for fortified maize but this depended on consumer familiarity and levels of awareness. Chelang'a *et al.* (2013) found that Kenyan consumers were on average WTP a premium of 79 percent to obtain African leafy and exotic vegetables. They found a positive association between presence of children in a household, years of schooling and age of household decision maker, as well as the number of years respondents had been consuming the vegetables and WTP. Alemu *et al.* (2015) reported that Kenyan consumers had a preference for and were willing to pay a premium to obtain termite-based food products with a high nutritive value. However, they did not estimate the mean amount for which there was a willingness to pay. Jerop *et al.* (2013) also noted that Kenyan consumers were willing to pay a 38 percent premium to obtain goat's milk. Factors identified included age, education levels and number of children in a given household. Emukule *et al.* (2011) showed that a consumer's level of awareness significantly affects their WTP for camel milk. On average, consumers were WTP a 7 percent price premium over a unit volume to obtain camel milk.

## Materials and Methods

This study was carried out in Mbeere District (Latitude 0°20'2" and 0°50'2" S; Longitude 37°16'2" and 37°56'2" E), Kenya. The district has a population of 130–185 persons, of which 29 percent of the children (6–59 months) were stunted, 4 percent wasted and 19 percent underweight (KNBS, 2009). To reduce malnutrition, the pearl millet innovation project objective was to breed high yielding pearl millet varieties adaptable to dry-land areas. As a result, KAT PM 1, KAT PM 2, KAT PM 3 and ICVM varieties were produced and farmer trials done to test their suitability. This study examined these newly introduced varieties and their attributes.

In the Mbeere district, 90 percent of the population are considered to be pearl millet consumers, therefore, using 50 percent as a proportion of importance was considered a representative size with minimal error. Following the formula by Kothari (2004) and a margin of error as 8.95 percent, 100 consumers aged 18 years and above were selected using simple random sampling to participate in the survey between June and August 2012.

Face-to-face interviews were conducted in Ishiara, Siakago and Motuobare markets of Mbeere District. By choosing market centres where actual purchases are undertaken, the true views of actual decision makers were incorporated into the study. Of the total

consumers, only those purchasing finger millet for home consumption were interviewed. The selection of finger millet consumers as a comparison group was based on our 2011 baseline survey in which former pearl millet consumers reported to have shifted to finger millet (Kimurto and Obare, 2012). This means that in the area, consumers use finger and pearl millet interchangeably. The 75 respondents with positive WTP responses to the first question were provided with an option of selecting any of the five-bid amounts (10, 20, 25, 50 and 75 percent). Finally, we structured a contingent valuation (CV) survey questionnaire to cover information relating to consumers' level of awareness, preference towards millet products, WTP and socio-demographic characteristics. We verified this model significance through a chi-square test statistic.

### **Contingent valuation procedure**

Willingness to pay (WTP) is the amount of money a consumer is willing to give to obtain a product (in this case a biofortified pearl millet product) given their preference, income level and other characteristics (Ramasubramanian, 2012). It can be estimated using the contingent valuation method (CVM). The CVM involves creating a hypothetical market for a product by asking consumers whether they are willing to pay and how much they would pay to obtain a product. The method uses a stated preference approach based on the direct elicitation technique of an individual's preference. Although its critics believe that it is a poor indicator of actual WTP, it is flexible, can measure use and non-use value and therefore its fundamental utility is globally supported.

In determining WTP estimates, first, consumers were given hypothetical information concerning the benefits of biofortified pearl millet products. They were then requested to state their WTP estimates based on the information given. If the consumer answered 'yes', showing his willingness to pay, they were presented with a follow-up question with predetermined WTP premium amounts of 10, 20, 25, 50 and 75 percent- sometimes called the semi-double bound contingent valuation method. For instance, if a consumer chooses a 'yes' option for a 10 percent premium, he is given a second higher premium option, which in this case was 20 percent. This process continued until the consumer selected the highest WTP estimate. Consumers were also given an option to deny the given set of premium bids in the second stage by selecting a zero bid thus resulting in a unique scenario of a 'yes-no' response (sometimes called stuck in the middle) for those with a positive WTP response to the first question. This method is simple and enlightens unaware respondents who pick from options that give them a range of predetermined price premiums. Lusk *et al.* (2004) found that the use of a second price auction generated higher valuations than Becker-De-Groot-Marschak, English and random  $n^{\text{th}}$  price auctions. However, providing respondents with good information beforehand increases the chances of getting good results.

### **The econometric model**

When presented with a purchase situation, consumers are faced with two distinct but interrelated decisions: whether or not to buy and how much to pay. For consumers whose answer is yes to the first question, a follow up question of how much to pay (WTP amount) to get the product is posed. Separating these decisions hinges on the

notion that they are influenced by a different set of explanatory variables and considering the cross sectional nature of our data, a suitable econometric model is a Heckman's two-stage model (Heckman, 1979).

A two-stage Heckman model assumes that one set of independent variables affects consumer's decision to pay while a different set of variables affects the amount of premium consumers are WTP. The model also allows for potential correction of sample selection bias common in such studies. As variables influencing each decision (participation and amount paid) are different, a bid regression or an Inverse Mills Ratio (IMR) obtained from the Probit model is included.

In the first stage or participation level, a standard Probit regression model was estimated using a likelihood ratio statistic to obtain an Inverse Mills Ratio (IMR) used in the second equation. The dichotomous equation (WTP or not WTP) is denoted by equation 1:

$$P_i = Z_i\beta + \varepsilon_i \quad (1) \text{ Probit models}$$

$$P_i = 1 \text{ if } y_i^* = 1 \quad (2)$$

$$P_i = 0 \text{ if } y_i^* = 0 \quad (3)$$

The dependent variable i.e. dichotomous variable  $P_i$  (which in this study is whether a consumer is willing to pay for biofortified pearl millet or otherwise) assumes a value of one if consumers are willing to pay a premium or zero otherwise. If the dependent variable is one, it represents the magnitude of latent utility associated with pearl millet attributes and therefore shows the utility of participation. The value  $y_i^*$  represents the latent variable of the model and  $Z_i$  is the predictor variable of observable characteristics of individual, consumption behaviour (frequency of consumption) among other factors,  $\beta$  are parameter vectors to be estimated while  $\varepsilon_i$  is the error term representing unobservable characteristics which is normally distributed with a mean of zero and a fixed variance.

Once a consumer has deemed the product as desirable, he decides how much he is willing to pay. Thus there are possibilities of sample selection bias as only respondents who recorded a 'yes' to the first question are evaluated. An IMR for every observation was included to correct such bias. Therefore, a linear regression model was estimated for respondents who gave positive answers as follows;

$$Y_i = \beta x_i + nIMR + \mu_i$$

Where  $Y_i$  is the amount of premium a consumer is WTP;  $x_i$  are predictor variables;  $\beta$  and  $n$  are vectors to be estimated while  $\mu_i$  is the error term, which is normally distributed with a fixed variance and a mean of zero. The IMR was obtained using the following formula:

$$IMR = \frac{\vartheta(\beta^l X_i)}{1 - \vartheta(\beta^l X_i)}$$

Where  $\vartheta(\beta^l X_i)$  is the density function while  $1 - \vartheta(\beta^l X_i)$  is the normal distribution density function. The presence of the IMR is to remove heteroskedasticity thus making coefficients unbiased and consistent (Greene, 1993).

## Results and Discussion

### *Participants' demographics*

In the study, 100 consumers were interviewed and their demographic summary is shown in Table 1.

The survey results indicate that on average, consumers were 45.4 years old. This implies that pearl millet consumers were still in the economically active age bracket (27–60 years), implying their readiness to explore new ideas or try new technologies with ease. This suggests that the use of social media as a means of advertisement might prove to be a cost effective method of marketing biofortified pearl millet products in Kenya. Most (61 percent) consumers were males implying that biofortified pearl millet consumers are likely to be in male-headed households. On average, there were two children below 12 years of age in a given household in the district.

In terms of education, 5 percent of pearl millet consumers were illiterate, while 12 percent had tertiary and university education. The majority (80 percent) of consumers earned between KES 10 000–25 000. This implies that most of the respondents were in the low-income category. This is consistent with national statistics that estimate household incomes in arid and semi-arid lands to be below KES 15 000. In addition, most of the respondents (71 percent) were household heads who were the decision makers concerning food purchases in their households. Therefore, any promotional messages should target mainly household heads.

### *Distribution of WTP for biofortified pearl millet products*

In the first step, consumers were asked if they were willing to pay for the biofortified pearl millet product at the same price as a substitute product for finger millet. Of all the 100 consumers, 75 percent were willing to pay a premium price to obtain the pearl millet

**Table 1.** Demographic profile of respondents, Mbeere district, 2012.

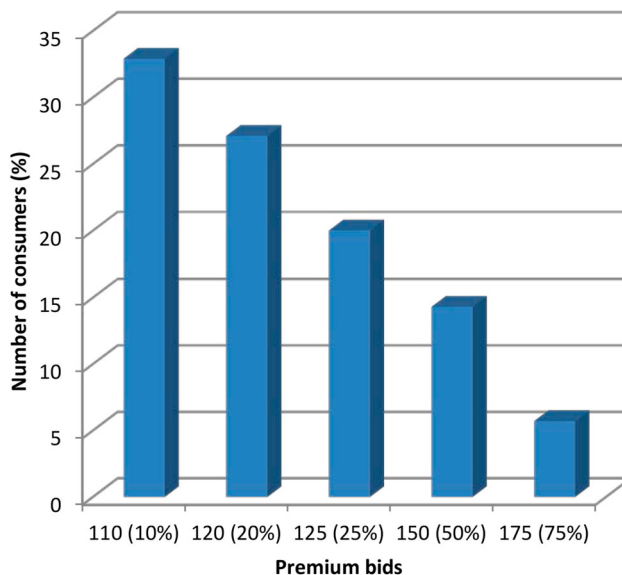
Category	Sample average
Age (Years)	45.4
Number of children below 12 years (%)	1.5
Education (Years of schooling) (%)	
Illiterate	5
Primary	52
Secondary	31
Tertiary	9
University	3
Monthly income (KES) (%)	
Less than 10 000	34
10 001–25 000	36
25 001–40 000	20
40 001–55 000	5
55 001–70 000	3
More than 70 000	2
Gender (Dummy) (%)	
Female	39
Male	61
Household head (HHhead) (%)	
Yes	71
No	29



product. Consumers who answered ‘yes’ to the first question (75 percent), were further asked to indicate their WTP estimates from the provided list of 10, 20, 25, 50 and 75 percent. The average price of the substitute product (finger millet) was estimated to be KES 100 per 2 kg (USD 1 = KES 102.39). Consumers randomly chose different levels of premiums based on their preferences (Figure 1).

Figure 1 shows the distribution of WTP estimates for biofortified pearl millet products in Mbeere district, Kenya. From the distribution of the results, 32.9 percent of consumers were willing to pay a 10 percent price premium while only 5.7 percent of consumers were willing to pay a 75 percent price premium to obtain a biofortified pearl millet product. For instance, of the consumers who selected a 10 percent premium, 32.9 percent were WTP and this demonstrates that 24.7 percent ( $0.329 \times 0.75$ ) of consumers would be WTP a 10 percent premium. On the other hand, of the consumers who selected a 75 percent premium, only 4.3 percent were WTP that rate. In general, more than half of consumers were WTP a premium price although the percentage decreased with an increase in price bids.

The high number of consumers willing to pay low premiums might imply that consumers did not believe in the effectiveness of biofortified pearl millet products in curbing malnutrition as described in our study information. In addition, consumers might not trust the information given considering the fact that iron in pearl millet is an invisible component. In addition, it might also mean that our initial price of KES 100 (USD 0.98) was above local consumers’ earning potential. It is important to note that the high initial price of USD 0.98 was because data collection was carried out at a time when demand for pearl millet outstrips its supply in the area. This is consistent with our findings (Table 1) that most consumers (70 percent) were earning below KES 25 000 (USD 244.15) per month and their first priority might be to pay for necessities instead of buying biofortified products. Figure 1 shows a downward sloping demand curve demonstrating the consistency of the CV question responses to economic theory.



**Figure 1.** Trend of bids for biofortified pearl millet.

**Table 2.** Estimates of mean WTP model.

Variable	Coefficient estimate	Standard error	P-value
Constant ( $\alpha$ )	9.235	1.662	0.001
Bid ( $\rho$ )	0.065	0.013	0.001
Mean WTP ( $\alpha/\rho$ )	142.077		

Number of observations = 100; Log likelihood = -63.862.

In addition, it indicates that the biofortified pearl millet product is a normal commodity and its premium price/bid value is therefore a key determinant of its demand.

### **Consumers' mean WTP for biofortified pearl millet products**

Table 2 presents the result of mean WTP for biofortified pearl millet products from a contingent valuation. In calculating the mean WTP, the initial step is calculating the coefficient of restricted equation without consumer characteristics. We estimated the mean WTP by dividing constant and bid (Table 2). Results showed that the mean WTP was KES 142 (USD 1.39) for 2 kg of biofortified pearl millet product (1 USD = KES 102.39). This represent a premium of 42 percent over the price of a finger millet product (considered the substitute product) estimated at KES 100 (USD 0.98) for 2 kg. The higher price premium (42 percent) for a staple food crop might have been due to the hypothetical bias inherent in the stated preference elicitation methods such as contingent valuation.

To broaden our understanding of consumer consumption preference, we compared our findings with previous studies in Kenya and around the world. For instance, Kimenju and De Groote (2005) found consumers' mean WTP for genetically modified maize meal was KES 58 per 2-kg packet, indicating a price premium of 13.7 percent above the price of favourite brands. Bett *et al.* (2013) found indigenous chicken consumers were willing to pay 23.26 percent per kg more for meat and 41.53 percent more for eggs. In Belgium, Verbeke *et al.* (2013) found that Muslim consumers were WTP a 13% premium to obtain meat identified as being Halal labelled meat at Islamic butcher shops rather than at supermarkets. De Groote *et al.* (2011) also observed an average WTP of 24 percent for fortified yellow maize among Kenyan consumers. Emukule *et al.* (2011) found that consumers were willing to pay a price premium of 7 percent above the unit volume to obtain camel milk, while Jerop *et al.* (2013) found consumers were willing to pay a 38 percent price premium to obtain goat milk in Kenya. Okech *et al.* (2014) also found Kenyan consumers as willing to pay 42 percent more to obtain biofortified pearl millet products. Lusk and Fox (2002) found that consumers were WTP 17% and 10.6% respectively to obtain information whether beef is from cattle produced with growth hormones or fed on genetically modified corn, while Meenakshi *et al.* (2010) found that consumers were WTP premiums between 15 and 32% for orange maize with nutritional information. Chelang'a *et al.* (2013) found that consumers were WTP on average 79 percent more to obtain African leafy and exotic vegetables in Kenyan markets. Although the above WTP studies reported low estimates compared to our estimates, they differ in terms of study respondents as they used urban consumers with relatively higher income levels than their rural counterparts. In the rural areas where income levels and educational standards are low, as in Mbeere district, consumers are usually constrained in terms of food choices, rendering biofortified products as the best alternatives to

**Table 3.** Econometric estimates of a two-stage Heckman model.

Independent variables	Probit (N = 100)		Independent variables	OLS (Amount paid) (N = 75)	
	Coefficient	Std. Err.		Coefficient	Std. Err.
HeardProducts	6.95***	3.56	AWARE	1.17*	0.31
HHhead	-10.36***	5.95	PCONPREF	-0.60*	0.22
AgeofHH	0.22	0.17	AgeofHH	-0.00	0.01
Income	7.26**	3.56	HHhead	-0.42	0.42
Gender	2.41	4.33	EDUC	-0.02	0.20
Educ	-7.64	4.96	Constant	1.74	1.00
constant	91.70	12.43	Lambda (IMR)	5.23	8.53
			rho ( $\rho$ )	0.32	
			sigma ( $\sigma$ )	16.26	

\*\*\* significant at 10%; \*\* significant at 5%; \* significant at 1%.

curbing malnutrition. This justifies the higher value in terms of price they are willing to pay to obtain biofortified products. It is clear that consumers are willing to pay more to obtain a biofortified pearl millet product if it is available on the market.

### **Determinants of WTP for biofortified pearl millet products**

Table 3 presents the result of a Heckman selection model. The consumers WTP (dummy) and the corresponding WTP amounts were used as dependent variables while a selection of socio-demographic, perception and attitudinal factors were used as independent variables. Results showed that the coefficient of Inverse Mills Ratio (IMR) was not statistically significant, showing no selection bias from using the non-zero WTP values. Therefore, in the second stage, an OLS was the most appropriate method for determining factors affecting the amount paid by consumers. We note a sigma value ( $\sigma$ ) greater than one providing additional support for the choice of our estimation technique. A Spearman's correlation coefficient ( $\rho$ ) was also positive and restricted between 0 and 1 showing that Mbeere consumers with greater WTP were more likely to answer the question.

Probit regression results indicate that household income (Income), whether the consumer had prior knowledge of a pearl millet (Heard Products) and whether the consumer was a household head (HHhead) significantly influence consumers' decisions to pay for biofortified pearl millet products. Being a household head (the person who makes purchase decisions) had a negative influence on consumer WTP decisions. However, in the second stage, consumer levels of awareness of biofortified pearl millet products (AWARE) and consumption preference whether weekly, monthly or daily (PCONPREF) significantly influenced the amount consumers were willing to pay to obtain biofortified pearl millet products. Other factors including age of household head (AgeofHH), gender (Gender) and educational level of consumers (Educ) had no effect on consumer WTP and amount paid.

In understanding consumers' willingness to pay for a commodity, household income becomes an important factor especially for credence attributes such as safety and nutrition (Gifford and Bernard, 2010). Wu *et al.* (2012) found that actual premiums paid by consumers are influenced by the level of food safety concern and income of households. Our findings (Table 3) indicate income as having a positive and significant effect on

consumer WTP ( $P < 10$  percent). This is consistent with our earlier assumption of a positive and significant relationship between income and WTP. This might be related to the fact that most pearl millet consumers also happen to be pearl millet farmers and thus might be deriving income from pearl millet. This was evident during our baseline survey undertaken in 2011 (Kimurto and Obare, 2012).

Increased income levels are likely to encourage respondents to pay more to obtain biofortified pearl millet products. Based on income, studies have reported conflicting results. For example, Okech *et al.* (2014) found a positive association between income and WTP among biofortified pearl millet consumers. We hypothesized that, when a consumer is a household head, the probability that they will pay higher prices will increase. Contrary to our expectations, the study found a negative but significant relationship to WTP ( $P < 0.1$ ). This implies that if a consumer is a household head, his/her chances of WTP decrease. The implication is that marketers should not only target household heads with information, but also include other household members such as the children who in turn affect purchase decisions. Senyolo *et al.* (2014) noted that consumers WTP was influenced by taste and preference, distance to nearest market, gender, age and level of urbanization.

Previous purchase exposure (HeardProducts) is an important factor affecting consumers' acceptance of biofortified pearl millet products. The results shown in Table 3 indicate that the level of exposure to pearl millet products had a significantly positive effect on WTP ( $P < 0.1$ ). This may be because past exposure might have influenced consumers' attitudes towards biofortified pearl millet, thereby translating to a greater WTP.

We hypothesized that the consumer who frequently purchases and/or consumes a product (PCONPREF) is more likely to pay premium prices than otherwise. This implies that once a consumer purchases and subsequently consumes a commodity, they are more likely to purchase it even at higher prices. Our findings (Table 3) showed that biofortified pearl millet product consumption had a significant ( $P < 0.01$ ) but negative impact on the amount paid by consumers. This implies that a unit change in consumption preference decreases the WTP amount by KES 0.6. This is against our *a priori* hypothesis that frequent consumers of a product become aware of its health benefits and are thus WTP a premium. The negative association might however be because of the constrained household expenditure common to most rural households in arid and semi-arid areas of Kenya.

We also hypothesized that consumers with prior knowledge of the benefits (nutritional) of pearl millet (AWARE) were more likely to pay higher price premiums than their counterparts. Our empirical findings showed a positive and significant ( $P < 0.01$ ) relationship between the amount paid by consumers and their level of awareness or knowledge of pearl millet attributes (AWARE). Prior knowledge might be because pearl millet is a staple crop of the Mbeere people and so consumers are used to it. This is consistent with our hypothesis that consumer's nutritional knowledge/awareness about the functions of micro-nutrients (zinc, magnesium) and the vitamin A and E food sources from which they are derived is related to a greater WTP.

## Conclusion and Implications

The results of this study indicated that the majority of consumers (60 percent) were willing to pay 20 percent to obtain biofortified pearl millet products. On average, consumers were

willing to pay KES 142.077 (USD 1.39) for a 2-kg packet of biofortified pearl millet product, representing a 42.07 percent premium. This implies that consumers would prefer and purchase biofortified pearl millet products compared to industrially fortified products. In terms of policy, this means that promoting biofortified products such as pearl millet as food would be effective in Kenya's arid and semi-arid lands. In addition, this study has shown that consumer WTP is directly influenced by the consumer's level of awareness of the nutritional benefits of consuming biofortified products, monthly income levels, and whether the consumer is a household head or otherwise. For consumption decisions (i.e. amount paid), findings indicate that consumer level of awareness about the benefits of consuming biofortified products and consumption preferences whether daily, weekly or monthly were the main factors affecting consumers WTP higher prices. As such, distribution channels targeting household heads with high incomes and knowledge of pearl millet might be interesting avenues for marketing biofortified products. Nevertheless, this study suffers from sample size, methodology and study period limitations. For instance this study only elicited information from 100 consumers and thus may not be representative of all Kenyan rural consumers. A broader sample might therefore be necessary. In addition, the data set was only for a short period of time and only in 2012, therefore longer period data sets might be of interest. Another consideration is that revealing the true value of a product does not necessarily translate into real buying behaviour. This calls for more research in estimating consumers' willingness to accept biofortified pearl millet products. Moreover, during the study period, the price of substitute products (finger millet) was high, with the result that mean price premiums may not be representative of the real situation in the market. However, insights provided from this study could be of importance to policy makers, breeders, seed companies and producers in designing targeted and equitable policy interventions.

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