Urban Consumers' Preferences and Willingness to Pay for Orphan Crop Products: Evidence from a Choice Experiment on Porridge in Kenya

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Abstract:

As a result of climate change, many of the region's staple crops are anticipated to decline in yield; further compromising food security. Orphan crops are better suited to extreme environmental stresses that many of the region's staple crops are unable to withstand. These crops provide a viable option in improving the future food security status of the region in the face of climate change and therefore their production and consumption should be encouraged. Consumer preferences are important to consider with regard to increasing the demand for orphan crops. Using porridge consumption in Kenya as a case study, this research has attempted to determine which porridge attributes consumers have a preference and willingness to pay for in order to gain a better understanding of how to increase the demand for orphan crop porridges. The data were collected using a choice experiment (900 respondents) and analyzed using the Random Parameter Logit. The findings of this research suggest that the most important attributes to consider with regard to increasing the consumer demand for orphan crop porridges in Kenya are the type of cereal used, the sugar content, the fibre content and the price. The use of orphan crops in other food products should be extensively explored.

Key words: orphan crops, porridge, choice experiment, preferences, willingness to pay

1. Background and Study Rationale

Climate change is arguably one of the most severe global challenges we are currently facing. The impacts of climate change are widely evidenced; ranging from an increase in the global mean temperatures, sea-level rises and more erratic rainfall patterns among others (Wheeler and von Braun, 2013). Climate change is expected to exacerbate the challenges currently faced by the global agriculture system particularly with regard to meeting the needs of a growing population as it is adversely affecting crop and livestock production systems in most of the world's regions; increasing the incidence of food insecurity (OECD, 2015). Sub-Saharan Africa (SSA) is identified as the most food insecure region in the world and is particularly vulnerable to the effects of climate change owing to its location in the warm topics and its inadequate capacity to cope with the effects of climate change (Pereira, 2017).

The region also produces the lowest global cereal yields; lagging significantly behind other regions of the world. The frequency and intensity of extreme weather events such as floods and droughts is anticipated to occur as a result of variable rainfall associated with climate change which will decrease the productivity of the region's predominantly rain-fed agriculture system (Adhikari et al., 2015). Other effects such as increased crop damage by pests and diseases and increased soil erosion are also expected to occur. The region's most prominent staple crops including maize, wheat and rice among others are all anticipated to decline in yield due to the effects of climate change (Adhikari et al., 2015); further compromising the food security status of the region.

As is the case with most countries in SSA, agriculture is the most important sector in Kenya and provides a livelihood source for more than 75% of the population. It is therefore a critical element for the food security of the country (USAID, 2018). Kenya's agro-climatic zones are broadly classified as either highly favourable for agricultural production owing to precipitation or semi-arid and arid areas characterised by low and erratic rainfall. The latter of these areas comprises almost 90% of the total country land mass and is particularly vulnerable to the effects of climate change and food insecurity owing to low and unpredictable rainfall, high temperatures and low yield production (Government of Kenya, 2012; Njoka et al., 2016). Droughts are observed to be the greatest constraint to agricultural production in most parts of the country and the production. As is the case throughout SSA, Kenya's major staple food crops are expected to be negatively impacted by climate change. Maize; Kenya's main staple food crop is reported to provide the daily food calories to more than 30% of the country's population (USAID, 2010). Maize as well as other major staple crops in the country including wheat and rice are sensitive to droughts particularly in arid and semi-arid regions and therefore an increase in temperature is generally anticipated to reduce yields (Huho and Mugalavai, 2010; Adhikari et al., 2015). Orphan crops are defined as crops that have received less attention than the major food crops grown in terms of

research and agricultural investment. These crops are underutilised, primarily grown in rural settings by smallholder farmers and have a historical importance in providing food security and income generation for the people in these areas (Chivenge et al., 2015; Tadele, 2018). Orphan crops such as sorghum and millet are better suited to extreme environmental stresses including water scarcity, heat, diseases, pests, and poor soil conditions that are characteristic of SSA and that other major crops grown such as wheat and maize are unable to withstand (Tadele, 2018). These crops therefore provide a viable option in improving the future food security status of the country in the face of climate change and their production and consumption should be encouraged.

Consumers' needs and preferences are an important aspect to consider in relation to increasing the acceptability and uptake of orphan crops. Without consumers' needs and preferences in mind, neither consumers nor farmers will benefit from these crops. It is therefore important that a balance be found between increasing yields and consumers' preferences in order to encourage the uptake of orphan crops (Buergelt et al., 2010). By increasing consumer demand for orphan crops, we can subsequently encourage farmers to increase their production which will in turn enhance their livelihoods and food security while building the overall resilience of the country's food systems to the impacts of climate change. Understanding consumers' preferences is also important for decision makers to design and implement efficient interventions tailored to the needs of the stakeholders interested in orphan crops.

Commercial product development can encourage the consumption of orphan crops. Orphan crops are used in many different foods; one of them being porridge. Porridge is the product that was chosen to be studied in this study because among other reasons, it is still largely consumed by both poor and affluent people. It is also a product that can be processed and therefore its taste and health attributes can be adjusted to satisfy the needs of different types of consumers. In Kenya, porridge (also known as 'uji' in swahili) is consumed primarily as a breakfast meal and sometimes as a refreshment drink and is an important dietary component and source of calories and nutrients for millions of people (Wanjala et al., 2016).

Many of these porridges are made with orphan crops such as millet and sorghum however, challenges such as over-reliance on maize, poor marketing and views of these crops as "poor man's crops" have limited their uptake by consumers (Onyango, 2016; Mwadalu and Mwangi, 2013). By determining which porridge characteristics Kenyan consumers consider to be favourable and unfavourable, we can gain a better understanding of how to increase the consumption and subsequent demand of orphan crop-based porridges. This may in turn encourage increased production of orphan crops in Kenya and possibly reduce the reliance on the current staple crops that are less resilient to the effects of climate change.

The aim of this study is to understand consumers' preferences for foods based on orphan crops and investigate whether there is a potential demand for these types of foods. The objectives of the study are as follows:

1) to assess consumer preferences and willingness to pay (WTP) for porridge attributes: type of cereal, flavour, convenience, sugar content, fibre content, gluten content and price.
2) to understand the heterogeneity of consumers' preferences and WTP through the identification of consumer segments with distinct preferences and choice behaviour.

1. Methodology

Study Area

According to a previous consumer survey by ICRISTAT (2013), the consumption of sorghum and millet is lowest in the urban centre of Nairobi. For this reason among others, Nairobi was chosen as the location for this study. In addition, food insecurity is prevalent in Nairobi particularly in slum areas which house an estimated 60% of Nairobi's population (Oxfam, 2017; Faye et al., 2011). In contrast, a large segment of affluent consumers also exists in the city. The study was carried out to determine the attitudes and preferences of Kenyan urban consumers in relation to different porridge attributes.

The study was conducted in three different areas of Nairobi: low-end income areas where poorer consumers are likely to purchase food, medium-end income areas where middle- class consumers are likely to purchase food and high-end income areas where more affluent consumers are likely to purchase food. This was carried out based on the assumption that even though there may be different income groups in one area, there will be a presence of one group more than the others based on the nature of the area as either low, medium or high-end. In total 900 respondents were face-to-face interviewed. The respondents were required to be responsible for food purchases in their households. 300 respondents were interviewed in each of the three income areas.

Data Collection

A discrete choice experiment was conducted to collect the data. The choice experiment was a survey that consisted of a choice task and a questionnaire. Only consumers of porridge or/and breakfast cereals were allowed to take part in the survey. In the choice task, respondents were provided with 6 different choice sets and were asked to choose between three different hypothetical porridge options. They were also provided with an opt-out option if they did not have a preference for the first three options.

Respondents were asked to choose the option they preferred the most and to make their choices based on their own purchasing behaviours. Each porridge option was described in terms of seven attributes: the type of cereal, flavour, convenience, sugar content, gluten content, fibre content and the price. A description of the seven attributes as well as their corresponding levels is displayed in table 1.

Given all the attributes' levels, a full factorial design of 3840 (5*4*4*3*2*2*4) profiles was generated. Presenting the survey participants with 3840 profiles would have been time consuming and cognitively challenging, therefore Ngene Software was used to generate a Bayesian D-optimal design with a minimum number of choice sets that allow a robust estimation of all the main effects. The Bayesian D-optimal design was obtained after 25,000 iterations with 500 Halton draws per iteration, achieving a D-error of 0.04. The obtained design consisted of 24 choice sets of four options each (i.e., three porridge options plus an opt-out alternative).

To make the choice task cognitively easier for the respondents, the design was blocked in four blocks (i.e., 6 choice sets per respondent). An illustration of one of the choice sets used in the choice experiment is displayed in in figure 1. In addition to collecting information on consumers' choices, the survey was also used to collect information on respondents' socio-demographics, purchasing habits as well as their attitudes towards issues related with the attributes considered in the study.

Table 1. Porridge attributes that were considered in the choice experiment.

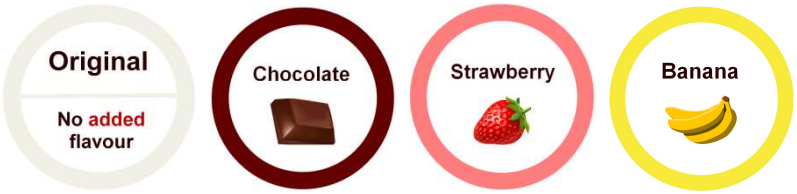
ATTRIBUTES	LEVELS
Type of Cereal	
Flavour	
Convenience	
Sugar content	
Gluten content	
Fibre content	
Price (Ksh)	110; 450; 750; 950

Figure 1. An example of a choice set used in the discrete choice experiment

Data Analysis

The conditional logit (CL) choice model is the work horse model for analysing discrete choice data. However, its assumptions (i.e., homogeneity of respondents' preferences and the alternatives included in any choice set are treated by respondents as independent) were found to be unrealistic and do not generally hold as there is often a significant overestimation (Hensher et al., 2015). Train (1998) proposed a less restrictive model (Random Parameter Logit (RPL)) that allows individuals' preferences to be heterogeneous and the assumption of the Independence of Irrelevant Alternatives to be relaxed. In the RPL model, at least some of the parameters are specified as random. In other words, each individual is considered to have a unique set of preferences. In the case of this study, all the parameters to be estimated were assumed to be distributed normally except for the parameter price that was assumed to have a lognormal distribution.

According to the random utility theory, utility-maximising individual i who is confronted with a set of j alternatives at a given choice occasion *t*, should choose the alternative that yields the highest utility. Therefore, the unconditional probability that individual i makes a choice j is the expected value of the logit probability over all possible values of β, that is, integrated over these values and weighted by the density of β. So the unconditional probability is:

$$P(j|X_{it}, \Omega) = \int_{\beta} P(j|X_{it}, \beta)\, f(\beta|\Omega) d\beta \qquad (1)$$

where X_{ijt} is a vector of explanatory variables that are observed by the analyst (i.e., the seven porridge attributes). β_i denotes the *K*×1 vector of utility parameters that correspond to *K* choice characteristics. The subscript *i* on β_i indicates that β_i are individual-specific parameters. In the RPL, β_i are considered as draws from the population distribution $f(\beta|\Omega)$ where Ω are the fixed parameters of the distribution such as the mean and the variance. The expression in equation 1 does not have a closed form solution and is therefore approximated through simulation methods. In particular, draws of β_{ir} are taken from the distribution $f(\beta|\Omega)$ for $\mathrm{r} = 1, \ldots, \mathrm{R}$, and the resulting probabilities are then averaged. The simulated log-likelihood (SLL) for all respondents, which is estimated via maximum likelihood procedures, is calculated as:

$$SLL = \sum_{i=1}^{I} \sum_{t=1}^{T} ln\left(\frac{1}{R} \sum_{r=1}^{R} \frac{\exp\left(\beta_{ir} X_{ijt}\right)}{\sum_{k=1}^{J} \exp\left(\beta_{ir} X_{ikt}\right)}\right) \qquad (2)$$

The first RPL model was estimated using the data from the full sample. The results showed that respondents' preferences are highly heterogeneous. To further explore the heterogeneity of respondents' preferences and understand the sources of preferences' heterogeneity, the 900 respondents were classified in different clusters. Then, an RPL model was estimated for each group. Two classifications were performed. First, respondents were segmented in three income clusters: high income, medium income and low income clusters. Respondents' income cluster was determined based on the collected information on their area of residence. The second classification segmented respondents in three clusterss depending on whether they are consumers of breakfast cereals only, porridge only or they are consumers of both breakfast cereals and porridge. Therefore, in total, seven RPL models were estimated, one for the full sample and one for each of the six consumer clusters. For comparison purposes, a conditional logit (CL) model was also estimated using the data from the full sample.

In addition to the estimation of respondents' preferences, choice data is often used to calculate respondents' WTP. WTP is commonly expressed as the negative ratio of the non-price attribute coefficient to the price coefficient:

$$WTP_{non-price\ attribute} = -\frac{\beta_{non\ price\ attribute}}{\beta_{price}} \quad (3)$$

The calculated value represents respondents' marginal willingness to pay. For the attributes coded as continuous (e.g., convenience), the calculated value represents respondents' willingness to pay for a one unit increase of the continuous attribute. In the case of categorical attributes, the calculated value represents respondents' WTP for the attribute's level of interest (e.g., low in sugar) with respect to the baseline level (e.g., high in sugar).

3. Results

The results from the estimation of the CL and RPL models are presented in table 2. The estimated standard deviations of consumers' preferences (for each of the six segments) are presented in table 3. The statistical significance of many of the estimated standard deviations suggests that consumers' preferences are heterogeneous even within each segment.

It is noteworthy that for the estimated marginal WTP values (table 4), the non-statistical significance of the MWTP suggests that consumers are not willing to pay a price premium for the porridge attributes. Furthermore, the estimated price coefficient in the case of "medium-end income area" is marginally significant. This resulted in insignificant estimated WTP values. Therefore, the results corresponding to the estimated WTP of this group of consumers will neither be commented on nor discussed. Finally, since the attributes type of cereals, flavour, sugar content, gluten content, and fibre content are categorical, one of the attribute's levels were chosen and treated in the estimation of the RPL models as the baseline level. This implies that estimated coefficients must be interpreted as marginal preferences or WTP (i.e., the preference or the WTP for the attribute's level of interest with respect to baseline level). For the attributes type of cereals, flavour, sugar content, gluten content and fibre content, the baseline levels are "Maize", "Original", "High", "No label" and "No label", respectively. The attributes convenience and price are continuous attributes, and hence, the estimated coefficients represent consumers' preferences/WTP for an increase in the level of the attribute by one unit (i.e., 1 minute for the attribute convenience and Ksh.100 for the attribute price).

Type of Cereal

The estimated coefficients for millet, sorghum, oats and the porridge mix are positive and significant, suggesting that porridge based on these cereals is more preferred than maize based porridge. On average, most respondents prefer the porridge mix to all the other cereals followed by millet, sorghum and finally, oats. Respondents in high-end income areas prefer the porridge mix over all other cereals with oats as a second preference and finally, millet and sorghum. Medium-end income area respondents also show a stronger preference for the porridge mix, followed by sorghum, oats and millet. Finally, low-end income area respondents also showed a stronger preference for the porridge mix, followed by millet, sorghum and lastly, oats (table 2).

Table 2: consumers' preferences and willingness to pay for porridge's attributes

Attributes' levels	Mean		Standard deviation		Willingness to pay	
Millet	0.326		3.881	***	0.000	
Sorghum	0.018		2.835	***	0.000	
Oats	0.108		3.964	***	0.000	
Mix of cereals	1.710	***	4.716	***	442.721	***
Strawberry	0.115		1.687	***	0.000	
Chocolate	0.042		1.988	***	0.000	
Original flavour	0.700	***	2.618	***	181.282	***
Time	-0.019		0.132	***	0.000	
Low sugar	0.805	***	3.422	***	208.432	***
Moderate sugar	1.234	***	1.977	***	319.596	***
Gluten free	0.143		0.879	***	0.000	
High in fibre	0.429	***	1.270	***	111.014	***
Price	-0.003	***	0.008	***	--	--
Millet X Original	0.681	**	--	--	176.256	**
Millet X Low sugar	0.771	***	--	--	199.556	***
Millet X High fibre	0.726	***	--	--	187.957	**
Mix X Original	0.117		--	--	0.000	
Mix X Low sugar	1.169	***	--	--	302.710	***
Mix X High fibre	0.304		--	--	0.000	
none	0.964	***	--	--	--	--

Number of observations	5706
Log-likelihood constant only	-7903.95
Log-likelihood conditional logit	-7280.23
Log-likelihood mixed logit	-6029.69
LR chi2	1259.93
Probability > chi2	<0.0001

Table 3: consumers' willingness to pay by income area.

Attributes' levels	**Low-end** income area		**Medium-end** income area		**High-end** income area	
Millet	65.73	**	-357.91	***	0.00	
Sorghum	-161.96	***	0.00		-194.43	*
Oats	-226.60	***	-261.59	***	877.93	***
Mix of cereals	100.55	***	818.84	***	0.00	
Strawberry	0.00		0.00		0.00	
Chocolate	56.76	***	0.00		-518.06	***
Original flavour	58.45	**	0.00		0.00	
Time	0.00		0.00		-24.56	***
Low sugar	-95.88	***	378.95	***	501.24	***
Moderate sugar	-19.12		415.12	***	505.60	***
Gluten free	0.00		0.00		0.00	
High in fibre	120.98	***	0.00		0.00	
Millet X Original	137.82	***	359.99	***	353.21	**
Millet X Low sugar	162.71	***	0.00		756.60	***
Millet X High fibre	0.00		697.40	***	418.53	**
Mix X Original	135.34	***	0.00		0.00	
Mix X Low sugar	241.43	***	435.01	***	637.95	***
Mix X High fibre	-125.56	***	328.80	**	422.03	***

Annex 1: consumers' preferences to pay by income area.

Attributes' levels	Low-end		Medium-end		High-end	
Mean						
None	-1.267		1.215	**	0.480	
Millet	3.353	**	-2.258	***	-1.456	*
Sorghum	-8.261	***	0.445		-0.828	*
Oats	-11.558	***	-1.651	***	3.737	***
Mix of cereals	5.128	***	5.167	***	-0.213	
Strawberry	-0.851		0.400		0.281	
Chocolate	2.895	**	0.280		-2.205	***
Original flavour	2.981	**	0.184		-0.242	
Time	0.037		-0.042		-0.105	***
Low sugar	-4.890	***	2.391	***	2.134	***
Moderate sugar	-0.975		2.619	***	2.152	***
Gluten free	0.416		0.243		0.281	
High in fibre	6.171	***	0.807		0.427	
Price	-0.051	***	-0.006	***	-0.004	***
Millet X Original	7.029	***	2.271	***	1.503	**
Millet X Low sugar	8.299	***	1.044		3.221	***
Millet X High fibre	-1.442		4.400	***	1.782	***
Mix X Original	6.903	***	0.465		0.292	
Mix X Low sugar	12.314	***	2.745	***	2.716	***
Mix X High fibre	-6.404	***	2.075	**	1.796	***
Standard deviation						
Millet	18.217	***	8.876	***	6.312	***
Sorghum	18.631	***	6.108	***	3.523	***
Oats	18.907	***	10.963	***	7.801	***
Mix of cereals	27.473	***	13.720	***	5.344	***
Strawberry	10.125	***	2.002	***	4.987	***
Chocolate	11.493	***	4.768	***	4.491	***
Original flavour	11.119	***	6.247	***	5.865	***
Time	0.839	***	0.385	***	0.191	***
Low sugar	18.852	***	7.706	***	7.099	***
Moderate sugar	13.000	***	6.059	***	4.109	***
Gluten free	6.991	***	2.113	***	2.467	***
High in fibre	7.967	***	5.947	***	2.292	***
Price	0.081	***	0.015	***	0.007	***
Number of observations	1048		9,120		7,416	
Log-likelihood constant only	-2167.25		-3138.47		-2563.60	
Log-likelihood conditional logit	-1814.77		-2854.075		-2369.69	
Log-likelihood mixed logit	-1385.45		-2301.25		-1930.73	
LR chi2	858.63		1105.66		877.91	
Probability > chi2	<0.001		<0.001		<0.001	

Porridge mix is also the most preferred cereal for cereal-only consumers, porridge-only consumers and consumers who eat both cereals and porridges (table 2). The preference for porridge mix is more apparent with porridge-only consumers who also show more positive and significant preference for millet and sorghum and are indifferent between oats and maize. Cereal-only consumers and consumers of both cereals and porridges show more preferences for oats than millet and sorghum. Cereal-only consumers are also indifferent between millet, sorghum and maize.

The estimated MWTP in the RPL model indicates that that consumers are willing to pay a substantial price premium for the porridge mix than all other cereals, followed by millet, sorghum and finally oats with respect to maize. High-end income area respondents show a stronger WTP for the porridge mix and oats and the lower WTP for millet and sorghum. Low-end income area respondents show a stronger WTP for the porridge mix, millet and sorghum and the least WTP for oats (table 4). Porridge-only consumers show higher WTP for porridge mix than the two other consumer groups. Cereal-only consumers and consumers of both breakfast cereals and porridge show the least WTP for sorghum and millet. Cereal-only consumers are also only willing to pay a price premium for porridge mix but revealed to be not willing to pay a price premium for millet, sorghum and oats with respect to maize (table 4).

Flavour

The results from the estimation of the RPL model for the full sample indicate that respondents prefer original porridge more than the three flavoured porridges (chocolate, strawberry and banana) and therefore they generally do not consider flavour to be important. Banana also appears to be the least preferred flavour. By income area, high and low-end income area respondents are generally indifferent between flavoured and non-flavoured porridges (table 2). A similar trend is observed for cereal-only consumers, porridge-only consumers and consumers of both cereals and porridges. Porridge-only consumers and consumers of both cereals and porridges generally show a preference for original flavoured porridges. Cereal- only consumers are generally indifferent towards flavour and if given a choice between the original/ non- flavoured and these flavours, are likely to go for the cheapest option (table 2).

The estimated MWTP from the RPL model indicates that most respondents are willing to pay less for flavoured porridges than for original porridge. On average, consumers they are willing to pay Ksh.139.04 more for original-flavoured porridges than chocolate-flavoured ones. High-end income area respondents do not show any WTP a price premium for chocolate and strawberry flavours and are willing to pay Ksh.476.49 more for original porridge than banana-flavoured porridge. Low-end income area respondents

are not willing to pay a price premium for any of the flavoured porridges (table 4). Cereal-only consumers are also unwilling to pay for flavoured cereals and generally, porridge-only consumers and consumers of both cereals and porridges are willing to pay a price premium for original flavoured porridges over flavoured ones (table 4). Overall with regard to flavour, WTP decreases with the addition of flavour.

Convenience

The results from the estimation of the RPL model for the full sample indicate on average, respondents are indifferent towards convenience. With regard to income area, some respondents are more likely to choose porridges with a shorter cooking time. High-end income area respondents in particular appear to value convenience more than medium and low-end income area respondents who are indifferent to convenience. Consumers of both cereals and porridges also value convenience more than cereal-only and porridge-only consumers who are indifferent towards convenience (table 2).

In general, the estimated MWTP indicates that on average, respondents are not willing to pay for convenience as there is no statistical significance. With regard to income area however, respondents' WTP decreases when the cooking time increases by 1 minute. Convenience is valued more by high-end income area respondents who are willing to pay an average of Ksh.27.31 for 1 minute less of cooking time compared to low-end income area respondents who are willing to pay an average of Ksh.6.19 for 1 minute less of cooking time. Consumers of both cereals and porridges are also willing to pay Ksh.17.23 for 1 minute less of cooking time whereas cereals-only consumers and porridge-only consumers are not willing to pay a price premium for convenience (table 4).

Sugar Content

The results from the estimation of the RPL model for the full sample indicate that most respondents prefer porridges with low sugar and moderate sugar over high sugar porridges. A low sugar content is also preferred more than a moderate sugar content. High-end income area respondents typically value low sugar content more than medium and low-end income area respondents. As there is no statistical significance, low-end income area respondents are indifferent to low and moderate sugar levels and typically if given a choice between these sugar levels and the high sugar level baseline, they would likely choose the cheapest option. Porridge-only consumers have a higher preference for low sugar than cereal-only consumers and consumers of both cereals and porridges. Cereal-only consumers have the least preference for low and moderate sugar levels (table 2).

The estimated MWTP indicates that respondents are generally willing to pay more for porridges with a low sugar content (Ksh.178) and moderate sugar content (Ksh.110)

than for porridges with a high sugar content. Respondents are also more willing to pay for low sugar content porridges than moderate sugar porridges and therefore, WTP increases with a decrease in sugar content. High-end income area respondents are willing to pay the highest price premium for low and moderate content porridges. The non-significance of the MWTP value indicates that low- end income area respondents are not willing to pay any price premium for low and moderate sugar contents. Porridge-only consumers are willing to pay a higher price premium for low sugar content porridges than consumers of both porridges and cereals and cereal-only consumers (table 4).

Gluten Content

The results from the estimation of the RPL model for the full sample indicate that most respondents are indifferent between gluten free porridges and porridges with no gluten free label. Consequently, if consumers are given a choice between the gluten free option and no label option, most consumers are likely to go for the cheapest option. High-end income area respondents have more preferences for porridges labelled as gluten free whereas medium and low-end income area respondents are generally indifferent to these porridges. Consumers of both cereals and porridges are more likely to buy porridges labelled as gluten free than cereal-only and porridge-only consumers who are indifferent between the two types of porridges (table 2).

The estimated MWTP indicates that most respondents are not willing to pay a price premium for porridges labelled as gluten free as there is no statistical significance with regard to WTP. High-end income area respondents are willing to pay a higher price premium for porridges labelled as gluten free than low-end income area respondents who are generally not willing to pay any premium for these porridges. Consumers of both cereal and porridges are more willing to pay for porridges labelled as gluten free than cereal-only and porridge-only consumers who are not willing to pay any price premium for these porridges (table 4).

Fibre Content

The results from the estimation of the RPL model for the full sample indicate that most respondents prefer porridges labelled as 'high in fibre' in comparison to the no label baseline. High-end income area respondents have a stronger preference for porridges that are labelled as high in fibre than low and medium-end income area respondents respectively. Porridge- only consumers show more of a preference for porridges labelled as high in fibre than consumers of both cereals and porridges and cereal-only consumers respectively (table 2).

The estimated MWTP indicates that respondents are willing to pay a high price premium for porridges that are labelled as high in fibre (Ksh.218.40). By income area, high-end

income area respondents are willing to pay the highest price premium for porridges labelled as high in fibre than low-end income area respondents. Consumers of both cereals and porridges and porridge-only consumers are more willing to pay for porridges that are labelled as high in fibre cereal-only consumers. Overall however, all segments of consumers are willing to pay a higher price premium for porridges that are high in fibre in comparison to many of the other attributes previously discussed (table 4).

Price

Regarding the estimated coefficient for the price attribute, the results show that the respondents are more likely to choose the cheapest porridge option if all of the other porridge attributes apart from the price are the same (table 2).

4. Discussion

The type of cereal used is a particularly important attribute to consider as respondents in this study generally prefer millet, sorghum, oats and the porridge mix to the country's staple crop; maize as the main cereal component of porridge. In addition, all segments of consumers show more of a preference and WTP for porridge mix over all the other cereals and in general, for all the other attributes considered in this study. Porridge mixes should therefore be a significant focus with regard to porridge production. Millet and sorghum are generally preferred less by respondents than the porridge mix however there is a potential market for porridges that contain them as there consumers are willing to pay a price premium for the two cereals. Additionally, as porridge mix incorporates other cereals including millet and sorghum, porridge mix can be used to create a demand for millet and sorghum as orphan crops. This may however require getting the right taste balance that will be appealing to consumers as taste is generally an important factor to consider in regard to consumers' preferences.

In a study on sensory characteristics and consumer preferences for porridge in Ghana, Tortoe et al. (2014) determined that among all sensory attributes including texture and odour, taste alone had a strong influence on consumers' porridge preferences. In support, Jones and Sheats (2016) and Heinio et al. (2015) also highlight that taste has a significant impact on consumer behaviour and consumption with regard to cereals and is one of the most criterion considered in food choices. As previously highlighted, sorghum is less preferred by consumers in comparison to porridge mix and millet respectively. A similar survey on consumer preferences (ICRISTAT, 2013) determined that taste is a significant reason for the non-consumption of sorghum. Studies (Heinio et al., 2015; Wanjala et al., 2016) highlight that sorghum has an astringent, bitter taste which restricts its usage to small amounts for porridge production and consumption in Kenya. Modifying the cereal composition of porridge mixes could mask the taste of cereals that consumers' consider to be unpalatable; encouraging more consumers' to

purchase porridge blends while subsequently introducing more orphan crops into the market.

High-end income area respondents show a stronger preference and WTP for the porridge mix and while sorghum and millet are not as much of a preference, this consumer group is also willing to pay a price premium for porridges made from these two orphan crop cereals. This appears to occur despite poor marketing and views of these crops as "poor man's crops" which have been highlighted in studies (Onyango, 2016; Mwadalu and Mwangi, 2013) as challenges that limit their uptake by urban consumers in Kenya. To explain this trend, a comparative studyby French et al (2010) suggests that high income households spend more money on healthy foods than other income groups. In support, a previous consumer survey in Kenya (ICRISTAT, 2013) highlights that high income consumers in Nairobi recognise the health value of sorghum and millet which is an important reason for their consumption by this consumer group. For this reason, increased marketing efforts should be put in place to promote the consumption of orphan crop-based porridges and subsequently increase the market demand for orphan crops such as millet and sorghum. Owing to their recognition and WTP for healthy foods, high-end income area consumers in particular should be targeted.

It is unknown why oats are generally the least preferred cereal type for porridge however, a likely reason is that oats are generally more expensive and are not well known, especially, in low-income areas. After porridge mix, low-end income area consumers show a higher preference and are willing to pay more for porridges containing millet and sorghum, most likely because they are the group that most frequently consumes these orphan crop cereals. In addition, the presence of children in the household may be a factor contributing to their preference and WTP for sorghum and millet.

In this study, a majority of low-end income area respondents (68%) have 1 to 3 children in their households. According to Wanjala et al (2016), porridges comprised of millet and sorghum (uji) are considered a crucial source of energy and nutrients for young children in Kenya. Wanjala et al also highlight that in low-income households, the per capita consumption of these porridges is high as only small amounts of flour are required to make large quantities of porridge. Despite showing indifference towards and no WTP for millet and sorghum- based porridges, cereal-only consumers (non-consumers of porridges) also show a strong preference and WTP for the porridge mix. In this case, the porridge mix can help to attract non-porridge consumers; subsequently expanding the proportion of porridge consumers and increasing the demand for millet and sorghum.

The addition of flavour does not seem to be an effective strategy to increase the consumption of orphan crop-based porridges, since consumers in the different groups were found not to prefer flavoured over unflavoured porridges. As high and low-end income area respondents are generally indifferent towards flavoured porridges and not willing to pay a price premium for them, it may be ideal to keep the prices of flavoured porridges the same as original porridge. Should flavoured porridges be more expensive (probably due the additional cost of flavouring the porridge), it is likely that these consumer groups would not purchase them.

As previously highlighted, taste is considered to have a significant influence on consumers' preferences (Tortoe et al., 2014; Jones and Sheats, 2016; Heinio et al., 2015) therefore it is recommended that the addition of flavour should not be considered a priority to increase the demand for orphan crop porridges. The preference for flavoured products varies by factors such as the type of product. An article by Mwaniki (2013) highlights that in Kenya, flavoured milk is a popular consumer product and a driver of the growth of the country's dairy sector. It is also estimated that in 2012, the consumption of flavoured milk increased 61% from the previous year and this rise was anticipated to continue in the recent years to come. (Mwaniki, 2013). This suggests that what works for one product such as milk may not necessarily work for a different product such as porridge.

Although a significant proportion of the respondents prefer original porridge or are indifferent to flavoured porridges and are not willing to pay a price premium for them, other respondents may prefer flavoured porridges. This may be due to the presence of children in the household (60%, 62% and 68% respectively of high, medium and low-end income area households have 1 to 3 children in their households). A recent study by Hoffman et al (2016) highlights that flavour preference varies by age and that children have a higher preference for sweet and flavoured food products than adults. It is therefore recommended that flavoured porridges should not be completely disregarded as there could be a potential market for them.

As previously mentioned, in this study convenience is referred to in terms of the cooking time for porridge. Today, increasingly busier lifestyles have increased the demand for convenient, ready-to-eat and ready-to-cook food options that are an easier and quicker option than other food options in the past (Kaur and Singh, 2014; Lappo et al., 2013). Marketers and food companies are therefore increasingly focusing on the production of time-saving, convenient foods. Studies (Jones and Sheats, 2016; Kaur and Singh, 2014) have highlighted the importance of convenience as an attribute that has a strong impact on consumers' behaviour and preferences with regard to food and cereals. A study by Carrillo et al (2011) highlights that in Spain, convenience is one of the most significant factors in peoples' food choices.

In contrast however, this study indicates that many consumers are generally indifferent towards the convenience of porridges and are not willing to pay a price premium for porridges with a shorter cooking time. In this case, convenience should not be one of the main attributes of focus with regard to increasing the demand for orphan crop porridges. Although a significant proportion of the respondents of this survey are indifferent to convenience and are generally not willing to pay a price premium for them, the opposite applies to many of the survey respondents who value convenience and are willing to pay for these porridges. In this study, high-end income area respondents show a preference and WTP for porridges with a shorter cooking time compared to low-income area respondents who are indifferent to convenience and unwilling to pay a price premium for convenience. This is consistent with other studies (McCullough et al., 2008) suggesting that urban consumers with higher wages are typically willing to pay a price premium for convenience which frees up time for work or leisure than consumers with lower wages.

It is unknown why low-end income area respondents do not have a preference or WTP for convenience with regard to porridges however as low-income area respondents are frequently struggling to earn a substantial income, paying a price premium for convenience foods is unlikely to be a priority for many. It may also be that time constraints are not an issue for them or because they are used to cooking porridge which in turn makes a shorter cooking time less relevant. Despite this observation, a study by De Groote et al (2017) highlights that some participants of focus group discussions in Kenya and Senegal expressed an interest in instant cereals. For low-income come groups, this was because instant cereals provided a way to save energy and similar to high-income respondents in this study, middle-income groups were interested in instant cereals because of the cooking time saved. Although convenience should not be an attribute of focus, porridges with a shorter cooking time should not be completely ruled out as an avenue to increase the demand for orphan crop porridges as there is a potential market for them particularly with regard to high-end income area consumers.

Consumers are increasingly becoming more aware and concerned about the importance of health attributes in their food purchasing behaviours and are increasingly willing to pay a premium for them (Küster and Vila, 2017; Nielsen, 2015). Healthy diets are typically defined as adequate in quantity, diverse and low in food components of health concern including sugars (FAO, 2016b). Results of a survey on global health and wellness highlights that in 2014, low sugar was considered to be very important attribute in purchasing decisions for 33% of the respondents in Africa and the Middle East (Nielsen, 2015). Sugar content is an important attribute to consider in this study as respondents generally value low sugar porridges over high sugar porridges and are

willing to pay a price premium for them. Having a low sugar content can therefore help create a demand for orphan crop porridges.

Sugar content is also considered in this study because of the awareness that consumers, particularly in high-end income areas, will trade off the type of cereal used in porridges with other food attributes such as sugar content. High-end income area respondents show a greater preference and are willing to pay a price premium for porridges with a lower sugar content whereas low-end income area respondents are indifferent towards and are unwilling to pay a price premium for them. If high-end income area consumers are provided with maize porridge labelled as low in sugar and millet porridge labelled as high in sugar, they may choose the maize porridge although they value millet more than maize. This is because they also highly value the sugar content of the porridge. The main objective of considering attributes such as sugar content in addition to the type of cereal is to assess how consumers trade off different attributes with the main attribute of interest: the type of cereal.

Around 87.5% of high-end income area respondents prefer to buy healthier porridges even though they are more expensive than less healthy porridges. These results are consistent with studies (Küster and Vila, 2017; Deloitte, 2016) suggesting that consumers with higher incomes express a greater WTP for attributes associated with health. According to Chen et al (2012), lower income limits available options; often restricting their capacity to make healthy food choices. The Overseas Development Institute (ODI, 2015) highlights that low-income consumers are unlikely to choose healthy food options if they are more expensive than less healthy ones. In addition to income, Kearney (2010) further suggests that well educated individuals are more likely to adopt healthier lifestyles than low income individuals who are more limited with regard to nutrition education.

This is consistent with the results of this study. A majority of high-end income area respondents are university undergraduates and postgraduates (73%) whereas a majority of low-end income area respondents have been educated to secondary school level or attained a technical certificate or diploma (87%). This would possibly suggest that with regard to sugar content in this study, preference for low sugar increases with education as well as an increase in income. Other reasons for the low preference for low sugar porridges by low-end income area respondents may be the unavailability of low-sugar porridges, the lack of awareness on the effects of sugar on health, a possible preference for high sugar foods for energy due to intense physical activities to earn a living, the effect lower levels of sugar have on the taste of food, etc.

Respectively, porridge-only consumers and consumers of both cereals and porridges also show a stronger preference and WTP for low sugar porridges than cereal-only consumers (non-consumers of porridge). This trend may be attributed to the association

of porridges (cereals and wholegrains) with a healthy diet as experts highlight (ODI, 2015; FAO, 2016b). Many of the porridge consumers are likely aware of the associated health benefits of certain porridges and are therefore more inclined to choose and pay for porridges with a low sugar content. Low-sugar varieties of orphan crop porridges should be explored and possibly the use of sweeteners as opposed to conventional sugar. Strategically, to encourage the purchase and subsequently increase the demand for orphan crop porridges, marketing efforts for varieties with a low sugar content could be a significant focus in high-end income areas where low sugar porridges are more valued. Ignoring sugar content is likely to hamper the expansion of the demand for orphan crop-based porridges.

As previously highlighted, consumer awareness on the importance of health attributes in food purchasing is increasing (Küster and Vila, 2017). Dietary fibre is also widely recognised as an important component of a healthy diet (Dhingra et al., 2012; Li and Komarek, 2017). A similar trend to sugar content has been observed in relation to consumers' attitudes towards fibre content in this study. With regard to income area, high-end income area respondents show the strongest preference and WTP for porridges labelled as high in fibre compared to low-end income area respondents. As is the case with sugar content, this may be attributed notion that higher income earners and more educated individuals express a greater WTP for attributes associated with health (Küster and Vila, 2017; Deloitte 2016; Kearney, 2010). This may suggest that preference for high fibre porridges increases with both income and education.

The only difference in this study is that in comparison to the observed trend for sugar content, low-end income area respondents also show a preference and WTP for porridges labelled as high in fibre. It is unknown why this is the case however, foods with a higher dietary fibre content may be associated as foods that leave individuals feeling fuller for longer. A majority of low-end income area respondents in this study (90%) agree that they prefer to buy porridges that are more filling even though they are more expensive than those that are less filling. Studies in Kenya (Mukui, 2003; Jackson, 2012) have suggested that one of the purposes of consuming foods such as ugali (stiff porridge) are to provide a quick energy source and leave the person feeling fuller for longer particularly when carrying out jobs that are physically demanding and also during times of food scarcity.

Similarly to sugar content, porridge-only consumers and consumers of both cereals and porridges also show a stronger preference and WTP for high fibre porridges than cereal-only consumers (non- consumers of porridge). This trend may be attributed to the association of porridges (cereals and wholegrains) with a healthy diet as experts highlight (ODI, 2015; FAO, 2016b). Many of the porridge- consumers are likely aware of the associated health benefits of many porridges (including a high fibre content for many porridges) and are therefore more inclined to choose and pay for varieties with a

high fibre content. In this respect, fibre content is one of the most important attributes to consider when processing orphan crop-based porridges as all segments of consumers show a higher preference and WTP for porridges labelled as high in fibre. In addition, this attribute is significant for consideration as respondents are willing to pay higher price premiums for the claim "high fibre" than for other claims such as "low sugar". It is recommended therefore that manufacturers should retain fibre in orphan crop porridges in order to encourage their purchase. The use of labels indicating porridges that are high in fibre is also key.

In this study, respondents are generally indifferent to porridges labelled as gluten free and are not willing to pay for them. Celiac disease is induced by gluten in the diet and is well documented in developed countries. It is however considered to be rare in SSA which is often considered to be a celiac-free region (Catassi et al., 2015). High-end income respondents are the only income group that show a preference and WTP for porridges labelled as gluten free. As previously mentioned, a higher income and education level may prompt a greater preference and WTP for attributes associated with health. According to Ibrahima and Thierry (2013), celiac disease does in fact exist in the region and emerges primarily in middle and high income populations due to an increasing tendency to adopt Western diets that are often gluten-rich. This may also explain why high-end income area respondents are more willing to pay a price premium for porridges labelled as gluten free. With regard to consumer segment by cereal preference, only consumers of both cereals and porridges show a preference and WTP for these porridges. It is likely that most high-end income area respondents also fall in this consumer category.

In contrast, low-end income area respondents are indifferent to these porridges and not willing to pay for them. Ibrahima and Thierry (2013) highlight that a lack of education, awareness and diagnosis in SSA may explain the ignorance towards the disease. This is likely a reason why low-end income area respondents do not consider gluten free as an important attribute with regard to porridge purchases. The consideration of gluten content as an attribute of importance with regard to increasing the demand for orphan crop-based porridges depends on the targeted consumer segment and whether labelling the porridge as gluten does or does not increase the cost of production. If labelling does not increase the cost and therefore the retail price, then there is no issue in labelling the porridge as gluten free even when it is sold in low-end income areas. This is because the results show that consumers are indifferent between gluten and gluten free porridges. In contrast, if producing gluten free porridge is expected to increase the price of porridges, it would be better to label porridges as gluten free only if the porridges are destined to target high-end income area consumers. Some of the orphan crops grown in Kenya such as sorghum are free of gluten (Adiamo et al., 2017)

and therefore strategic marketing of such orphan crop porridges high-income areas could contribute towards an increase in their overall demand.

With regard to the price, the results in the study are consistent with the general economic theory that consumers are likely to pick the cheapest porridge option if all the other attributes apart from the price remain the same. Price is an important attribute to consider in this study with regard to increasing the demand for orphan crop porridges. None of the porridges should be sold at a higher price than what consumers are willing to pay for them otherwise consumers are unlikely to purchase them; subsequently lowering their demand.

5. Conclusion

From this study, the most important attributes to consider with regard to increasing the consumer demand for orphan crop porridges in Kenya are the type of cereal, sugar content, fibre content and the price. With regard to the type of cereal, porridge mix should be a significant focus as it appeals to all segments of consumers by income group (high, medium and low income) as well as by the type of cereal consumed (cereals only, porridges only and consumers of both). Millet and sorghum porridges on their own are generally not preferred as much as the porridge mix by consumers in this study however, as the porridge mix incorporates these two cereals, it can be used to create the demand for them. Additionally, as cereal-only consumers (non-porridge consumers) also show a strong preference and WTP for porridge mix, it can be used to expand the proportion of porridge consumers and subsequently increase the demand for millet and sorghum.

Sugar content is also an important attribute to consider as respondents generally value low sugar porridges over high sugar porridges and are willing to pay a price premium for them. High-end income area respondents show a greater preference and WTP for low sugar porridges whereas low-end income area respondents are indifferent towards and are unwilling to pay a price premium for them. Preference for low sugar possibly increases with an increase in income and education. Consumers with higher incomes and a higher level of education express a greater WTP for attributes associated with health. Porridge-only consumers and consumers of both cereals and porridges also show a stronger preference and WTP for low sugar porridges than cereal-only (non-porridge) consumers. This may be attributed to their association of porridges with a healthy diet, therefore they are more inclined to choose and pay a price premium for low sugar porridges.

Fibre content is an important attribute to consider as all segments of consumers show a preference and WTP for porridges labelled as 'high in fibre'. As is the case with sugar content, individuals with a higher income level and higher education level express a

greater preference and WTP for attributes associated with health such as high in fibre. Low-end income respondents may show a preference and WTP for high fibre porridges because of the association of dietary fibre with foods that leave individuals feeling fuller for longer particularly during physically demanding activities and times of food scarcity. Similarly to sugar content, porridge-only consumers and consumers of both cereals and porridges also show a stronger preference and WTP for high fibre porridges than cereal-only consumers (non- consumers of porridge) which may be attributed to the association of porridges with a healthy diet.

As is generally the case with food products, price is important to consider as consumers would be unlikely to purchase porridges that are more expensive than what they are willing to pay for them. Despite not having as much of a priority with regard to increasing the demand for orphan crop porridges, flavour, convenience and gluten content should not be overlooked as some consumers may prefer and are willing to pay for porridges that encompass these attributes; potentially creating a market for them. For example, flavoured porridges may appeal to consumers who have younger children and many consumers particularly in high-end income areas value porridges that take a shorter time to cook and are gluten free. By increasing consumer demand for orphan crops through products such as porridge, we can subsequently encourage producers, processors and retailers to increase their production and commercialisation which will in turn enhance livelihoods and food security while building the overall resilience of the country's food systems to the impacts of climate change.

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