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This paper is dedicated to the memory of Constance Owori

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HarvestPlus, c/o IFPRI 2033 K Street, NW, Washington, DC 20006-1002 USA
Tel.: +1-202-862-5600 • Fax: +1-202-467-4439 • www.harvestplus.org

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Are Consumers in Developing Countries Willing to Pay More for Micronutrient-Dense Biofortified Foods? Evidence from a Field Experiment in Uganda[1]

Shyamal Chowdhury,[1] J. V. Meenakshi,[2] Keith Tomlins[3] and Constance Owori[4]

ABSTRACT

Vitamin A deficiency is a major health problem in Africa and in many other developing countries. Biofortified staple crops that are high in beta-carotene and adapted to local growing environments have the potential to significantly reduce the prevalence of vitamin A deficiency. One such example is the orange sweet potato (OSP). Because of its distinctive orange color, which is in contrast to the white varieties that are typically consumed in Africa, it is important to assess whether consumers will accept it. This paper attempts to address this question by using a choice experiment with the real product to quantify the magnitude of the premium or discount in consumers' willingness to pay that may be associated with it. It also considers the extent to which the provision of nutrition information affects valuations. Finally, the paper addresses whether the use of hypothetical scenarios is justified in a developing country context, and quantifies the magnitude of hypothetical bias that results as a consequence. We examine whether a "cheap talk" script, which as elaborated in the paper, reminds respondents that hypothetical scenarios are to be treated as if they are real, is effective in mitigating hypothetical bias. The experiment was conducted in Uganda, a key target country for the dissemination of orange sweet potato. Our results suggest that in the absence of nutrition information, there is no difference between white and orange varieties in consumers' willingness to pay, but there is a discount for yellow sweet potato (which does not have any beta-carotene). The provision of nutrition information does translate into substantial premia for the orange varieties, indicating that an information campaign may be key to driving market acceptance of the new product. Finally, there is a substantial hypothetical bias in both the willingness to pay (WTP), and the marginal WTP, for the new varieties; while "cheap talk" may mitigate this bias, it does not eliminate it.

Keywords: Cheap talk, Field experiments, Hypothetical bias, Conjoint analysis, Universal logit
JEL classifications**:** C35, C93, D 83, Q18

This paper is dedicated to the memory of Constance Owori.

[1] Corresponding author: Shyamal Chowdhury, Agricultural and Resource Economics, A04 RD Watt Building, Science Road, University of Sydney, NSW 2006, Australia. Tel: +61-2-93512786, Fax: +61-2-93514953, Email: s.chowdhury@usyd.edu.au

[2] HarvestPlus, Washington, DC, USA

[3] Natural Resources Institute, University of Greenwich, Chatham Maritime, ME4 4TB, UK.

[4] Kawanda Agricultural Research Institute, P. O BOX 7065, Kampala, Uganda

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I. INTRODUCTION

Millions of people in developing countries suffer from micronutrient malnutrition. Vitamin A deficiency (VAD), for example, is a major public health problem, leading to vision problems and impaired immune systems; it is estimated that nearly 127 million pre-school children worldwide suffer from vitamin A deficiency. Between 250,000 and 500,000 children go blind every year, and over 600,000 deaths of children annually may be attributed to VAD (West Jr. and Darnton-Hill, 2001; Black et al. 2008). A major cause of micronutrient malnutrition is the poor quality of diets in developing countries. Good sources of vitamin A include leafy green vegetables, and animal and fish products, foods that are typically out of the reach of most poor people.

While there is no single strategy to eliminate micronutrient malnutrition, biofortification is emerging as a new intervention that can have significant impact through the introduction of locally adapted staple foods that are bred to be high in micronutrients (Bouis, 1999). One example is the orange sweet potato (OSP), which is high in beta-carotene, a precursor to vitamin A; the consumption of as little as 50 grams of OSP a day is enough to provide a child's recommended dietary allowance. Nutritionists have determined that the consumption of relatively modest amounts of boiled orange sweet potato (OSP) by young school children in South Africa significantly improved their vitamin A status (Van Jaarsveld et al. 2005); and a similar result was obtained in a community setting by Low et al. (2007).

As the name suggests, the biofortified sweet potato is orange in color because of the beta-carotene, in sharp contrast to the white and cream varieties that are commonly consumed. People's lack of familiarity with the OSP and its appearance can be a major barrier to consumer acceptance and hence may limit its potential impact on improving nutritional outcomes. This provides the motivation for this study, the primary objective of which is to elicit consumers' valuation of the orange (high beta-carotene) sweet potato.

Because biofortification is a public health intervention, the paper also attempts to assess the extent to which information on the nutritional value of the new biofortified foods influences consumers' willingness to pay. The literature—which pertains mostly to a developed country context—suggests that the impact of health information on food demand has been mixed. While McGuirk et al. (1995) and Kinnucan et al. (1997) find evidence of significant impact in the U.S. context;[1] with the magnitude of the impact of health information exceeding own price effects, Robenstein and Thruman (1996) find no

[1] In fact the impact of health information in these studies was found to be larger in magnitude than the own-price effects.

discernible impact on future prices from negative health information. In this paper, we examine the degree to which the provision of nutritional information influences the magnitudes of premia or discounts for OSP relative to the more common white varieties.

A final objective of the paper is to assess the validity of hypothetical elicitation mechanisms in developing country settings. There is extensive literature on the presence and extent of bias involved in valuations elicited from hypothetical scenarios, especially in the literature on natural resources (see Frykblom, 1997, for an early example). To our knowledge, however, these questions have never been systematically addressed in a developing country setting, as we attempt in this paper. While valuations in absolute terms are likely to be overstated in a hypothetical scenario, it is possible that estimates of the marginal willingness to pay (for OSP relative to white sweet potato, for example) are not subject to the same degree of bias. In developed country settings, there is some evidence that marginal valuations are not as subject to hypothetical bias, as noted in List, Sinha and Taylor (2006) and Lusk and Schroeder (2004). However, Carlsson, Frykblom and Lagerkvist (2005) find evidence to the contrary.

One way to mitigate hypothetical bias is to use so-called "cheap talk" scripts, as proposed by Cummings and Taylor (1999) and subsequently used by List (2001), among others. We attempt to test the validity of such an approach in reducing hypothetical bias in an African context. To the extent that there are relatively long time lags and substantial costs involved with producing sufficient quantities to test market a new staple food—the ability to use carefully designed hypothetical scenarios, with the inclusion of a cheap talk script to mitigate any biases—can have significant programmatic implications.

This paper thus addresses three principal sets of questions: first, how much are consumers willing to pay for biofortified sweet potato? Does the distinct color and, perhaps, taste of OSP imply a price discount/premium relative to the more familiar white sweet potato varieties? Second, does information on the nutritional value of biofortified foods affect consumers' valuations? If so, by how much? Third, to what extent is it possible to elicit marginal willingness to pay using a hypothetical scenario? Does cheap talk, which is commonly used to mitigate hypothetical bias, result in magnitudes of premia or discounts that are comparable to those obtained from "real" scenarios?

We attempt to answer these questions from a field experiment involving rural and urban consumers in Uganda. Sweet potato is a major staple food in Uganda, especially among rural populations, and is the target for OSP deployment efforts. Our sample was randomly assigned to one of four scenarios or treatments: (1) those who received no information on the nutritional value of OSP and were asked to make real choices with real commitments; (2) those who were told about the nutritional value of the OSP and dealt with real choices and real commitments; (3) those who received nutrition information but were asked to make hypothetical assessments; and (4) those who received nutrition information and a cheap talk script, and who were then asked to make hypothetical choices.

We used a choice experiment (CE) to elicit valuations; in addition to possessing desirable theoretical properties, a CE is also easy to implement in poor agrarian settings. CEs are consistent with random utility theory (McFadden 1974) and Lancaster's theory of consumer demand (Lancaster 1966, 1974). Moreover, CEs can be designed to resemble actual purchasing scenarios where more than one product attribute can be simultaneously evaluated (Lusk and Schroeder 2004). The experiment conducted here was a "between-subject" design whereby samples of similar respondents participated as subjects and where payment was required to ensure incentive-compatibility. While the experimental procedure is detailed in Section 2, we note here that this is perhaps one of the few studies that attempts to examine these questions in a developing country setting, where real consumers in the field (rather than student subjects in the laboratory) make purchase decisions.

Another notable feature of this study is the use of food science techniques to elicit taste preferences in conjunction with the choice experiment. In the literature on the valuation of private goods, it is customary to estimate demand equations only over prices and quantities, and to attribute any significant unexplained part of data to "taste." This is primarily due to the assumption that individual preferences are constant and stable (see, for example, Stigler and Becker 1977). In contrast, accounting for taste in valuation requires the incorporation of its determinants directly in estimation (Chalfant and Alston, 1988). This is rarely done in the literature because of the lack of data on taste or the availability of adequate proxies for it. In this paper, we use hedonic scales to measure sensory attributes and consumer acceptance (Tomlins et al. 2005, 2007).

This paper is arranged as follows: Section 2 describes the general theory underlying the CE mechanism and the experimental design used in this study; Section 3 describes the estimation methods and the econometric model; Section 4 presents the results; and Section 5 presents conclusions and draws implications for further research.

II. EXPERIMENTAL DESIGN

We use a discrete choice experiment to elicit consumers' preferences for biofortified sweet potato in Uganda. Since OSP is relatively new to consumers there, there is no market data available for analysis, and some form of stated preference (SP) data needs to be generated. The limitations of SP data, usually generated through various contingent valuation approaches where respondents do not face any real budget constraint, are well known: they may not represent actual behavior, and may not reveal the underlying preferences of consumers. List and Gallet (2001) report that, in hypothetical settings, on average, subjects overstate their preferences by a factor of about three. The data generated for this study addresses this issue by ensuring that participants evaluate real products and face real budget constraints (although we also include hypothetical treatment arms for comparison).

Among the various ways of eliciting willingness to pay, there has been growing interest in the use of discrete choice experiments (DCEs).[2] DCEs have a theoretical base in Lancaster's theory of consumer choice (Lancaster 1966), which states that commodities can be described in terms of underlying attributes or characteristics, and that consumers value these attributes rather than the commodities per se. Choice experiments are also econometrically tractable as they are based on the random utility model (RUM) of behavior (McFadden 1974).

DCEs not only enable a quantification of the premium or discount that biofortified staples may command; they also enable a disaggregation of the various attributes embodied in a new product. For example, subjects are able to make trade-offs between products that have a higher price combined with higher nutrient content and those with a lower price but lower nutrient content. Furthermore, when a DCE involves real money and real products, as in this case, the common problems of hypothetical bias encountered in SP data can be avoided too.

In the DCE, the consumer is assumed to make a choice from *j* alternatives. The utility that the *i*th consumer derives from choosing the alternative *j* consists of two components—a systematic component and a random component—and can be expressed as:

(1) $U_{ij} = V_{ij} + \varepsilon_{ij}$

Here V_{ij} is the systematic portion of the utility function determined by the product attributes, and the rest is stochastic.

Assuming that consumers maximize their utility, the choice problem involves a comparison of utilities associated with each of the *j* alternatives, and a rational consumer makes choices among different alternatives that yield the maximum utility. Let Yi be a random variable that denotes the choice outcome, then the probability that individual *i* chooses *j* is given by:

[2] See the special issue of *Environmental & Resource Economics* (2006) vol. 34

(2) $P(Y_i = j) = P(V_{ij} + \varepsilon_{ij} > V_{ik} + \varepsilon_{ik})$ for all k=1, …j; k≠j

The mapping from a probabilistic choice model to an econometric model of choice is conceptually straightforward and discussed in Section 3.

Field Design

In line with the questions set out in Section 1, there were four treatment arms to the study, each with approximately the same number of subjects. The first was what we term "real, without information". These respondents were asked to make purchase decisions on the prototype OSP varieties, but were provided no information on their nutritional value. This was designed to mimic a strategy where the product would be supply-driven, and can be construed as constituting a control group. In the second treatment arm, consumers were told about the nutritional value of OSP, because a consumer's decision may vary depending on the amount of information s/he has about a product, and was designed to examine the impact of a demand pull strategy on WTP. Since valuations may also differ depending on whether the transaction is hypothetical, as in a contingent valuation study, the third arm was implemented in a hypothetical setting with information. In the fourth arm, the hypothetical setting was replicated using a cheap talk script. The design is summarized in Figure 1, where the shaded cells represent the four treatments:
An almost equal number of participants were drawn from the rural areas of two districts (Kamuli and Luweero) and one urban district (Kampala).

Figure 1: The Field Design

	Without Nutrition Information	**With Nutrition Information**
Real	(1)	(2)
Hypothetical, no cheap talk		(3)
Hypothetical, with cheap talk		(4)

Table 1 shows the distribution of participants across treatments and their geographic origin.

Table 1: Distribution of Participants According to Treatments and Geographic Origin

Region	District	Without Information (1)				Total
		Real (1)	Real (2)	Hypo (3)	Cheap Talk (4)	
Rural	Kamuli	41	37	34	41	153
	Luweero	40	40	44	32	156
Urban	Kampala	40	38	40	40	158
Total		**121**	**115**	**118**	**113**	**467**

In the rural areas, participants were drawn from two districts where OSP is new to the population. Four villages were selected from each district based on ethnicity and distance from the district headquarters. Once selected, a systematic random sample of 40 households was drawn from each village, and the heads of, or the spouse of the heads of the selected households, were invited to take part in the experiment. For Kampala, the urban district, two marketplaces were selected where low- and middle-income urban consumers buy their sweet potato for consumption. Consumers were selected randomly in cooperation with the markets' management committee.

Varieties

For each treatment, consumers were exposed to the traditional white variety and two orange varieties, one of which was deeper orange in color than the other. These were grown out for use in the study by the National Agricultural Research Organization of Uganda. Those who received nutrition information were told that there was a positive association between the color of the sweet potato and its beta-carotene content. A fourth variety that is yellow in color was also included, although the yellow varieties are not nutritionally enhanced. Thus, there were four varieties of sweet potato cultivars in all: i) white (Nakakande variety); ii) yellow (Tanzania variety); iii) orange (SPK004/1/1 variety); and iv) deep orange (Ejumula variety). Each participant tasted and valued all four varieties, and the varieties remained constant across treatments. As noted earlier, each individual participated in only one treatment where the selection to a treatment was randomly assigned.

Experimental Procedure

The experiment followed the following sequence of steps:

Step1: sensory acceptability: consumers tasted the samples and ranked them on sensory attributes

Step 2: nutrition information: respondents in the appropriate treatment arms were told about the nutritional benefits of OSP

Step 3: choice experiment; of the seventeen scenarios over which consumers made choices, one was binding

Step 4: demographic module: respondents were asked background information on their education level, sources of income and so on.

Participants were organized in groups of four, and were randomly assigned among four treatments. Each participant was given 500 Ugandan Shillings (UGS) (equivalent to about 30 US cents) at the beginning of the experiment for participation, which s/he could keep or spend during the experiment depending on the treatments assigned and choice made. Participants who were assigned to hypothetical and real treatments went through all four steps. Participants who were assigned to the "real without information" treatment went through Step 1, Step 3, and Step 4 only.

Sensory Acceptability

Each participant tasted a portion (30 to 50 grams) of each cooked sweet potato variety (simultaneously presented in random order and coded with three digit random numbers on white paper plates). The samples were prepared in a way similar to that normally used by Ugandan households for their own consumption. Fresh sweet potato roots were sorted to remove diseased and insect-damaged ones, peeled and cut into roughly equal-sized portions (5 to 10 cm in length) and boiled until the texture, assessed by a fork, was considered correct for eating. During testing fresh samples of cooked sweet potato were frequently prepared. The four varieties were scored for: a) taste; b) appearance; and c) overall acceptability, using a nine point hedonic scale. The administrator explained the score sheet to participants on a one-to-one basis. The process followed here is similar to that usually followed in food science for collecting information on consumer acceptance of products (Tomlins et al. 2005, 2007). The score sheet used in the experiment is given in Appendix 1.

Nutritional Information

Participants selected for the three treatments "with information" (treatments 2, 3 and 4) were given nutritional information on OSP by one administrator. The nutritional message that was given to participants is similar to the one that implementing non-governmental organizations are using to promote OSP in Uganda. The message is attached in Appendix

2. [3] Respondents who took part in the real treatment "without information" (treatment 1) did not receive any information. These subjects were asked about whether they had any prior information on OSP; this information is used as a control variable in the empirical estimation.

Choice Experiment

All participants then proceeded to the choice experiment; they were given a choice sheet that contained seventeen repeated CE questions (see Appendix 3 for CE scenarios). The administrators worked on a one-on-one basis, and explained instructions to the subjects. In the instructions, we followed the approach of Cummings and Taylor (1999), List (2001), and List et al. (2006), with necessary changes due to differences in goods and allocation mechanisms (see Appendix 4 for subject instructions). Participants responded to a series of 17 CE questions. Subjects taking part in hypothetical treatments were instructed "… choices that you will make are hypothetical and no purchase will take place." Subjects assigned to the two real treatments were informed that after completing all CE questions, one number out of 17 would be randomly selected as binding for which actual payment would occur.

Prices of traditional varieties of sweet potato were collected from the local marketplaces immediately prior to the experiment. Sweet potato in Uganda is usually sold in heaps (supermarkets in Kampala being the exception, as they sell in kilograms [kg]), where each heap varies from three to five kilograms, depending on the season. In our experiment, we kept the weight of heaps constant at three kg for all varieties across treatments. The prices of the white variety were varied between Ugandan Shillings(UGS) 500, UGS700, UGS800, and UGS1,000. These encompassed the minimum and the maximum prices of traditional sweet potatoes observed in Uganda (again, with the exception of supermarkets in Kampala). Regarding OSP for which market prices did not exist, we had focus group discussions and local experts' opinions; and prices were varied between UGS300, UGS500, UGS1,000, and UGS1,200. These were constructed as ± one standard deviation from the minimum and maximum price of the traditional variety.[4] A "none of these" option, in addition to four products, was also included that acts as a base from which other alternatives are compared (Louviere 1988).

A consumer's valuation of a product depends on various attributes such as taste, appearance, and nutritional value, among other factors. The choice set given to the respondents was prepared by using a fractional factorial design. It is similar to the one

[3] We are grateful to Anna-Marie Ball for providing us with this information.

[4] The standard deviation is 208.177. However, in Uganda, the minimum denomination of exchange usually used is UGS50, so the prices were kept in-line with the common denomination of exchange.

used in Lusk and Schroeder (2004), which represents a suitable fraction of all possible combinations of factor levels, and captures the main effects for each factor level. In addition, it also avoids multicollinearity and ensures that prices of each product are uncorrelated with the prices of each of the other three products.

Demographic Module

The experiment was followed by a survey that collected information on income, demographic characteristics, exposure, nutritional information and awareness, consumption, and buying and selling behavior. These variables were then used to provide additional controls in the estimation of their willingness to pay.

III. THE ECONOMETRIC MODEL

To estimate consumers' valuation for different varieties of sweet potato, a universal logit model[5] that estimates the impact of prices on four different OSP alternatives—white, yellow, orange, and deep orange—has been estimated. The reference alternative consists of "none of these," which means not choosing any of the four varieties.

In the universal logit model, the ith subject's utility, if s/he chooses the *j* variety of sweet potato, is given by the following:

$$V_{ij} = b_j + \sum_{k=1}^{5} a_{jk} P_{ik} + c_i' X_i + \varepsilon_{ij} \quad (3)$$

Here j=1…5, k=1…5, b_j is alternative specific constant; a_{jk} is the effect of k^{th} product's price on the utility of the jth product; P_{ik} is the kth product price for the subject i; X_i is a vector of observed subject-specific characteristics, including variables such as the subject's age, schooling, income and other household characteristics. Note that unlike multinomial logit, both the subject-specific characteristics and choice-specific characteristics are allowed here to affect the utility of all choices. A subject chooses V_{ij} if $V_{ij}>V_{ik}$ for all other k possible choices. It is assumed that ε_{ij} is independent and follows a type 1 extreme value distribution given by $exp[-exp(-\varepsilon_{ij})]$, which assumes that the omission of an irrelevant choice set should not change the parameter estimates.

Unlike multinomial logit (MNL), the universal logit model specified above relaxes the MNL cross- elasticity properties by including attributes of competing alternatives in the utility function for all alternatives in the choice set (McFadden, Train and Tye 1978). To

[5] Universal logit is the most generalized model in the generalized extreme value family of models, which include the multinomial logit (MNL) and nested logit models (Lusk and Shroeder, 2004).

test the independence of irrelevant alternatives (IIA) assumption, the appearance of significant cross-effects for the effect of alternative *k* would imply that the utility of an alternative depends on the attributes of other alternative(s), and therefore the IIA assumption no longer holds. Though they are not the central focus, examination of the cross-effects of some of the attributes of interest, such as price and taste, are shown to be different from zero, and therefore the selection of universal logit over MNL is justified.

Demographic variables such as family size, number of children under the age of five years, and the presence of pregnant women and breastfeeding mothers can have significant influence on household consumption decisions (Pollak and Wales 1981). These variables have been included in the willingness to pay analysis in order to examine how they condition preferences for OSP.

Table 2 provides summary statistics on the demographic characteristics of the respondents in the four different treatment arms as well as information on their incomes and any prior information on OSP. It is clear that there is no significant difference among four different treatments with respect to individual characteristics. This means that there was no systematic bias in subject selection among treatments, and that the random assignment of subjects to the four treatments was properly done.

IV. RESULTS

Table 3 reports parameter estimates of the full sample and all four treatments estimated by the universal logit model. Only the alternative specific constants (b_j of equation 3) and own-price effects (a_j of equation 3) are reported in Table 3.

The test for parameter equality across treatments given by $-2(LL_j - \sum LL_i)$, which is distributed as χ^2 with *K(M-1)* degrees of freedom, where LL_j is the log likelihood value for the full sample, and LL_i is the log likelihood value for each of the treatments, *K* is the number of restrictions (17), and *M* is the number of treatments (4), is strongly rejected (χ^2 =1959.9; p<0.01) (Lusk and Schroeder 2004, and Louviere, Hensher and Swait 2000). Hence, in the rest of the paper, we report results based on the four separate treatments, and not those for the pooled full sample.

Second, to test the validity of the IIA assumption, we implement Hausman's specification test, which suggests that the omission of an irrelevant choice set should not change the

Table 2: Variable Definitions and Summary Statistics

Variable	Definition	Full Sample	Real, Without Information	Real	Hypothetical	Cheap Talk
				With Information		
Taste	Participants' relative preference among the four varieties					
White	% of participants who preferred the white variety most	9.24	12.61	10.68	7.96	5.66
Yellow	% of participants who preferred the yellow variety most	26.10	22.52	22.33	23.89	35.85
Orange	% of participants who preferred the orange variety most	13.16	14.41	11.65	13.27	13.21
Deep Orange	% of participants who preferred the deep orange variety most	51.50	50.45	55.34	54.87	45.28
Demography and Income						
Gender	Percentage of male respondents	0.46	0.42	0.51	0.46	0.43
		(0.006)	(0.011)	(0.012)	(0.011)	(0.012)
Education	Years of schooling	6.39	5.97	6.74	6.46	6.44
		(0.041)	(0.074)	(0.090)	(0.161)	(0.082)
Family Size	Number of members in the household	6.14	5.87	6.28	6.35	6.05
		(0.056)	(0.089)	(0.087)	(0.011)	(0.077)
Children under five	Number of children under the age of five	1.39	1.35	1.49	1.27	1.45
		(0.015)	(0.035)	(0.029)	(2844.921)	(0.027)
Pregnant/Breast-feeding Women	Number of pregnant/ breast-feeding women in the household	0.40	0.44	0.36	0.31	0.50
		(0.007)	(0.015)	(0.012)	(0.011)	(0.014)
Income	Household income in UGS/year	83282	81685	94073	80333	93320
		(81281)	(135195)	(87667)	(83453)	(77942)
Prior Information on OSP	% of participants who received information on OSP	0.38	0.29	0.27	0.42	0.56
	% that received information prior to the experiment	(0.006)	(0.010)	(0.011)	(0.011)	(0.012)
Kampala	# of observations from Kampala	2686	680	646	680	680
Kamuli	# of observations from Kamuli	1,955	527	425	493	510
Luweero	# of observations from Luweero	2,720	680	680	748	612

Standard errors are in parentheses.

parameter estimates (Hausman and McFadden 1984). The test rejects the assumption of the IIA. [6]

Table 3: Parameter Estimates – Universal Logit Model

Alternative Specific Constant	Full Sample		Real without Information (1)		Real with Information (2)		Hypothetical, No Cheap Talk (3)		Hypothetical, with Cheap Talk (4)	
White	9.344	(0.616)	16.786	(1.625)	5.660	(1.411)	5.825	(1.801)	15.904	(1.965)
Yellow	6.854	(0.516)	5.500	(1.064)	3.435	(1.207)	9.994	(1.628)	11.548	(1.370)
Orange	7.196	(0.493)	5.001	(1.061)	5.547	(0.987)	10.283	(1.582)	11.662	(1.339)
Deep Orange	7.298	(0.466)	6.421	(1.114)	7.110	(0.856)	9.021	(1.550)	11.901	(1.234)
Own-price Effects										
White	-0.010	(0.001)	-0.024	(0.002)	-0.008	(0.001)	-0.006	(0.001)	-0.019	(0.002)
Yellow	-0.007	(0.000)	-0.011	(0.001)	-0.009	(0.001)	-0.006	(0.001)	-0.010	(0.001)
Orange	-0.006	(0.000)	-0.009	(0.001)	-0.008	(0.001)	-0.005	(0.001)	-0.010	(0.001)
Deep Orange	-0.005	(0.000)	-0.009	(0.001)	-0.007	(0.000)	-0.004	(0.000)	-0.007	(0.001)
Log Likelihood	-5124		-872		-985		-1368		-919	
No. of Observations	6640		1760		1568		1728		1584	

Numbers in the parentheses are standard errors.

Because the IIA property is violated, we have estimated a multinomial probit (MNP) model that does not assume errors are independently distributed across alternatives. The results show that the WTP and marginal WTP based on a MNP model are not statistically different from those obtained from the universal model (see Table A1 in Appendix 5).

How much consumers value a particular variety of sweet potato *j* is obtained as the ratio of variety- specific constant to the price coefficient ($-b_j / a_j$). Table 4 reports the willingness to pay (WTP) for each variety calculated from the parameters (reported in Table 3) estimated by the universal logit model (Equation 3). The reported WTPs are for one kilogram of sweet potato (Table 4). Standard errors of WTP are generated through a parametric boot strapping method and reported in Table A2 of Appendix 5.

[6] For the full sample, the chi2 (37)=(b-B)'[(V_b-V_B)^(-1)](b-B)=65.47, prob>chi2=0.0027. The test statistics for others are available upon request.

The marginal willingness to pay for a particular OSP *j* versus traditional white variety *k* is calculated as the difference in willingness to pay between *j* and *k* ($-b_j / a_j + b_k / a_k$). Table 4 also reports these marginal WTP estimates, while the corresponding boot-strapped standard errors are in Table A3 in Appendix 5.

Table 4: Willingness To Pay (WTP) and Marginal Willingness To Pay (WTP) for OSP (UGS/Kg)

	Real Without Information (1)	Real With Information (2)	Hypothetical (3)	Hypothetical With Cheap Talk (4)
Total WTP				
White	237	250	331	274
Yellow	168	123	574	392
Orange	189	221	631	394
Deep Orange	232	357	750	553
Marginal WTP				
Yellow vs. White	-68	-126	243	118
Orange vs. White	-47	-28	301	120
Orange vs. Yellow	21	98	58	2
Deep Orange vs. White	-5	108	419	279
Deep Orange vs. Yellow	63	234	176	161
Deep Orange vs. Orange	42	136	118	159

* These are WTP values for 1 kilogram of sweet potato.

Willingness to Pay (WTP) for OSP in the Absence of Nutrition Information

The WTP estimates obtained in the "real without information" treatment suggest that relative to the familiar white varieties, there is no difference in the willingness to pay for deep orange sweet potato. This is also true for orange varieties, for which consumers appear to be willing to pay as much as they would for the white, suggesting that the new color and taste do not adversely affect consumer acceptance. However, the yellow variety commands a statistically significant and substantial discount of nearly 30 percent. There is no difference between the willingness to pay between the two orange varieties. These results suggest that, even in the absence of an information campaign, OSP, if accepted by farmers, are likely not to suffer a price disadvantage in the market, although there is clearly no premium for the orange color either.

The Impact of Nutrition Information

The provision of nutrition information translates, as might be expected, into a premium for the orange varieties. The difference in WTP between the two real treatments—with and without information—indicates an increase of UGS32 per kg and UGS126 per kg, respectively; both of which are statistically significant. With knowledge of the nutritional value, there is a substantial premium for orange varieties relative to white, which is also significant, unlike the case when no information was provided. In this case, the WTP for deep orange varieties is nearly 40 percent higher than that for the white. It is also noteworthy that the premia for the deep orange are higher than those for the orange. This result is consistent with what one might expect, as the deep orange varieties have higher beta-carotene content relative to the orange. Indeed, with nutrition information, even the yellow varieties command a premium over the white, reversing the finding of a discount for the yellow varieties in the absence of any information on nutrition.

These premia are in line with the findings of McGuirk et al. (1995) and Kinnucan et al. (1997), who find a significant impact of health information on food demand in the United States.[7] The magnitude of the premium for deep orange varieties when nutrition information is provided is in line with those found in other studies: a 25-50 percent premium for non-genetically modified foods is reported in Europe and Japan, although the magnitudes are far more modest in the United States (see, for example; Li, McCluskey and Wahl 2004).

Nevertheless, given the developing country setting of the study, the premia for nutrition information appear high, especially considering the relatively limited purchasing power of most study participants, and the salience of this staple food in average budgets in countries such as Uganda. One explanation may be that the nutritional information was given in a one-to-one setting, making it the most effective and perhaps the most costly form of communication. This communication may have biased in an upward direction the size of the impact due to nutritional information, and may well have been lower had other forms of communication been used. This can also be seen from the coefficient of prior information (see Table 5), which is negative and significant. Participants who had prior information had a negative coefficient on OSP valuation, suggesting that the effect of nutritional information may decline over time. Another explanation may be that where children's health is concerned—as is the case here—premia may well be high; in any case, all the respondents were endowed with some money with which to make purchases.

[7] Since our study has a between-subject design, it was not possible to examine how subjects' valuation for OSP changes once information is given.

The Magnitude of Hypothetical Bias

The extent to which WTP for new products, and the marginal WTP for nutrition information, can be accurately assessed in a hypothetical setting can be seen by comparing the magnitudes of WTP in treatments 2 and 3, as shown in Table 4. It is evident that in the absence of a cheap talk script, hypothetical bias is large: on average, participants overstated their WTP by a factor of above 2 in hypothetical scenarios compared to real scenarios. This supports the findings reported in List and Gallet (2001). In addition, the *marginal* WTP estimates from the hypothetical choices are also overstated. As might be expected, the degree of hypothetical bias for white varieties is minimal, since this is the product with which consumers are familiar. Note that unlike the case in most hypothetical elicitation experiments, consumers in Uganda had an opportunity to taste the three products that they were being asked to assess. So the difference in the "real" and "hypothetical" arms cannot be attributed to their experience with the product, but entirely to the fact that in the real treatment respondents had to make a purchase, whereas in the hypothetical arm, they did not have to do so.

The Mitigation of Hypothetical Bias through Cheap Talk

Turning to the effectiveness of cheap talk in mitigating hypothetical bias, the results suggest that although the use of a cheap talk script does result in a reduction in the magnitude of the willingness to pay, the bias remains substantial. This finding is of interest because, unlike most other cheap talk scripts, such as those used by Cummings and Taylor (1999) and List (2001) which explicitly indicate the direction of bias, the cheap talk script used in this study was deliberately neutral in its wording. Nonetheless, the cheap talk had the desired effect of lowering hypothetical bias, but it did not eliminate it. For example, the WTP for deep orange in the hypothetical arm was UGS750 per kilogram, more than double the UGS357 in the real arm, whereas with cheap talk the WTP estimates drop to UGS553/kilogram; hence considerably lower than 750UGS/kilogram, but still much higher than the UGS357/kilogram. Upward biases are also seen in the estimated *marginal* willingness to pay for orange and deep orange varieties as well, although once again these biases are lower than was the case in the hypothetical scenario without using a cheap talk script.

Table 5: Universal Logit Estimates – Real Treatment with Information

Coefficient	White Variety	Yellow Variety	Orange Variety	Deep Orange Variety
Price of white sweet potato	-0.00756***	-0.00142	0.000183	0.0000686
	(0.0014)	(0.0012)	(0.0009)	(0.0006)
Price of yellow sweet potato	0.000198	-0.00929***	-0.00165***	-0.000227
	(0.0007)	(0.0009)	(0.0005)	(0.0003)
Price of orange sweet potato	-0.000187	0.00106	-0.00835***	-0.00133***
	(0.0007)	(0.0007)	(0.0008)	(0.0003)
Price of deep orange sweet potato	-0.000825	-0.000432	-0.000668	-0.00663***
	(0.0007)	(0.0006)	(0.0005)	(0.0004)
Gender	1.188***	-0.312	0.198	0.174
	(0.4400)	(0.2700)	(0.2500)	(0.2100)
Education	0.0879	0.126***	-0.0122	0.0666**
	(0.0600)	(0.0410)	(0.0380)	(0.0330)
Family size	-0.0485	-0.0205	-0.133***	-0.0256
	(0.0750)	(0.0520)	(0.0500)	(0.0410)
Children under five	0.356	0.139	0.409***	0.338***
	(0.2700)	(0.1500)	(0.1300)	(0.1100)
Pregnant/Breast-feeding mother	-0.127	-1.191***	-1.024***	-1.271***
	(0.4500)	(0.2800)	(0.2500)	(0.2100)
IncomeX10^5	0.0109	0.00954	0.0212	0.00723
	(0.0190)	(0.0180)	(0.0180)	(0.0160)
Prefer yellow variety	-1.395**	2.681***	2.867***	1.075***
	(0.5400)	(0.4900)	(0.4900)	(0.4100)
Prefer orange variety	-1.717**	-0.326	2.091***	-0.635
	(0.7100)	(0.5400)	(0.5100)	(0.4400)
Prefer deep orange variety	-4.690***	-0.373	1.001**	1.487***
	(0.7300)	(0.4300)	(0.4100)	(0.3500)
Prior information on OSP	-2.257***	-1.468***	-0.989***	-0.936***
	(0.6900)	(0.3500)	(0.3100)	(0.2700)
Kamuli district	-1.827**	2.138***	0.895**	-0.0143
	(0.8600)	(0.4700)	(0.4100)	(0.3500)
Luweero district	-0.249	1.675***	0.773**	-0.273
	(0.5400)	(0.4100)	(0.3800)	(0.3200)
Constant	5.660***	3.435***	5.547***	7.110***
	(1.4100)	(1.2100)	(0.9900)	(0.8600)
Observations	1568			
Log Likelihood	-984.567			

Standard errors are in parentheses. *** p<0.01, ** <0.05, * p<0.1

Correlates of Willingness to Pay
To demonstrate how taste, income and demographic factors influence WTP, the estimated coefficients of the universal logit model for the real treatment with information are presented in Table 5.[8]

Though the income coefficient is positive, it is not significant. Since sweet potato is one of the prime staple foods for the participants in this study, this is not an entirely inexplicable result. Taste factors are also important: all own-taste and most cross-tastes coefficients are significant (Table 5). These also provide a justification for the inclusion of a consumer acceptance taste test prior to the CE, although collinearity problems precluded the inclusion of all the sensory variables.[9] Urban/rural differences in WTP and marginal WTP are captured in two rural district dummies. Rural households have a lower WTP for the traditional variety of sweet potato but have a higher WTP for varieties with higher beta-carotene content sweet potato (based on real treatment with information).

Preference Consistency
In its simplest form, a violation of the weak axiom of revealed preference (WARP) occurs if a subject chooses a particular variety of sweet potato (e.g., white) in one scenario when another variety of sweet potato (e.g., orange) is less expensive, but chooses orange in a different scenario when white was less expensive. In the present case, around 30 percent of the participants violated the WARP in at least one circumstance, and the violations took place irrespective of the type of treatment. This may suggest that using as many as 17 choice sets may be problematic; this is an area for further research.

V. CONCLUSIONS

We used real money and real products to compare the willingness to pay for sweet potato that are both traditional (white and yellow) and that are biofortified (orange and deep orange OSP), and compared these with results constructed from hypothetical scenarios. We also relied on methods from food science to enable consumers to taste the products that they would be asked to value.

Our results suggest that the use of hypothetical scenarios which are typically easier and less expensive to implement are unlikely to be of use in the case of staple foods; it is

[8] We present the parameter estimates only of one of the treatments; the coefficients in the other treatments have, by and large, the same sign. The full set of estimates is available from the authors on request.
[9] The pair-wise correlation coefficient between taste and overall acceptability for each of the four samples is a high 0.9.

necessary to introduce and work with the real product in order to elicit accurate estimates of the marginal WTP for biofortified crops in developing country settings.

The introduction of a cheap talk script does result in a significant reduction in valuations, even when the script does not mention the direction of possible bias. However, the estimated WTP and marginal WTP are higher than those obtained in the real treatment, suggesting that while the bias is reduced, it is not eliminated and, indeed, remains substantial. The additional expense of working with real incentives and products appears justified.

Turning now to the scenarios using the real product, our results for Uganda, a key target country for the orange sweet potato, suggest that in the absence of a promotional campaign, OSP varieties are likely to compete on par with the traditional white varieties in the market. Therefore, to the extent that sweet potato is produced and consumed onfarm, provided the agronomic properties are acceptable to farmers, there should be no obstacle to its acceptance within the household.

The impact of nutrition information on consumers' willingness to pay is substantial. When informed about the nutritional value of the OSP, consumers are willing to pay a premium, and the size of the premium is higher for the deep orange than for the orange; the deep orange has more beta-carotene than the orange. This suggests that nutritional messages and social marketing may be key for the promotion of OSP in the market to ensure that traders have an incentive to demand and sell the biofortified varieties.

This paper represents perhaps one of the few examples where choice experiments have been conducted in a developing country setting using rural and urban consumers. This is likely to more accurately predict consumer acceptance, as compared to valuations elicited from students in a laboratory. Our results provide a validation of the use of choice experiments in developing country settings, although the percentage of respondents who exhibited inconsistent switches in preferences is somewhat high.

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APPENDIX 1

HEDONIC SCALE USED BY CONSUMERS FOR THE ACCEPTABILITY (APPEARANCE, TASTE, AND OVERALL ACCEPTABILITY) OF COOKED SWEETOTATO

Please taste the four samples on the plate in front of you. Each sample is identified by a code. Please tick each box according to how acceptable you find each sample for appearance, taste and overall acceptability

	Appearance	**Taste**	**Overall**
Like extremely	☐	☐	☐
Like very much	☐	☐	☐
Like moderately	☐	☐	☐
Like slightly	☐	☐	☐
Neither like nor	☐	☐	☐
Dislike slightly	☐	☐	☐
Dislike moderately	☐	☐	☐
Dislike very much	☐	☐	☐
Dislike extremely	☐	☐	☐

Comments:

APPENDIX 2

NUTRITION MESSAGE GIVEN TO SELECTED PARTICIPANTS (HYPOTHETICAL, CHEAP TALK, AND REAL WITH INFORMATION)

Orange sweet potato can help improve health because it is a good source of vitamin A. Without vitamin A we can become more susceptible to blindness, infection, reduced growth and development of our bodies, and less healthy skin, and lack of vitamin A can even lead to death, in particular among children. We all need vitamin A, but young children especially need it because their bodies are rapidly growing. Pregnant and nursing mothers provide food for growing babies, so they too should have diets rich with vitamin A.

Good sources of vitamin A in the diet include fruits and vegetables, especially those that are deep orange or dark green in color. Orange sweet potato is an excellent source of vitamin A. Vitamin A is also be found in dairy products, liver and egg yolks. White or yellow sweet potato are poor sources of vitamin A.

APPENDIX 3

CHOICE EXPERIMENT SCENARIOS FOR THREE KILOGRAMS (KGS) OF OSP CULTIVARS

Scenario	White-Fleshed	Yellow-Fleshed	Orange- Fleshed	Deep Orange-Fleshed
1	500	300	300	300
2	800	1000	300	1000
3	1000	1200	300	1200
4	700	500	300	500
5	700	1200	1000	300
6	1000	1000	500	300
7	800	500	1200	300
8	500	1200	1200	1000
9	1000	300	1200	500
10	500	1000	1000	500
11	700	1000	1200	1200
12	700	300	500	1000
13	800	300	1000	1200
14	800	1200	500	500
15	1000	500	1000	1000
16	500	500	500	1200
17	300	300	300	300

APPENDIX 4

SUBJECT INSTRUCTIONS

Subject Instructions for the "Real" Treatment

Now you have the opportunity to buy one of the four products that you just tested. They are arranged in 17 different scenarios. We would like you to make a choice in each scenario described below. In each scenario, there are four products that you just tested, and you may choose any of them. Alternatively, you may choose none of them.

Once you have made your choice for each scenario, I will pick a number from the box that contains all scenario numbers (show them the box and the numbers inside). Each number has an equal chance to be picked. The number that I will pick will be the binding scenario. Only one of your choices will be binding. For example, if I pick 17, then the scenario number 17 will be binding. Depending on the choice that you have made, you will purchase the product or no purchase will be required if you have selected the option "none of these" in the binding scenario.

Do you have any questions?

Subject Instructions for the "Hypothetical" Treatment

Now imagine that you have the opportunity to buy one of the four products that you just tested. They are presented in 17 different scenarios. We would like you to make a choice in each scenario as if you were actually facing them in real life. In each scenario, there are four products that you just tested, and you may choose any of them. Alternatively, you may choose none of them. Note that all these choices that you will make are hypothetical and no purchase will take place.

Cheap Talk Script (CT 1999, List 2001, and List et al. 2006**)**

Before you make your choices, I want to talk to you about a problem that we have in studies like this one. As I told you a minute ago, this is a hypothetical choice; that is, it is not a real one. No one will actually pay money at the end. But I also asked you to choose as though the result would involve a real cash payment. And that's the problem.

In most studies of this kind, folks seem to have a hard time doing this. They act *differently* in a hypothetical setting, where they don't really have to pay money, from how they do in a real purchase, where they really could have to pay money. For example, in a recent study, several different groups of people bid in an auction. Payment was hypothetical for these groups, as it will be for you. No one had to pay money if they won the auction. The results of these studies showed that consumers were stating their willingness to pay very differently in hypothetical settings as compared to real situations where payments need to be made.

We call this a "hypothetical bias." "Hypothetical bias" is the difference that we continually see in the way people respond to hypothetical scenarios as compared to real scenarios, just like in the example presented above.

In the real auction, where people knew they would have to pay money if they actually bid, people put their bid differently.

How can we get people to think about their choices in a hypothetical situation like they think in a real situation, where a person will really have to pay money? How do we get them to think about what it means to really dig into their pocket and pay money, if they are not going to have to do it?

Let me tell you why I think that we continually see this hypothetical bias, why people behave differently in a hypothetical situation than they do when in a real situation. I think that when we behave in a hypothetical situation we place our best guess of what we really like to do. But, when the choice is real, and we would actually have to spend our money if we win, we think a different way: We think if I spend money on this, that's money I don't have to spend on other things…we act in a way that takes into account the limited amount of money we have… This is just my opinion, of course, but it's what I think may be going on in hypothetical situations.

So, if I were in your shoes, and I were asked to make several choices, I would think about how I feel about spending my money this way. When I got ready to choose, I would ask myself this: If this were a real situation, and I had to pay X amount of dollars if I win, would I really want to spend my money this way?

Please keep this in your mind when making your choices.

APPENDIX 5

Table A1. Willingness to Pay for Sweet Potato: Multinomial Probit Estimates

	Hypothetical	Cheap Talk	Real	Real Without Information
Total WTP				
White	347	271	260	237
Yellow	535	358	118	161
Orange	580	368	212	179
Deep Orange	636	557	350	212
Marginal WTP				
Yellow vs. White	187	87	-142	-77
Orange vs. White	233	97	-48	-58
Orange vs. Yellow	46	10	94	19
Deep Orange vs. White	289	285	90	-25
Deep Orange vs. Yellow	102	199	232	51
Deep Orange vs. Orange	56	188	138	33

Table A2. Mean Willingness to Pay (WTP for 3 Kg in UGS) and Bootstrap Standard Error

	Observed WTP	Bootstrap Std. Err.	z	P>z	95% Confidence Interval	
Full Sample						
White	944	51.685	18.270	0.000	842.830	1045.435
Yellow	1008	67.807	14.870	0.000	875.561	1141.363
Orange	1108	72.852	5.210	0.000	965.147	1250.727
Deep Orange	1399	107.226	13.040	0.000	1188.559	1608.883
Hypothetical, no cheap talk (4)						
White	992	217.248	4.570	0.000	566.576	1418.188
Yellow	1721	201.711	8.530	0.000	1326.074	2116.782
Orange	1894	257.580	7.350	0.000	1389.547	2399.259
Deep Orange	2250	457.735	4.910	0.000	1352.563	3146.883
Cheap Talk (3)						
White	822	84.972	9.670	0.000	655.004	988.096
Yellow	1176	178.424	6.590	0.000	826.145	1525.567
Orange	1181	151.080	7.820	0.000	884.592	1476.824
Deep Orange	1658	156.285	10.610	0.000	1351.661	1964.297
Real, with information (2)						
White	749	208.441	3.590	0.000	340.515	1157.602
Yellow	370	134.726	2.740	0.006	105.704	633.830
Orange	664	116.473	5.700	0.000	436.116	892.692
Deep Orange	1072	104.512	10.260	0.000	867.626	1277.312
Real, Without Information (1)						
White	710	45.076	15.760	0.000	622.000	798.696
Yellow	505	96.662	5.230	0.000	315.818	694.734
Orange	568	98.540	5.770	0.000	374.994	761.272
Deep Orange	695	120.951	5.750	0.000	458.104	932.230

Results are based on 100 replications.

Table A3. Marginal WTP (for 1 kg. in UGS) and Bootstrap Standard Error

	Hypothetical			Hypothetical with Cheap Talk			Real With Information			Real Without Information		
Yellow vs. White	243.02	(75.60)	*	118.10	(50.29)	*	-126.43	(41.40)	*	-68.36	(33.16)	*
Orange vs. White	300.67	(83.99)	*	119.72	(50.29)	*	-28.22	(42.40)		-47.40	(34.73)	
Orange vs. Yellow	57.65	(71.13)		1.62	(45.80)		98.21	(51.66)		20.95	(34.25)	
Deep Orange vs. White	419.11	(165.06)	*	278.81	(59.81)	*	107.80	(46.31)	*	-5.06	(35.39)	
Deep Orange vs. Yellow	176.09	(137.62)		160.71	(71.87)	*	234.23	(31.38)	*	63.30	(40.83)	
Deep Orange vs. Orange	118.44	(133.71)		159.09	(49.84)	*	136.02	(39.67)	*	42.34	(32.92)	

* Significant at 5 percent or more.