Comparing Contingent Valuation Method, Choice Experiments and Experimental Auctions in soliciting Consumer preference for maize in Western Kenya: Preliminary results

Simon Chege Kimenju[1], Ulrich B. Morawetz[2] and Hugo De Groote[1]

[1] International Maize and Wheat Improvement Centre (CIMMYT), International Maize and Wheat Improvement Centre (CIMMYT), P.O. Box 25171-00603, Nairobi, Kenya (s.kimenju@cgiar.org, h.degroote@cgiar.org)

[2] University of Natural Resources and Applied Life Sciences (BOKU), Vienna, Austria

Draft: June 2005

Paper prepared for presentation at the African Econometric Society 10th Annual Conference on Econometric Modeling in Africa, Nairobi, Kenya, 6-8 July 2005.

Abstract

Vitamin A deficiency (VAD) is a serious problem causing severe eye problems and affects the immune system. One effort to reduce VAD is biofortification, the breeding for increased content of pro-vitamin A carotenoids. Since maize is a major food staple for East and Southern Africa, there is a large interest in breeding maize for increased carotenoids content, which however causes coloration of maize. Since most consumers in these regions prefer white maize, it is unclear how they will balance the improved nutritional quality against the undesired color change. It is therefore important to study consumers' attitudes and preferences before introduction of such products. In order to determine the most appropriate method for such a study, a methodological study trying three methods, Contingent Valuation, Choice Experiments and Experimental Auctions was undertaken in Western Kenya in 100 households. The experimental auction produced the most realistic preference estimates though it was more expensive.

Keywords: consumer, maize, Africa, contingent valuation, choice experiments, experimental auctions.

Comparing Contingent Valuation Method, Choice Experiments and Experimental Auctions in soliciting Consumer preference for maize in Western Kenya: Preliminary results

1. Introduction

1.1. Background

Throughout the developing world, poor people subsist on diets consisting mostly of staple foods such as rice or maize. The lack of diversity in their diet, caused by lack of purchasing power or awareness, often leads to insufficient intakes of micronutrients. Among the nutritional deficiencies, lack of sufficient amounts of vitamin A, iron, and zinc has the greatest impact on public health. Vitamin A deficiency (VAD) is a major problem in large parts of the developing world. An estimated 250,000 to 500,000 VA-deficient children go blind every year (West Jr. and Darnton-Hill 2001). Apart from acute eye symptoms, VAD also weakens the immune system, thus increasing the incidence and severity of infectious diseases and infant mortality rates. For adults, the implications can be serious, too, especially for pregnant and lactating women. Nearly 600,000 women die from childbirth-related causes each year, many of them from complications which could be reduced through better provision of vitamin A (Sommer and West Jr. 1996)

Vitamin A is available from animal sources in the form of retinol and from dark green, leafy vegetables and yellow and orange non citrus fruits and vegetables in the form of pro vitamin A carotenoids. Vitamin A from plant sources is less easily absorbed and utilized by the human body (less bio-available) than the vitamin A coming from animal products. Since vitamin A from plant sources is usually found in large amounts in only a few fruits and vegetables, many of which are highly seasonal, low income populations may suffer from VAD and severe seasonal deficiencies unless VA is available in staples (Ruel 2001).

It is well recognized that no single strategy exists to eliminate micronutrient deficiencies globally. Multidisciplinary teams must join together to design and implement global strategies to attack the problem in a sustainable way (Ruel 2001). Recently, a lot of efforts have been made to reduce VAD in developing countries. Food fortification, supplementation, and dietary education programs have been undertaken. A new approach is to enrich major staple foods with pro vitamin A through plant breeding (Bouis 1999). For some crop species such as maize and sweet potatoes, cultivars or landraces with high beta-carotene contents have been identified, which can be used in breeding programs. The Consultative Group of International Agricultural Research (CGIAR) has responded to this challenge through a program, "HarvestPlus" aimed at decreasing micronutrient deficiencies through biofortification of major staple crops. One of the crops of great interest in Eastern Africa is maize since it is the predominant staple in Eastern and Southern Africa

1.2 The Problem

When crossing varieties with particular traits, scientists also attempt to monitor and maintain consumer characteristics such as taste, cooking qualities, colour and appearance. These characteristics are important because they have a bearing on acceptability of the new products. In maize, color is a very important trait. While almost 90% of the world maize production is yellow, Central America and Eastern Africa produce mostly white maize (FAO and CIMMYT 1997). About 9 million ha in each region is planted in white maize annually, and this maize is largely for human consumption. In East Africa, although the first maize varieties were colored varieties from the Caraibbean, they were largely replaced by improved white varieties. Factors that played a role in this preference were the demand from the British starch industry in colonial times and a familiarity with the product since it was the dominant staple produced to feed labor on large-scale farms of European settlers (Smale and Jayne 2003). Moreover, yellow maize has been associated with relief food and animal food, making it less attractive to human consumers.

The preference of East-African consumers for white maize might pose a barrier to the adoption of biofortified maize. Biofortification with vitamin A is likely to be achieved through an increase of the beta carotene content, turning it yellow. It is unclear how consumers will react to such a change since they will have to weigh the improved nutritional quality against an undesired change in color. Consumer's experience with yellow maize, social background, and the price difference could influence attitude towards yellow maize. Knowledge about the attitude toward maize is of crucial interest in order to target the appropriate regions, varieties, and consumer groups.

In developed countries, with majorities of urbanized and well-educated consumers, consumer preferences and interest in new products are investigated through focus group discussions, consumer surveys, and experimental markets. A large body of literature is available to provide theoretical justification and empirical evidence. Earlier consumer surveys mostly used Contingent Valuation Method (CVM) and solicited consumers' willingness to pay (WTP) for a hypothetical product. In this method, the researcher creates a hypothetical market in a non-market or new good, invites a group of subjects to operate in that market, and records the results. The values generated through the use of the hypothetical market are treated as estimates of the value of the non-market good or service, contingent upon the particular hypothetical market (Mitchell and Carson 1989).

Choice experiments (CE) have also been widely used. These are based on Lancasterian consumer theory which proposes that consumers make choices not on the simple marginal rate of substitution between goods, but based on preferences for attributes of these goods. CE predicts consumers' choice by determining the relative importance of various attributes in consumers' choice process (Hanemann and Kanninen 1998). Various attributes of maize including colour, nutrient quality and price will be entered at their different levels to determine possible combinations of the attributes. Of great interest would be the trade-off between nutrient quality and colour, and how much consumers are willing to pay for higher nutrient quality by itself.

Both of these methods are easy and cheap, and use discrete choice models to derive average WTP, WTP for product attributes and factors influencing WTP. But stated preference methods have been criticized for being unrealistic and not offering proper incentives so that consumers would reveal their true preferences. Economics literature has shown that individuals overstate the amount they are willing to pay in hypothetical settings as compared to when real money is on the line and there are true budget constraints. In the more recent experimental auctions, on the other hand, real transactions take place and participants bid with real money on real products. Auction outcomes are therefore considered closer to true WTP, but unfortunately these auctions are more difficult to organize, and require more time and resources. In a typical incentive compatible experimental auction, subjects bid to obtain a novel good. The highest bidder(s) win the auction and pay a price that is determined exogenously from the individuals' bid. Experimental auctions are advantageous in that they create an active market environment with feedback where subjects exchange real goods and real money, and exact WTP measures are obtained.

In Africa, experience with these methods is limited, and it is therefore hard to determine the best way for studying maize consumers' trade-off of color versus pro-vitamin A carotenoids content. Therefore, a methodological study is being carried out to compare the methods. This study compares these methods in their convenience and cost of data collection, and in the precision and accuracy of the resulting WTP for nutrient rich maize in rural Africa. The resulting recommendations will determine the most appropriate method to estimate WTP for the biofortified maize, to be conducted later this year.

The general objective of this study is to determine the potential demand for yellow VA biofortified maize. The specific objectives are: i) to determine consumer awareness and knowledge about vitamin A fortification, ii) to determine consumer attitudes toward yellow maize, iii) determine mean WTP for yellow biofortified maize, and iv) determine the factors that influence mean WTP for yellow biofortified maize.

2. Soliciting consumers' preferences

2.1. Overview

Economists have been struggling for many years to find ways to estimate how much people value certain goods that are not yet on the market. The most direct way to elicit people's willingness to pay is to ask them how much they would be willing to spend for a certain good. In his historic overview,(Green, Jacowitz et al. 1998) explain that this kind of open-ended protocol was used by (Davis 1963). Ten years later, (Randall, Ives et al. 1974) used a sequential bidding procedure, asking consumers repeatedly if they were willing to pay a certain amount for a public good. Still, until the early 1980s the most commonly used protocols were either open-ended or used payment cards. Payment cards ask the respondent for a choice from a series of ranges. A reason for this was that sequential bidding outcomes as Randell used them were found by some studies to be quite sensitive to the starting point (Rowe, D'Arge et al. 1980; Boyle, Bishop et al. 1985; Mitchell and Carson 1989).

This only changed after an adopted version of sequential bidding was introduced (Bishop, Heberlein et al. 1983), (Hanemann 1984), called a referendum protocol where each respondent was offered a single bid, but different bids were offered to different respondents. Advantages of the referendum protocol, which is now more generally referred to as contingent valuation, are that respondent's answers are confined by the researcher's questions. This excludes unrealistic bids which cause embarrassment in open-ended protocols.

An improvement of the contingent valuation in terms of efficiency is the double bounded contingent valuation where the subject is offered a second bid, higher or lower depending on the first response (Carson, Hanemann et al. 1986). This method showed an improved statistical efficiency (Hanemann, Loomis et al. 1991). Drawback of the double-bounded contingent valuation are that responses to the first and second choice question may not be perfectly correlated and that it might suffer from starting point biases (Lusk and Hudson 2004). The origins of contingent valuation are the estimation of non-market goods, but it is now widely used to evaluate willingness to pay for new products.

Parallel to the evolution of contingent valuation, analysis of discrete choice models developed. Originally developed by psychologists, they were later introduced to economics as Random Utility Maximization models (Marschak 1960; Lusk and Hudson 2004). In 1968, McFadden applied this Random Utility Maximization to an econometric model which is now famously known as conditional or multinomial logit model (McFadden 1968). Since the conditional logit found numerous applications it triggered a vast research effort to develop model with less stringent assumptions. This effort was accelerated by the availability of calculation power in the last twenty years which allowed models with simulation to gain ground (Train 2003). But due to its simplicity, McFaddens conditional logit model is still widely used. Discrete choice models with stated preferences are frequently applied in marketing to elicit the preferences for new products or product attributes since the experiment mimics a typical consumer experience (Lusk and Hudson 2004). Other advantages are the avoidance of yea-saying and built-in tests of sensitivity to scope to the list of advantages over contingent valuation (Hanley, Wright et al. 1998). Drawbacks of choice experiments are that they are much more demanding for the respondent to answer in comparison to contingent valuation, that preferences may be unstable throughout the experiment and the difficulty of designing the experiment.

Contingent valuation and discrete choice experiments have the disadvantage that only a limited number of discrete choices are observed, from which the willingness to pay and consequently the market demand relatively complex (Lusk and Hudson 2004). A procedure to elicit continuous values for the willingness to pay are the increasingly popular experimental auctions. Their application for marketing is relatively new, but it builds on a long history. Roth pins down economic experiments concerned with individual choices as long back as to the year 1930 (Roth 1995). Since it is common to apply real transactions in experimental auctions, the resulting incentive to reveal true preferences is often regarded as one of the main advantages. But for testing the willingness to pay for new goods contingent valuation and choice experiments can also be run with real transaction (Lusk and Schroeder 2004). While the procedure of an auction is comparatively complicated the willingness to pay is directly derived.

The various methods for willingness to pay measurement allow a range of variations of the experimental design which in many cases influences the results as numerous papers show (List and Gallet 2001; Lusk and Fox 2003). It thus remains the researcher's task to determine which design is most appropriate for the study. What follows is a more detailed description of the three methods employed for this study to allow a comparison of the estimated willingness to pay.

2.2. The models used in the survey

Contingent Valuation: the double bound logistic model

To apply a double-bound contingent valuation the respondent *n* is asked if she was willing to pay a certain bid *B* for a good. She can either accept or reject. If she accepts she will be offered a second, higher bid B_n^u. If she rejects the second bid B_n^d will be lower. This results in four possible responses: "yes-yes", "yes-no", "no-yes" and "no-no" and, respective probabilities $P^{\bullet}$ can be written as:

$P^{yy}(B_n, B_n^u) = \Pr(WTP_n > B_n^u) = 1 - G(B_n^u;\theta)$,

$P^{yn}(B_n, B_n^u) = \Pr(B_n < WTP_n < B_n^u) = G(B_n^u;\theta) - G(B_n;\theta)$,

$P^{ny}(B_n, B_n^d) = \Pr(B_n^d < WTP_n < B_n) = G(B_n;\theta) - G(B_n^d;\theta)$ and

$P^{nn}(B_n, B_n^d) = \Pr(WTP_n < B_n^d) = G(B_n^u; \theta)$

where WTP_n is the maximum willingness to pay, $G(\bullet;\theta)$ is a cdf of the WTP and θ are the parameters to be estimated (Hanemann, Loomis et al. 1991). In this study the cdf is assumed to be logistically distributed and hence $G(B_n^\bullet) = [1 + e^v]^{-1}$ where $v = \alpha - \rho B_n^\bullet$. The parameters of the index function α and ρ are then estimated by maximizing the log-likelihood function

$$LL(\theta) = \sum_{n=1}^{N} \{d_n^{yy} \ln P^{yy}(B_n, B_n^u) + d_n^{yn} \ln P^{yn}(B_n, B_i^u) + d_n^{ny} \ln P^{ny}(B_n, B_n^d) + d_n^{nn} \ln P^{nn}(B_n, B_n^d)\}$$

where $d_n^\bullet$ are binary-valued indicator variables that are 1 if the respective responses were chosen. The estimated mean willingness to pay is then derived by calculating $\frac{\alpha}{\rho}$. The variance-covariance matrix is asymptotically given by the information matrix derived from the likelihood function.

Choice experiments: McFadden Conditional Logit

In a choice experiment a respondent *n* is asked to choose one out of *J* alternatives that differ in their attributes x_{nj}. With each alternative *j* there is a utility *U* associated which can be different for different respondents. The utility that decision maker *n* obtains from alternative *j* is U_{nj}. The research cannot observe U_{nj}, but he can assume that *n* will only choose *i* if and only if $U_{ni} > U_{ni} \forall j \neq i$. Using this assumption and following (Train 2003), it is possible to construct a representative utilities $V_{nj} = V(x_{nj}) \forall j$. The representative utility is the explained part of utility: $U_{nj} = V_{nj} + \varepsilon_{nj}$, where ε_{nj} captures the variables that influence utility but are not included in V_{nj} as they are not observed. If the representative utility is linear in the observed attributes of the alternatives it can be noted as $V_{nj} = x_{nj}{}'\beta$. If the joint density of the error terms, $f(\varepsilon_n)$, is assumed, it is possible to estimate the probability which alternative is chosen:

$$P_{ni} = \Pr(U_{ni} > U_{nj} \forall j \neq i)$$
$$= \Pr(V_{ni} + \varepsilon_{ni} > V_{nj} + \varepsilon_{nj} \forall j \neq i)$$
$$= \Pr(\varepsilon_{nj} < \varepsilon_{ni} + V_{ni} - V_{nj} \forall j \neq i)$$

Following McFadden's conditional logit model we assume a type I extreme value distribution of the error terms. All unobserved factors are assumed to be uncorrelated over alternatives and the variance is implicitly normalized. For each ε_{nj} the probability to be chosen is then the cdf of the type I extreme value distribution evaluated at $\varepsilon_{ni} + V_{ni} - V_{nj}$, $\exp(-\exp(-(\varepsilon_{ni} + V_{ni} - V_{nj})))$. The cumulative distribution over all alternatives $j \neq i$ is, due to the assumed independence of the ε's, the product of the individual cdf's. But since ε_{in}'s are not known, the sum must be derived by integrating over all values of ε_{in} weighted by its density:

$$P_{ni} = \int \left\{ \prod_{j \neq i} \exp(-\exp(-(\varepsilon_{ni} + V_{ni} - V_{nj}))) \right\} \exp(-\varepsilon_{ni}) \exp(-\exp(-\varepsilon_{ni}) d\varepsilon_{ni} .$$

Algebraic manipulation results in a succinct, closed form expression $P_{in} = \frac{e^{V_{ni}}}{\sum_j e^{V_{nj}}}$ and

$P_{in} = \frac{e^{\beta' x_{ni}}}{\sum_j e^{\beta' x_{nj}}}$ for linear parameters (Train 2003).

The probability that a respondent *n* chooses the alternative he actually chose, can then be expressed as $\prod_i (P_{ni})^{y_{in}}$ where $y_{ni} = 1$ for the chosen alternative and zero otherwise. Given that each decision maker's choice is independent of the others, the probability that each respondent chooses the alternative actually chosen is $L(\beta) = \prod_{n=1}^{N} \prod_i (P_{ni})^{y_{ni}}$ and the log-likelihood is then $LL(\beta) = \sum_{n=1}^{N} \sum_i (y_{ni} \ln P_{ni})$ where β is the vector of parameters to be estimated. As variance-covariance matrix the information matrix may be used. To derive the mean willingness to pay for an attribute the negative of the parameter for the attribute must be dived by the parameter for the price. The variance for the willingness to pay can be estimated by bootstrapping from the distributions of the two parameters and then calculating the variance of the fraction of the bootstrapped parameters.

Experimental auctions

The bids collected from an experimental auction state the willingness to pay of a respondent for a particular product. The mean and the variance is derived by the bids of all participants. The willingness to pay derived from contingent valuation and the experimental auction are in regard to the product in question. The willingness to pay elicited through the choice experiment regards to a particular attribute. In case of an choice experiment with unlabeled alternatives, the estimations are therefore not directly comparable. But for the procedures used in this study allow to calculate the willingness to pay for a particular attribute from the experimental auction and contingent valuation.

The differences in bids of a respondent from the auction for products that only differ in one attribute allow to derive the willingness to pay for this particular attribute. From there, the calculation of the mean and the variance is straightforward. The results can be compared by bootstrapping, based on the estimated distribution of the willingness to pay of two products that differ only in one attribute, taking the differences and calculating the mean and the variance.

3 Methodology

31. Sample design

Since the major objective of the survey was to test the methodology, the major criteria for survey design are a sufficient sample size, low cost, and an area where at least some part of the population is familiar with yellow maize. Therefore, two districts in Western Kenya were selected, Vihiga and Siaya, since CIMMYT already has a project with support staff in these districts.

The sample was selected using a stratified two-stage stages desing, with the two districts forming the strata. From each district, five sublocations where randomly selected proportionate to size, with number of households in each sublocation as the measure for size (obtained from the 1999 population census). From each sublocation, 10 households were randomly selected, resulting in a samples size of 100 households. From each household, one individual (head of the household or spouse) was selected, based on availability (who was at home during the time of the survey), and responsibility for food purchases in the household.

3.2 evelopment of the instruments

To compare the different methods, different survey instruments were used, appropriate for each method. A questionnaire was administered asking personal information of the respondents (age, education, gender and years of formal schooling) and of their households (size, land size, land size under maize). The questionnaire also included questions regarding knowledge, attitudes and practices on yellow maize, food nutrients and fortification. After the general questionnaire, three different methods were used to estimate consumers' preferences for color, price and nutrient content: contingent valuation, choice experiments and experimental auctions.

The contingent valuation method was applied for three products: yellow unfortified maize, yellow biofortified, and white biofortified maize, each at time. For each product, respondents were first asked if they would be willing to pay 40 shilling for a container of 2 kg maize grain (the first bid). This is the current average price of maize. Those who accepted were further asked if they would be willing to pay for the maize if the price were higher (higher bid). Two levels of higher price were used, 50 and 60 Kenya shillings. However, each person who accepted the first bid faced only one higher bid. The higher bids were randomly assigned to the respondents in order to have an equal number facing each higher bid. Those who refused the first bid were randomly offered a second bid, either 20 or 30 Kenya shillings (lower bid).

For the choice experiment the respondent was read a short text that explained the experiment and then presented a card with three different maize types. Each of the maize meal types was specified regarding the Vitamin A content (plain or fortified), the color (white or yellow) and the price (varying in five levels around the mean price for maize meal). A "none" option was also included to represent all the alternatives not shown on the card. Forty different such cards were designed and each respondent had to answer ten. To design the sample, all possible combinations of maize meal attributes were constructed. Assuming that all respondents prefer lower prices and higher nutrient content, all cards where one maize meal was cheaper and had a higher nutrient content than another maize meal on the same card were dropped. Cards where two maize meal types only differed in the price were also discarded. From the remaining cards, a sample of 40 was chosen my maximizing the D-Efficiency for 4 subgroups of 10 cards each using the R-package AlgDesign (Wheeler 2004).

The auction is the most difficult part of the survey and enumerators were carefully trained for the procedure. After explaining the BDM auction protocol to the respondent, a training round with cakes, but exactly the same protocol as the maize meal auction, was carried out. For this purpose the respondent was endowed with 15 Kenyan Shillings, with the knowledge that the money would not be required back, but was to facilitate them to purchase the product if they won. Respondent were also told that they had to purchase the product if they won. After doing three BDM auctions with three different cake types (but of the same size), exchanging cakes for money in case the respondent won and clarifying questions that emerged during the training round. Thereafter, the respondent was endowed with 70 Kenyan Shillings for the maize meal auction. A 2 kg packet of plain white maize meal was presented and the respondent was asked to set a bid for it. The enumerator collected the bid and the procedure was repeated for similar packages of white fortified maize meal and yellow plain maize meal[1]. It was then determined randomly which of the three rounds was binding. Purchase of the product took place only if a randomly drawn number[2] was less then the participant's bid for the binding round.

3.3. Execution of the survey

Two informal group discussions were held in two villages of Vihiga district in Western Kenya to have an understanding of people's knowledge and perception on yellow maize, nutrient quality and fortification. This lead to the development of a questionnaire which was tested in the same villages, and adjusted accordingly. Similarly, the details of the choice experiment and the experimental auctions were adjusted. Following this, 5 enumerators were hired for the survey and adequately trained on the three methodologies and on administration of the questionnaire. The survey execution, which took place from 3rd to 9th June 2005, was supervised by a CIMMYT economist

4. Results

4.1. Consumer characteristics

Table 1. Consumer characteristics

Variable	Siaya		Vihiga		Total	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
age in years	45.50	15.99	46.60	14.30	46.04	15.11
years of normal schooling attained	5.57	4.15	6.52	4.21	6.06	4.18
total numer of people living in the household	5.88	2.72	6.71	2.41	6.29	2.59
total farm size (acres)	2.83	2.96	1.80	1.53	2.32	2.41
farm area planted with maize (acres)	1.29	0.88	0.98	0.91	1.13	0.91
number of cattle	2.51	3.28	2.18	1.55	2.34	2.51

Socioeconomic characteristics of the respondents were similar in both districts, especially age (46 on average), and schooling (6 years of formal schooling on average). Household and farm characteristics, however, differ substantially: Siaya has a lower population density and more

[1] The order of the bidding for the different maize meal types is varied between respondents.
[2] The random number is drawn from a normal distribution with mean 50 and variance 50.

available land, which is reflected in a larger farm size (2.8 acres vs. 1.8), more area in maize (1.3 vs. 1.0) and more cattle (2.5 vs. 1.5) than in Vihiga.

4.2. Knowledge, Attitudes and Practice

Another majore difference between the two sites is in the cultivation of yellow maize (Table 2). Where 92% of farmers in Siaya usually plant yellow maize (Nyamula, a local variety), only 42 of farmers in Vihiga grow a yellow variety (named Kipendi here). It is not surprising then that more respondents in Siaya like the color (84% vs. 64%), and more respondents in Vihiga dislike the color (32% vs 6%).

Table 2. Respondents' awareness and opinion about yellow maize, nutrients and fortification

Percentage of respondents who:	Siaya	Vihiga	Total
- usually plant yellow maize	92	42	67
- like the colour of yellow maize	84	64	74
- don't like the colour of yellow maize	6	32	19
- considers colour of yellow maize as normal	8	0	4
- are aware of energy in food	90	98	94
- are aware of vitamins in food	90	94	92
- are aware of protein in food	82	90	86
- are aware of night blindness	88	62	75
- are aware of maize meal brands with added nutrients	36	44	40
- buy maize meal brands with added nutrients	20	14	17
- are aware of fortified baby foods	78	80	79
- are aware of biofortification	24	28	26

Large majorities are aware of food components such as energy (94%), vitamins (92%) and protein (86%) with little difference between the sites. People in Siaya, however, are more aware of nightblindness (88%) than in Vihiga (62%). The people in Vihiga, who live closer to the provincial capital Kisumu, are more aware that there is fortified maize meal on the market (44% vs. 36%), although only few buy it (20% vs. 14%). Most people are aware of fortified baby foods (79%) but not of biofortification (26%). These figures are awareness as perceived by the respondents, and does not reflect actual understanding of these concepts.

4.3. Contingent valuation

In the contingent valuation method, people were first told the current price of white maize in the market (40 Ksh/2kg or about US$0.25 per kg), and then if they would accept to buy yellow maize at that same price. Three quarters of the respondents would accept the offer (76%) (middle bar in Figure 1). The acceptors were asked if they would buy it at a second bid, either 50 or 60 Ksh/2 kg. Two thirds of those offered 50 Ksh accepted to buy yellow maize at that price, which amounts to 50% of all respondents, while only 40% of those offered the Ksh 60 bid would accept, amounting to 30% of all respondents (second and third column in Figure 1). Similarly, if the price is reduced, an increasing number of respondents would be willing to buy the yellow maize, 87% at Ksh 30 and 95% at KShs 20. If we plot the percentage of acceptors against the price, we see an S-shaped curve, representing the distribution of the willingness to pay (WTP). The graph shows how about half the population would accept to pay for yellow maize at 50 Ksh/2 kg, representing the mean WTP of the population (under a symmetric distribution).

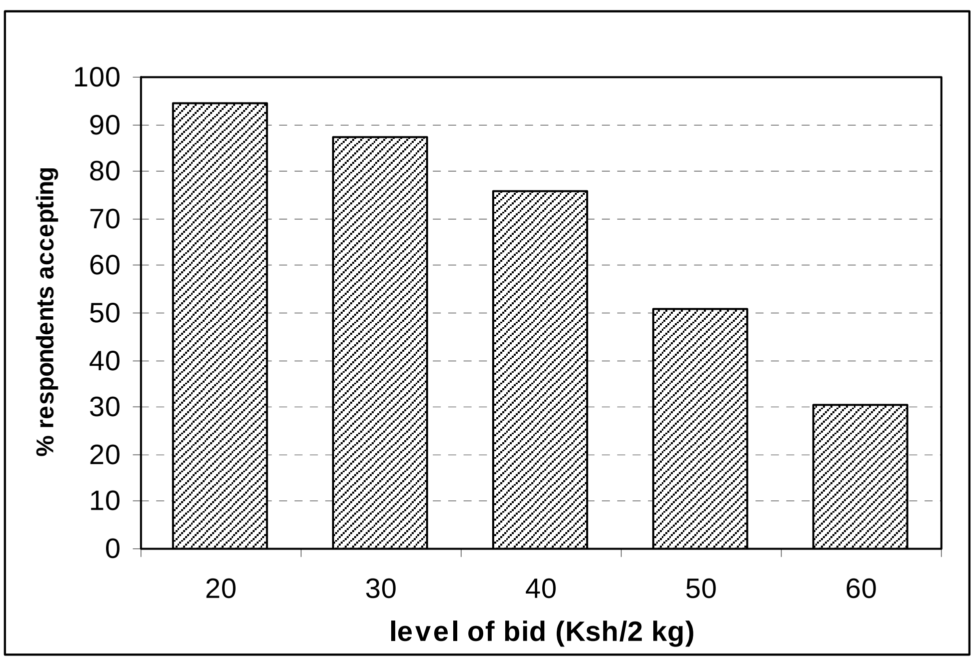

Figure 1. Percentage of respondents willing to buy yellow maize, in function of its price.

Similarly, people were asked about their WTP for yellow fortified maize meal, and for white fortified maize meal (Figure 2). The WTP for fortified maize meal is clearly much higher, with little difference between yellow and white.

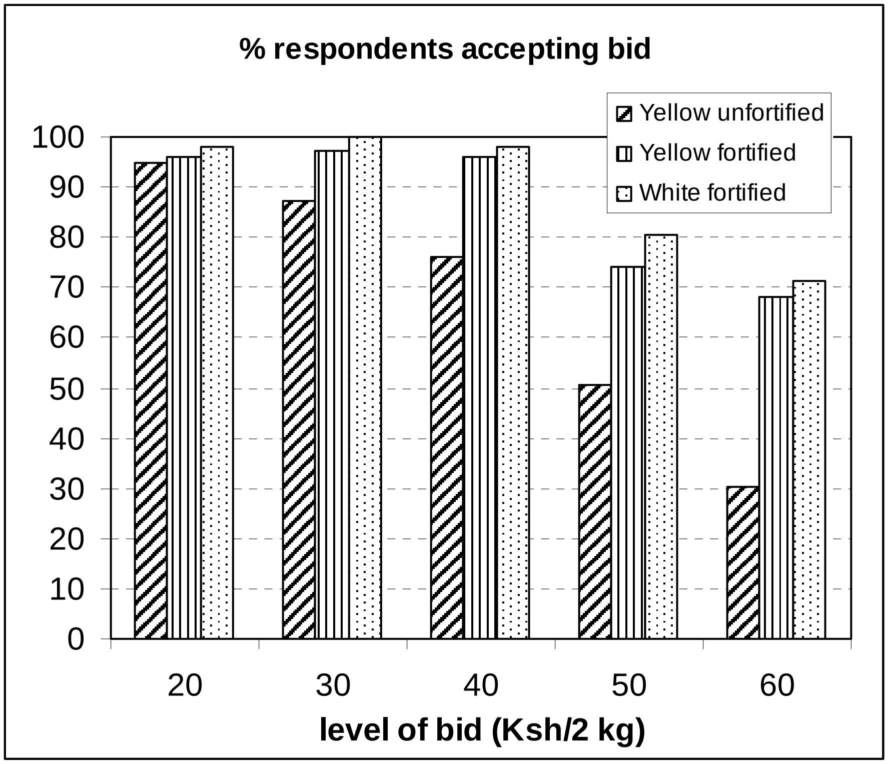

Figure 2. Percentage of respondents willing to buy different maize meals, in function of its price.

The mean WTP of these products is now a bit more difficult to derive from the graph. However, estimating the parameters of a logistic, double-bound model with the standard logistic procedure, allows for the calculation of the mean WTP. For yellow maize, for example, the constant (α) is estimated at 4.9, and the coefficient of the bid (β) at -0.096 (last column in Table 3). From here, the mean WTP ($-\alpha/\beta$) is calculated at 51 Ksh/2kg, as already was expected from the graph. Similar calculations indicate a mean WTP for yellow biofortified maize at 64.5 and white biofortified at 65.2 Ksh/2 kg.

Table 3. Consumers' WTP for maize estimated using CV

Type of maize meal	analysis	Estimate	Siaya (N=50)	Vihiga (N=50)	Total (N=100)
Yellow unfortified	regression	Constant (α)	4.8165	5.0038	4.9070
			(0.8169)	(0.8087)	(0.5746)
		Bid (β)	-0.09453	-0.0975	-0.0960
			(0.0162)	(0.0161)	(0.0114)
		Loglikelihood fn.	60.8885	59.6032	120.5066
	calculation of WTP	Mean WTP (-α/β)	50.95	51.32	51.14
			(3.1880)	(2.6790)	(2.047)
Yellow biofortified	regression	Constant	7.9798	5.6275	6.7596
			(1.8887)	(1.1373)	(0.9792)
		Bid	0.1308	0.0800	0.1048
			(0.0332)	(0.0201)	(0.0173)
		Loglikelihood fn.	41.1910	37.0392	79.5816
	calculation of WTP	Mean WTP (-α/β)	60.99	70.31	64.50
			(2.9180)	(6.6750)	(3.4330)
White biofortified	regression	Constant	9.3401	6.8824	8.0862
			(3.0679)	(1.4521)	(1.3315)
		Bid	0.1502	0.0982	0.1239
			(0.0538)	(0.0253)	(0.0233)
		Loglikelihood fn.	34.2639	31.6944	66.9509
	calculation of WTP	Mean WTP (-α/β)	62.18	70.10	65.25
			(4.2090)	(7.3580)	(2.6080)

4.4. Choice Experiments

In the choice experiments, respondents were asked repeatedly to choose between three products, a randomized combination of color (yellow or white), nutritional quality (fortified or not) and price. Estimating the conditional logit model, as is the standard for these choice experiments, calculates the log-likelihood ratio for the attributes. As for contingent valuation, the mean WTP for the attribute (the premium or discount) can be calculated by dividing the coefficient. Overall, we find a premium of 3.5 Ksh/2 kg, but the premium is much larger in Siaya (8.8 Ksh/2 kg)), while it is a discount (-4.2) in Vihiga. Premiums for fortifications are very high, 82 Ksh/2 kg overall, and even higher in Vihiga.

Table 4. Estimation of WTP from choice experiments

	Estimate	Siaya (N=50)		Vihiga (N=50)		Total (N=100)	
Regression	Price (x_p)	-0.04	***	-0.02	***	-0.03	***
		(0.0064)		(0.00587)		(0.0043)	
	Yellow (x_y)	0.33	**	-0.09		0.10	
		(0.1167)		(0.1098)		(0.0794)	
	fortification (x_f)	2.71	***	2.14	***	2.39	***
		(0.1821)		(0.1583)		(0.1186)	
	Log likelihood	-343.477		-400.181		-750.412	
	Pseudo R2	0.3632		0.2656		0.3079	
Calculation	WTP yellow (x_p/ x_y)	8.76		-4.18		3.50	
		(4.7451)		(7.9855)		(3.7016)	
	WTP fortification (x_p/ x_f)	72.36		94.48		81.64	
		(13.6478)		(304.3652)		(13.8340)	

4.5. Experimental auctions

After the choice experiments, respondents received a small amount of money and were invited to bid for three products, which were physically presented: yellow maize meal, white maize meal, and white fortified maize meal. If the bids fell above a certain level, the transaction was concluded, and the respondent bought the maize meal at the bid he set. The average bid can now be interpreted as the average WTP for the different products. Unfortunately, no fortified yellow maize is on the market, and we were not able to puchase vitamin supplements in time for the experiment.

The results show that the average WTP is 39.9 Ksh/2kg for yellow maize and 39.6 for white maize, which is very close to the market price (Table 5). As expected, Siaya has a slight premium for yellow, and Vihiga a small discount. Mean WTP for the white fortified meal is 51.8 Ksh/2kg, and a bit higher in Vihiga

Table 5. Mean WTP derived from the experimental auctions.

Maize meal type	Siaya	Vihiga	Total
Yellow maize meal	40.60	39.14	39.87
	(13.27)	(11.7)	(12.47)
White maize meal	38.72	40.54	39.63
	(10.72)	(11.04)	(10.86)
White fortified maize meal	50.40	53.20	51.80
	(12.64)	(14.28)	(13.49)

Table 6. Comparison of premiums for colour and fortification using Contingent Valuation, Choice Experiments and Experimental Auction methods

Method	Premium (for a 2 kg package) of	Siaya	Vihiga	Total
Contingent valuation	Yellow colour on unfortified maize	10.95	11.32	11.14
	Yellow colour on fortified maize	-1.19	0.21	-0.75
	Fortification on yellow maize	10.04	18.99	13.36
	Fortification on white maize	22.18	30.10	25.25
Choice experiments	Yellow colour on unfortified maize	8.76	-4.18	3.50
	Yellow colour on fortified maize			
	Fortification on yellow maize			
	Fortification on white maize	72.36	94.48	81.64
Experimental auctions	Yellow colour on unfortified maize	1.88	-1.40	0.24
	Yellow colour on fortified maize			
	Fortification on yellow maize			
	Fortification on white maize	11.68	12.66	12.17

Premiums for colour and fortification differ by method (Table 6). Using contingent valuation, the mean premium that the respondents are willing to pay for yellow colour is KShs 11.14 more for a 2 kg packet of maize yellow maize grain as compared to white. People in Vihiga are willing to pay slightly higher premiums for yellow color than those in Siaya. The premium for yellow colour reduces to KShs 3.50 using choice experiment and further to KShs 0.24 under experimental auctions. In the later two methods, people in Siaya have discounts for yellow colour implying they would prefer white more. The premiums/discounts for yellow maize in the experimental auctions are similar in sign to those of the choice experiments, but substantially smaller.

Conclusions

This study showed that different methods to study consumer preferences can conveniently be used in rural Kenya. However, comparing the premiums/discounts of the different methods (applied to the same respondents), we can derive some strong conclusions.

First, the premiums derived from contingent valuation are very high, even unrealistic. We don't expect a poor farmer to pay 20% more for yellow or for fortification. The differences between the two sites are also contrary to what we would expect: we would expect the farmers in Siaya, who grow more yellow maize, to have a higher premium for yellow colour than those in Vihiga.

In the choice experiments, the results on color are as expected: yellow gets a premium in Siaya and a discount in Vihiga. However, these differences are much larger than what is observed in the market in this area, where yellow and white maize prices do not differ much. The premium on fortification is calculated at more than 80 Ksh/2kg, or 200% of the current price. This is very unrealistic.

The experimental auctions, finally, produce realistic premiums for yellow maize (1.9 KSh/2kg in Siaya and -1.4 in Vihiga) corresponding to differences in the market. The premium for fortification is the lowest of the three methods (12.2 Ksh/2kg). The premium for fortification as observed in the supermarkets in Nairobi ranges from 4 KSh/2k for the cheapest brand, to 23 Ksh/2kg for the most expensive brand. Again, the premium observed with the experimental auction falls in the range observed in the market.

The different methods were also compared in their ease of use. We found contingent valuation to be easy and fast. Choice experiments are more difficult, people often have a hard time making a choice and are afraid they are going to make mistakes (examination fear). Experimental auctions take a lot of preparation, require more financial resources and training of the enumerators. However, after some experience, enumerators had no problem executing the procedure and could easily obtain the bids from the respondents. The procedure was perceived as very enjoyable by the respondents.

Given the ease of use and the more realistic results, we therefore conclude that the experimental auctions are the indicated method, even though they are somewhat more expensive.

References

Bishop, R., T. Heberlein, et al. (1983). "Contingent Valuation of Environmental Assets: Comparison with Simulated Market." Natural Resources Journal **23**: 619-633.

Bouis, H. E. (1999). "Economics of enhanced micronutrient density in food staples." Field Crops Research **60**(1-2): 165-173.

Boyle, K., R. Bishop, et al. (1985). "Starting-point bias in contingent vaulation bidding games." Land Economics **61**: 188-194.

Carson, R. T., M. W. Hanemann, et al. (1986). Determining the Demand for Public Goods by Simulating Referendums at Different Tax Prices, Department of Economics Working Paper,, University of California, USA.

Davis, R. (1963). "Recreation-planning as an econoimc problem." Natural Resources Journal . **3**: 239-249.

FAO and CIMMYT (1997). White Maize: a Traditional Food Grain in Developing Countries. Rome, FAO and CIMMYT.

Green, D., K. Jacowitz, et al. (1998). "Referendum Contingent Vaulation, Anchoring, and Willingness to Pay for Public Goods." Resource and Energy Economics **20**: 85-116.

Hanemann, M. W. (1984). "Welfare evaluations in contingent valuation experiments with discrete responses." American Journal of Agricultural Economics **66**: 332-341.

Hanemann, M. W. and B. Kanninen (1998). The Statistical Analysis of Discrete-Response CV Data. Working Paper No. 798, Department of Agricultural and Resource Economics and Policy. Universtiy of Carlifornia, USA.

Hanemann, M. W., J. B. Loomis, et al. (1991). "Statistical Efficiency of Double-Bounded Dichotomous Choice Contingent Valuation." American Journal of Agricultural Economics : **73**(4): 1255-1263.

Hanley, N., R. Wright, et al. (1998). "Using choice experiements to value the environment: Design issues, current experience and future prospects." Environment and Resource Economics **11**(3-4): 413-428.

List, J. A. and C. A. Gallet (2001). "What Experimental Protocol Influence Disparities Between Actual and Hypothetical Stated Values?" Environment and Resource Economics **20**: 241-254.

Lusk, J. L. and J. A. Fox (2003). "Value elicitation in retail and laboratory environments." Economic Letters **79**: 27-34.

Lusk, J. L. and D. Hudson (2004). "Willingness-to-Pay Estimates and Their Relevance to Agribusiness Decison Making." Review of Agricultural Economics **26**(2): 2-19.

Lusk, J. L. and T. C. Schroeder (2004). "Are Choice Experiments Incentive Compatible? A Test with Quality Differentiated Beef Staks." American Journal of Agricultural Economics **86**(2): 467.

Marschak, J. (1960). Binary choice constraints on random utility indicators. Stranford Symposium on Mathematical Methods in the Social Science, Stanford Universtiy Press.

McFadden, D. (1968). The Revealed Preferences of a Public Bureaucracy, Universtiy of California, USA.

Mitchell, R. C. and R. T. Carson (1989). Using Surveys To Value Public Goods: The Contingent Valuation Method. Resources for the Future. Washington DC.

Randall, A., B. Ives, et al. (1974). " Bidding games for valuation of aesthetic environmental improvements." Journal of Environmental Economics and Management.

Roth, A. E. (1995). Introduction to Experimental Economics. Handbook of Experimental Economics. A. E. Roth, Princeton University Press**:** 3-109.

Rowe, R., R. D'Arge, et al. (1980). "An experiment on the economic value of visibility." Journal of Environmental Economics and Management. **7**: 1-19.

Ruel, M. T. (2001). Can Food-Based Strategies Help Reduce Vitamin A and Iron Deficiencies?, International Food Policy Research Institute.

Smale, M. and T. Jayne (2003). Maize in Eastern and Southern Africa: "Seeds" of Success in Retrospect. Washington, D.C., IFPRI.

Sommer, A. and K. P. West Jr. (1996). Vitamin A Deficiency: Health, Survival, and Vision. New York., Oxford University Press.

Train, K. E. (2003). Discrete Choice Methods with Simmulation, Cambridge University Press.

West Jr., K. P. and I. Darnton-Hill (2001). Vitamin A deficiency. Nutrition and Health in Developing Countries. M. W. Bloem. Totowa, NJ,, Humana Press,**:** 267–306.

Wheeler, R. E. (2004). opt.Block.AlgDesign. The R project for statistical computing.