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Consumers' Willingness to Pay for Genetically Modified foods in Kenya

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Abstract

A survey of 600 consumers was conducted in Nairobi to determine attitudes and willingness to pay (WTP) for GM maize meal. WTP was estimated using the double-bounded logit model. Overall, 38% are aware of GM crops. Most consumers believe in the technology's positive impacts, but are concerned about environmental and health risks. Majority (68%) would buy GM maize meal at the price of their favourite maize meal brand. The mean WTP for GM maize meal is KShs 58 for a 2kg packet, a premium of 13.7 % over mean average price of favourite brands. WTP is influenced more by subjective than socio-economic characteristics.

Keywords: GMO, biotechnology, consumer, Africa, maize

JEL classification: D12, C25, Q16

1. Introduction

1.1. Biotechnology in Africa

Genetically modified (GM) crops have seen a tremendous increase in area grown since they were first introduced in 1996. The global area of GM crops for 2004 was 81 million hectares, grown by 8.25 million farmers in 17 countries, an increase in area of 20% compared to 2003 (James, 2004). This increase is much higher in the developing countries (35%) than in the industrial countries (13%). The number of small farmers from developing countries growing GM crops has also steadily been increasing since the introduction.

GM technology has generally been accepted in North and South America, while the European Union and Japan remain very reluctant. Zhang et al., (2004) observe that unlike their EU and East Asian counterparts, American consumers do not seem to exhibit particular concerns over GM foods. However, uncertainties associated with consumer acceptance for GM foods have emerged in many countries, especially in Europe and Japan (Chern et al., 2002).

Though many studies have analyzed consumer acceptance of GM foods in the developed countries and Asia, little research has been done in Sub-Saharan Africa, even though this region could gain substantially from this technology (De Groote et al., 2003, De Groote H. et al., 2004). Therefore, consumer acceptability of GM crops in sub-Saharan Africa is largely unknown, and the debate has generally been conducted without involving African consumers, or producers for that matter. At the same time, GM technologies continue to be developed for this region, and success of any biotechnology program will depend on consumer acceptance of its products (Springer et al., 2002), which is particular critical in food markets (Hossain et al., 2003). Hence it is important to study potential demand for new products before they are developed, avoiding costly investments in products that might not have a market.

It is therefore important to determine the perceptions of African farmers and consumers on food derived from GM crops, as well as their willingness to pay (WTP) for these new products. This should preferably be done before they are developed for African markets, as these groups will determine the eventual success of biotechnology programs here.

Currently, the Insect Resistant Maize for Africa (IRMA), a collaborative effort of the International Maize and Wheat Improvement Centre (CIMMYT) and the Kenya Agricultural Research Institute (KARI), is developing maize varieties resistant to the stem borers. The project aims to increase maize production and food security through the development and deployment of insect resistant maize, hereby reducing crop losses due to stem borers for African farmers. The project focuses on identifying the best technologies to combat stem borers, using both conventional and GM technology (Mugo et al., 2002). Research activities include product development, product dissemination, impact assessment, technology

transfer, and awareness creation and communications. The project is taking a comprehensive approach by addressing views of all stakeholders. To incorporate consumer views and include them in the debate, a first consumer survey was conducted in Nairobi to elicit their awareness, attitudes and WTP for GM foods. The study also tried to identify factors that influence acceptance and WTP, and to guide scientists and communications specialists towards important concerns that need to be addressed.

1.2. Consumer acceptance of GM foods in different regions

Several studies have explored consumer acceptance of GM foods in different regions. In the US, acceptance of GM foods is generally high, although consumers remain concerned about the potential risks of GM crops on human health (Ganiere and Chern 2004). If the GM products offer extra benefits over traditional products (such as a price discount, health or environmental attributes), perceived benefits outweigh the perceived risks. Similarly, Chen and Chern (2002) found that US consumers were willing to pay on average small premiums for non-GM products. In a study comparing US and Chinese consumers, Zhang et al. (2004) found that, although the overall knowledge of GM food is low in both countries, attitudes of the majority of American and Chinese consumers are generally supportive of the new technology. However, consumers in both countries are clearly more willing to accept of GM plant products than GM animal products.

In comparison with the US consumers, European consumers are less appreciative of GM crops. Moon and Balasubramanian (2001) found that UK consumers were willing to pay significantly higher premiums to avoid GM foods than their US counterparts. However, important differences in acceptance of GM foods also exist within Europe (Springer et al., 2002). While the mean rejection rate for the 15 countries was 73%, this rate ranged from Greece at 85%, down to Great Britain with 58%. In another study, Swedish consumers did not see GM food as equivalent to conventional food. Consequently, these Swedish consumers support mandatory labeling and are willing to pay higher prices to ensure a total ban on the use of GM in animal fodder (Carlsson et al., 2004). A study of UK consumers found a strong demand for non-GM food in the UK, but a non-negligible segment expressed their willingness to substitute it with the GM version, either without discount (12 %) or with discounts (34 %) (Moon et al., 2004).

Several studies have also compared acceptance of GM food between countries in Asia and other regions, and between Asian countries themselves. Consumers in Beijing were willing to pay a 38.0% premium for GM rice and a 16.3% premium for GM soybean over their conventional counterparts (Li et al., 2002). In Japan, consumers who are less concerned about food safety, less knowledgeable about biotechnology in food production, and less concerned about labelling of GM foods are more willing to choose GM food products when they are offered more discounts on GM foods (McCluskey et al., 2001). In Korea, Kim and Kim (2004) found large number of consumers who are willing to buy GM products, if they are offered at a discount. In Asia, Japan and Korea stand out as the countries with low consumer acceptance for GM food in comparison with others like China and Taiwan that show greater acceptance.

Compared with developed nations and Asia, few studies have addressed consumer acceptance of GM crops in developing countries, especially in Africa. Curtis et al. (2004) generally found more positive perceptions towards genetically modified foods in developing nations (China and Colombia), than in developed countries (UK and USA), which might stem from more urgent food needs. De Groote et al. (2004) observe that in Africa where per capita food production struggles to keep pace with population growth and serious food shortages are a regular occurrence, we may not have the luxury of rejecting food with GM content. Additionally, perceived levels of risk may be smaller in developing countries because of a higher trust in government, more positive perceptions of science, and more positive media influences (Curtis et al. 2004).

Despite the recent introduction of GM crops in several African countries, no studies have so far been published on consumer acceptance in the continent. This study therefore addresses the attitudes and perceptions of consumers towards GM maize, the most important food staple in East and Southern Africa. As a start, this study focuses on the urban population of Nairobi. This focus largely increases efficiency,

since people in Nairobi generally have good access to information, and the city is relatively compact, reducing survey costs.

2. Methodology

2.1. Conceptual Framework

When investigating the viability of a new venture, production costs and consumer demand for the new demand need to be considered. Often, research evaluates products or services not yet on the market, so consumers are asked to value them, contingent on there being a market. To determine consumer demand or willingness to pay (WTP) for such products, economists create hypothetical markets (Lusk and Hudson 2004), typically using Contingent Valuation Methods (CVM) to ask consumers to value a new product. The values generated through use of the hypothetical market are treated as estimates of the value of the non-market good or service, contingent upon the existence of the hypothetical market. These surveys only give meaningful results if they properly grounded in a consumer maximization framework (Hanemann and Kanninen 1998). It is therefore assumed that the consumers interviewed maximize their utility subject to a budget constraint, and will therefore choose the option that gives them higher utility.

WTP is the maximum amount of money a consumer would be willing to pay for the new product. In CVM, WTP can be estimated using questions that are open-ended, asking the respondents to declare the maximum amount they would be willing to pay, or close-ended, asking the respondents if they would be willing to pay a specific amount or not (dichotomous choice). The open-ended format can be problematic since the respondent might not have sufficient information and stimuli to thoroughly consider the values they would attach to such good if a market were to exist, and might not return realistic estimates (Arrow et al., 1993).

Close-ended questions, on the other hand, are easier on the respondent and are more realistic since they correspond more to a real market situation, where the consumer is presented with a price for a product, and faces a yes/no decision. In the single-bounded method, the individual only responds to one bid. This approach is incentive-compatible in that it is in the respondent's strategic interest to say yes if her WTP is greater or equal to the price asked and no otherwise (Mitchell and Carson 1989). Utility maximization implies that a person will then only answer yes to the offered bid if her maximum WTP is greater than the bid. However, the single bound method requires a large sample size and is statistically not very efficient (Hanemann et al., 1991). Efficiency can improved by offering the respondent a second bid, higher or lower depending on the first response, in an approach generally known as the double-bounded CVM. This method incorporates more information about an individual's WTP and therefore provides more efficient estimates and tighter confidence intervals (Hanemann et al., 1991).

Different people have different WTP for a particular good, and it is the distribution of this WTP among the target population that offers interesting market information. In the dichotomous choice approach, WTP is not directly observed, but assumptions about its distribution can be made, allowing for the estimation of the parameters of this distribution. Thus, the mean WTP of a population, in monetary terms, can be derived from the survey (Lusk and Hudson 2004).

2.2. Estimating mean WTP

WTP can be assumed to have a particular probability density function (pdf) around a mean, in function of the price. The logistic distribution is commonly used in applied research, and the price is then entered indirectly in an argument, called the index function *v*. The most common index function is linear in the price or bid *B*:

$$v = \alpha - \rho\beta \tag{1}$$

and the pdf of the WTP is then presented by:

$$P(WTP = B) = \exp(v)/(1 + \exp(v)) \tag{2}$$

The logistic function has the advantage of a closed form cumulative distribution function (cdf), which then represents the proportion of the population whose WTP falls below a certain value *B*,

$$G(B) = P(WTP < B) = 1/(1+\exp(v)) \tag{3}$$

People who would accept an offer of value *B* are those whose WTP is higher than *B,* so the probability of someone accepting is the opposite of the above function:

$$P(WTP > B) = \pi^{y}(B) = 1 - G(B) \tag{4}$$

(where π^{y} = probability of a positive answer)

This is a downward sloping S-shaped function, starting at 1 and ending at 0, in function of the price of the good. It is this function can be estimated by asking different groups of people if they would be willing to pay at a certain level. The outcome of this exercise is the dichotomous variable $\pi(B)$. According to our specifications:

$$\pi^{y}(B) = 1 - G(B) = 1 - 1/(1+\exp(\alpha - \rho B)) \tag{5}$$

(with $\rho > 0$ and $B > 0$)

The probability of a respondent rejecting to pay at this price (rejecting the bid) is

$$\pi^{n}(B) = G(B) = 1/(1+\exp(\alpha - \rho B) \tag{6}$$

(where π^{y} = probability of a positive answer)

In the simple model of a single dichotomous choice, the likelihood function can be derived from equations (5) and (6):

$$\ln L(v) = \sum_{i=1}^{N} \{d_i^{y} \ln \pi^{y}(B_i) + d_i^{n} \ln \pi^{n}(B_i) = \sum_{i=1}^{N} \{d_i^{y} \ln(1 - G(B_i) + d_i^{n} \ln G(B_i) \tag{7}$$

Where d_i^{y} is 1 if the *i*th response is "yes" and 0 otherwise, while d_i^{n} is 1 if the *i*th response is "no" and 0 otherwise. Maximizing the likelihood function yields estimation of the parameters α and ρ, and mean and median WTP of a logistic pdf with specification from Equation (3) is calculated by α / ρ (Hanemann et al., 1991).

In this paper, however, the double bounded logit model is used, in which the consumer is presented with two bids, with the second bid being contingent upon the response to the first bid. If the individual responds "yes" to the first bid, the second bid, B_i^{u} is some amount greater than the first bid ($B_i^{u} > B_i$); if the individual responds "no" to the first bid, the second bid, B_i^{d} is some amount smaller than the first bid ($B_i^{d} < B_i$). Thus there are four possible outcomes to the questions: a "yes" to the first bid followed by a "yes" to the second bid (probability denoted by π^{yy}), a "yes" followed by a "no" (π^{yn}), a "no" followed by a "yes" (π^{ny}), and both answers are "no" (π^{nn}). To receive information on a wider range of values, the bids differ between respondents *i*.

The probability to receive a "yes" answer to both questions equals the probability that the respondent's WTP is higher than the highest bid:

$$\pi^{yy}(B_i, B_i^u) = \Pr(B_i^u \leq \max WTP_i) = 1 - G(B_i^u) \tag{8}$$

Similarly, the probability of receiving first a "yes" followed by a "no" answer equals the probability that the WTP of respondent *i* falls between the initial bid and the second, higher bid:

$$\pi^{yn}(B_i, B_i^u) = \Pr(B_i \leq \max WTP_i \leq B_i^u) = G(B_i^u) - G(B_i) \tag{9}$$

The probability of receiving a "no" followed by a "yes" is again the probability that WTP falls between the initial and the second, now lower bid:

$$\pi^{ny}(B_i, B_i^d) = \Pr(B_i^d \leq \max WTP_i \leq B_i) = G(B_i) - G(B_i^d) \tag{10}$$

Finally, the probability of receiving two "no" answers is equal to the probability that WTP falls below the second, lower bid:

$$\pi^{nn}(B_i, B_i^d) = \Pr(B_i > \max WTP_i \; and \; B_i^d > WTP_i) = G(B_i^d) \tag{11}$$

Combining the probabilities of the four outcomes, the log-likelihood function for a sample takes the form:

$$\ln L^D(\theta) = \sum_{i=1}^{N} \{d_i^{yy} \ln \pi^{yy}(B_{i,} B_i^u) + d_i^{nn} \ln \pi^{nn}(B_{i,} B_i^d) + d_i^{yn} \ln \pi^{yn}(B_{i,} B_i^u) + d_i^{ny} \ln \pi^{ny}(B_{i,} B_i^d)\} \tag{12}$$

Where d_i^{yy} , d_i^{nn} , d_i^{yn} and d_i^{ny} are binary variables with 1 denoting the occurrence of that particular outcome, and 0 otherwise. To operationalize this model, we need to specify the cdf $G(\bullet)$. Again, we use the logistic function (equation 3) with a linear index function (equation 1). As in the single bound model, estimations of the parameters are obtained by maximizing the likelihood function, and mean WTP is calculated as α / ρ .

2.3. Factors that influence WTP

Kaneko and Chern (2003) observe that though demand analysis has traditionally dealt with demand for homogeneous goods that is determined by a set of relevant prices and demographic variables, demand for quality need not be determined by the same set of variables. Even if there is an objective measure of a particular quality, it does not follow that all consumers perceive quality in the same way. It is possible that some quality yields a positive utility for some people but negative utility for some others. Therefore, demand for quality depends on an individual's perceived qualities also, which are subjective. Cognitive variables are therefore hypothesized to also influence WTP in addition to price and socio-economic factors. The question is how awareness, perceptions, trust in government together with price/bid and socio-economic factors influence WTP for GM foods.

The probability of a consumer to buy a product at a certain price *B* is also a function of a vector of cognitive and socioeconomic factors Z. This can be specified as:

$$\pi(B, ' Z) = \pi(v) \tag{13}$$

where v = index function, which gives the already predetermined relationship between B and Z. The most common is the linear index function:

$$v = (\alpha - \rho B_i + \lambda' Z_i + \varepsilon_i) \tag{14}$$

The probability of WTP for a bid, taking into account other consumer characteristics becomes

$$\pi(v) = 1 - G(v) \; or \; \pi(B, 'Z) = 1 - 1/(1 + \exp(\alpha - \rho B_i + \lambda' Z_i + \varepsilon_i)) \tag{15}$$

where B_i is the bid individual i faces, $'Z_i$ is a column vector of individual characteristics and ε_i is a random term.

The factors assumed to influence the WTP, and therefore included in the model, were based on a review of the relevant literature. Moon and Balasubramanian (2004), and Verdurme and Viaene (2002) note the importance of perceptions on the attitude towards GM foods and also WTP. Negative perceptions were found to have a particularly negative effect on WTP. Chinese consumer's positive opinion towards GM rice and soybean oil positively affected respondents' WTP, as were higher levels of self-reported knowledge for soybean oil (Li et al., 2003). Cognitive factors, such as beliefs, risk perception, knowledge, and trust in government, emerged as the most important factors explaining the differences between WTP within EU countries (Springer et al., 2002). They influence WTP positively except for risk perception. In the US, Income and presence of children in the household had a significant negative effect on respondents' willingness to consume GM food products, and female respondents and middle-aged consumers were found to be willing to pay a higher premium for non-GM food products (Chen and Chern, 2002).

Based on these results, perceptions on GM food and individual characteristics were included. To measure the perceptions, consumers were asked their opinion on statements concerning perceived benefits, health risks, environmental risks, and ethical and equity concerns. From these responses perception indices were derived (see next section). Further, the individual characteristics of age, gender, education and income were considered, and the presence of children in the household. Finally, trust the respondent has in the government to ensure food quality was also included.

2.4. Data collection

Data were collected in Nairobi in November and December 2003 from three points of sale: supermarkets, kiosks (small shops) and posho mills (mechanical hammer mills that grind maize grain into flour), to ensure representation of different categories of maize meal consumers. Five enumerators were hired specifically for this survey, and received appropriate training.

From a list of supermarkets obtained from Kenya's Central Bureau of Statistics, fifteen supermarkets were randomly selected: ten large (with more than three branches in the city), and five small ones. For the kiosks, a list of city estates (administrative subdivisions) was used to select seven estates using the estate population as an indication of the number of kiosks within the estate. From each of the selected estates, three kiosks were randomly selected leading to a total of 21 kiosks. For the posho mills, first a list of 16 estates (administrative subdivisions of Nairobi) with posho mills was assembled (posho mills are typically found in high-density neighbor hoods with many low-income families), and the number of mills for each estate was obtained. From each estate, a number of posho mills were selected randomly proportionate to their total number. In total, 21 posho mills were selected. From each of the selected posho mills, 10 consumers were interviewed. In total there were 604 respondents: 183 from supermarkets, 210 from kiosks and 211 from posho mills

The enumerators approached every third consumer that came along for a possible interview. First, the respondents were asked if they were aware of GM crops. If yes, the whole questionnaire was administered. However, consumers unaware of GM crops were given a short presentation on scientific background on GM crops, their pros and cons, countries growing them and GM crops that are currently

being grown in the world. Care was observed to ensure that balanced information was given on the pros and cons so as not to influence them either way. As observed by Lusk et al. (2004) information given to respondents may influence their acceptance or rejection. After this presentation, their opinions on GM crops were then sought. This group was not asked to answer questions on knowledge about GM crops.

Further, the questionnaire measured awareness about GM crops, knowledge, attitudes, demographic characteristics, maize meal consumption behavior, willingness to pay and sources of information sought and their frequencies. Awareness was determined by asking whether the respondents had read or heard something about biotechnology, GM crops in general and specific GM crops: Bt maize, Bt cotton and Virus-resistant sweet potato. Knowledge about GM crops was determined for only those aware of these crops. Respondents were asked if, according to their opinion, different statements on risk and benefits of GM crops were true or false, and to indicate how sure they were about the given answer on a five-point scale (ranging from 1= "not sure at all", to 5= "absolutely sure"). Based on the answers, a knowledge score was calculated for each respondent.

In order to determine consumer attitudes on GM crops, respondents were asked if they agreed with statements on genetic modification concerning 5 categories: benefits, health risks, environmental risks, and ethical and equity concerns. A statement in the benefit category would be, for example "GM technology increases productivity and offers solution to world food problem". Respondents would then be asked their opinion on the statement, which would be coded into five classes from "totally disagree" to "totally agree".

2.5. Data analysis

Awareness was coded into a dichotomous variable (1 for aware, 0 otherwise). For attitudes, perception indices were developed: Each response on the perception questions was scored on a quantitative scale (-1= 'totally disagree' –0.5 = 'disagree', 0 = 'neutral (don't know), 0.5 = 'agree' and 1= 'totally agree'). For each category of perception (benefits, health risk, environment risk and ethical and equity concerns) the scores were then averaged to form an index (a benefit perception index $I_{BP,}$ an index of environment risk perception $I_{ERP,}$ a health risk perception index $I_{HRP;}$ and an index for ethical, religious, and equity concerns I_{EREC}).

Age was expressed in years, and gender transformed into a dummy (1 for female, 0 for male). Respondents were also classified into four education categories, according to the highest education level attained: none or primary (only 6 respondents had not gone to school at all, so they were put together with primary), secondary, tertiary, and university. For each category a dummy was constructed (1 if the highest level attained included at least some education at that level, 0 otherwise). Finally, respondents were classified into five income categories: people without income (exclusive of students), students without income, and people with an income of up to KShs 15,000/month, from KShs 15,001 up to KShs 50,000, and above KShs 50,000/month (1US$=KShs 75).

The simple model (without consumer characteristics or setting $\lambda_i = 0$), was then estimated using the maximum likelihood module in the LIMDEP 8.0 software. Average WTP was then estimated from equation α / ρ. The confidence interval for mean WTP was estimated using bootstrapping method using Nlogit software. This method can be used to determine asymptotic variances where the distribution is not certain (Greene 2002). This is done by estimating mean WTP the specified number of times from subsets of the dataset obtained by sampling, with replacement, *m* observations and estimating mean WTP, and then the variation is calculated around the original estimate (the mean WTP for the whole data set). Greene (2002) observes that for a broader characteristic such as the asymptotic variance, research has found that 50 or 100 replications are likely to be sufficient. For this study, 75 replications were done, since more than that did not improve the estimation.

The unrestricted (with consumer characteristics) model was estimated next. For the categorical variables, the base for the education category was "none or some primary", and the base for monthly income was "none, exclusive of students". Marginal effects were then calculated in order to determine the influence of respondent's characteristics on WTP.

3. Results

3.1. Consumer characteristics, awareness and attitudes

The socioeconomic characteristics of maize consumers surveyed in this study differed substantially between the different points of sale (see Kimenju et al., 2004). The posho mills have the highest number of women among their maize buyers (59%), whereas more than half of the maize buyers in the supermarkets are male. Supermarkets have the highest percentages of formally employed clients, the highest percentage of those with university education, and also the highest percentage of those with high income levels (above KShs 15,000 per month). In general, there are slightly more male shoppers (55%) than female (45%) (Table 1). Almost two thirds (72%) had children below 18 years living with them.

Table 1. Consumers' characteristics

Variable	Category	%
Female respondents		45
Respondents living with children less than 18 years old		72
Highest level of education	none	1
	Some primary	20
	Some secondary	40
	Some tertiary	27
	Some university	12
Employment status	formally employed	41
	self employed	29
	unemployed	19
	student	11
Income level per month (KShs)	0 (student)	10
	0 (non-student)	18
	0 to 15,000	48
	15,001 to 50,000	22
	over 50,000	2
Point of sale	supermarkets	30
	posho mill	35
	kiosk	35
Respondents awareness about gm crops		38
Respondents of opinion that sufficient government controls are in place to ensure food quality		76

Awareness of GM crops is quite high: 38% of all the respondents have heard or read something about GM crops (Table 2). Awareness about biotechnology is also high, at 46%. Of the respondents aware of GM crops, 95% are also aware of the term “gene”, 65% know about the virus-resistant sweet potato, 54% about Bt maize, and 21% about Bt cotton. Awareness differed between socioeconomic groups. It increases strongly with education, from 17% for those with no formal education to 90% for those with some university as highest education level. Excluding students with zero income, awareness increases with income from 28% for those with no income, to 92% for those with monthly incomes of over KShs 50,000 per month. Men are more aware (45%) than women (29%).

Table 2. Consumers' awareness of biotechnology and gm crops by demographic characteristics (%)

		biotechnology	gm crops
Highest education level	none	17	17
	primary	19	10
	secondary	32	26
	tertiary college	68	53
	university	93	90
Income/month (KShs)	0 (students excluded)	35	28
	0 to 15,000	37	28
	15,001 to 50,000	64	59
	over 50,000	100	92
Gender	male	53	45
	female	38	29
All respondents		46	38

Attitudes of maize consumers towards GM crops are generally positive, although many have some important concerns, especially on their effect on the environment. Respondents generally have a positive perception of the benefits of the technology: 73 % agree (plus 9% strongly agree) that GM crops can increase productivity (Table 3). Giving each response a score (from -1 for strongly disagree to +1 for strongly agree), the scores can be averaged for each question (next to last column in Table 3). For example, the average score on the first question, perception on productivity, becomes 0.38, the most positive score (if everybody would agree, the score would have been 0.5, and 1 if everyone would have totally agreed). Similarly, respondents were generally positive about the benefits of GM crops on reducing pesticides on food (72% agree and 7% strongly agree, with an average score of 0.37). Averaging those scores over all four questions on perceived benefit produces the Index of Perceived Benefits (I_{PB}), with a mean of 0.36 (last column in Table 3).

On the negative points, consumers were asked about their perceptions on three categories: environmental risk, health risk and ethical and equity concerns. From all the perceived risks, people agree most with the environmental risk statements. More than half the consumers agree or strongly agree that GM crops can cause death of untargeted insects (score=0.11), and can lead to the loss of land races (score=0.07). However, more than half of the respondents disagree or disagree strongly with the general statement that GM threatens the environment (a negative score of -0.09). Averaging the three scores leads to a slightly positive index of environmental risk perception ($I_{ERP=}0.03$)

A larger group (15-22%) has no opinion on the effect of GM on human health, and more people disagree than agree, leading to a slightly negative index of health risk perception (I_{HRP} = -0.02). About half the consumers agree that GM crops mean tampering with nature and that GM food is artificial. However, more people disagree with the ethical and equity concerns, leading to a slightly negative perception score (I_{EEC} = -0.10)

Table 3. Consumers' attitudes and perception on GM technology (%)

		responses (% of respondents)						
Perceptions on	Statement	Strongly disagree (score=-1)	Disagree (score=-0.5)	Neutral or don't know (score=0)	Agree (score=0.5)	Strongly agree (score = 1)	Mean score	Perception index
Benefits	GM technology increases productivity and offers solution to world food problem	2	10	7	73	9	0.38	I_{BP}=0.36
	GM can reduce pesticides on food	1	10	10	72	7	0.37	
	GM can create foods with enhanced nutritional value	2	11	9	69	9	0.36	
	GM has potential of reducing pesticide residues in the environment	2	13	13	65	8	0.32	
Environment risks	Insect resistant gm crops may cause death of untargeted insects	2	34	14	43	8	0.11	I_{ERP}=0.03
	GM can lead to a loss of original plant varieties	2	39	8	43	8	0.07	
	GM threatens the environment	3	49	13	30	5	-0.09	
Health risks	People could suffer allergic reaction after consuming gm foods	3	36	20	35	5	0.02	I_{HRP}= -0.02
	Consuming gm foods can damage ones health	4	44	15	30	7	-0.04	
	Consuming gm foods might lead to an increase in antibiotic-resistant diseases	3	40	22	30	5	-0.03	
Ethical & equity concerns	GM is tampering with nature	4	42	7	39	9	0.03	I_{EREC} = -0.10
	GM food is artificial	3	38	10	36	14	0.10	
	GM technology makers are playing god	10	62	5	18	5	-0.27	
	GM products are being forced on developing countries by developed countries	3	51	10	29	7	-0.08	
	GM products only benefit multinationals making them	4	61	5	25	5	-0.17	
	GM products don’t benefit small-scale farmers	4	67	7	20	3	-0.25	

3.2. Willingness to pay for GM maize meal

Consumers were first asked if they would be willing to buy GM maize meal at the same price as their favorite maize meal brand. Of all consumers, 68% were willing to do so (central bar in Figure 1). Those who accepted were further asked if they would be willing to pay for GM maize if the price were higher or, in other words, if they would be willing to pay a premium. The average price of maize meal of the preferred brand was KShs 51/kg (US$1=KShs 75). Different premium levels were assigned randomly to the different respondents (5% of the price of their favorite brand, 10%, 20%, 30% or 50%), but they were only offered one second bid. Slightly more than half would be willing to pay more although the percentage decreased with the level of the premium. Of those offered a 5% premium, for example, 74% would be willing to pay. We can therefore calculate that half of the population (0.68 x 0.74=50.3) would be willing to pay a premium of 5% (1st bar to the right of the centre in Figure 1). Of those offered a 50% premium, only 39% would be willing to pay, or 27% of the population (last bar in Figure 1).

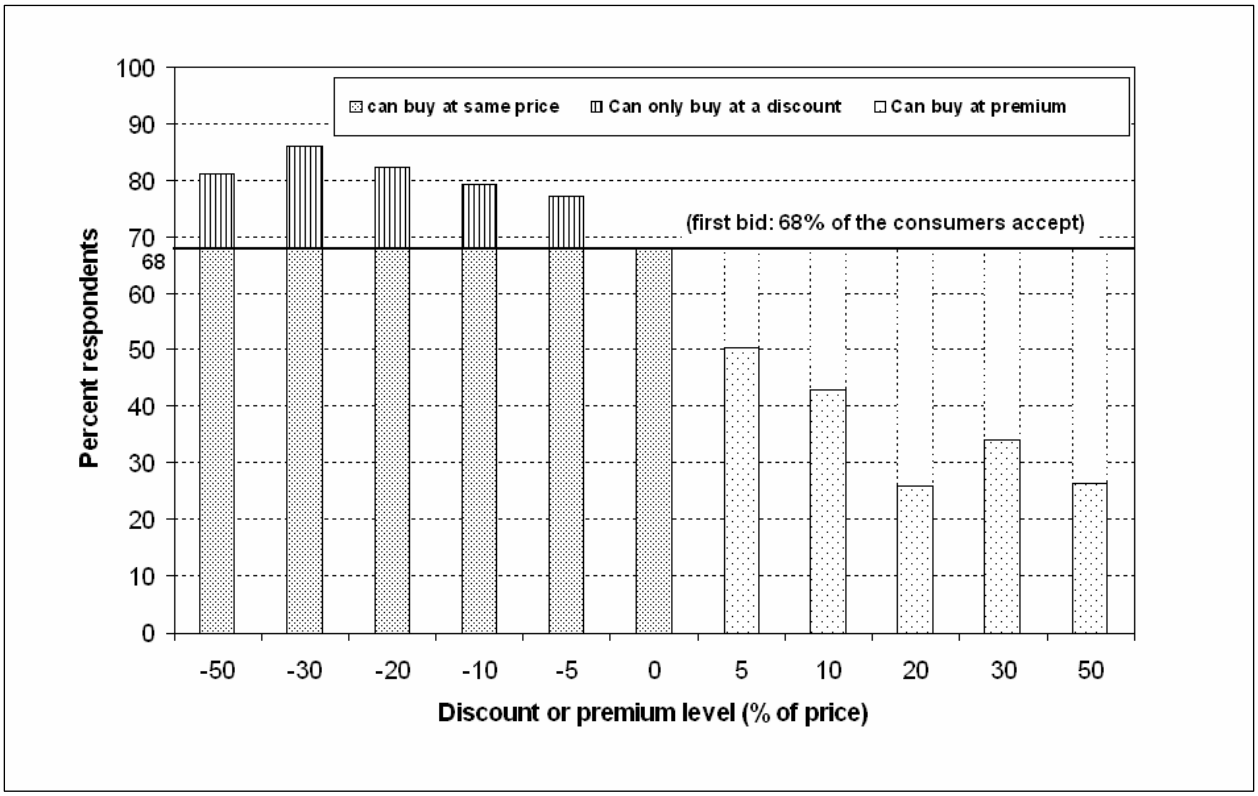

Figure 1. Consumers' willingness to buy GM maize meal at the same price as their preferred brand (first bid), at a premium (second bid, after they accepted the first bid), or at a discount (second bid, after they rejected the first bid)

Those who refused the first bid (32%) were offered a discount, again at different percentages of the price of their preferred brand. Of those offered a discount of 5%, 28% were willing to pay. We can therefore conclude that at a discount of 5%, an additional 9% of the population (0.32 x 28) would be willing to pay (first bar on the left of the middle bar in Figure 1). The percentage of those accepting to pay at a discount increases with the percentage of discount, and 41% of those offered a discount of 50% accepted.

Combining the percentage of consumers accepting the initial bid with those who accepted the discount or were willing to pay at a premium, provides an estimate of the of people willing to pay at different prices (Figure 1). As expected, the number decreases as the percent price increases. At the highest discount, 50%, 81% of the respondents are willing to pay, but at 5% discount, 77% are willing to pay. This further reduces to 50% when the price increases to 5% and to only 26% at a 50 % price premium.

To calculate the mean WTP, the coefficients of the restricted equation (without consumer characteristics) first need to be estimated (Table 4). The mean WTP can then be calculated at α / ρ = KShs 57.97. This price is an increase of 13.7 % over the average price for favorite brand (KShs 50.97). This percentage is higher than the level in Figure 1, since, as we will see, more consumers in the higher income groups are willing to pay a premium, and they buy at more expensive places. The standard error of the mean WTP, calculated using the bootstrapping method is 1.129 so the 95% confidence interval is KShs 55.75 - 60.18

Table 4. Parameter estimates for WTP model without consumer characteristics

Variable	Estimate	Standard error	p-value	
Constant (α)	4.1699	0.2169	0.0000	***
Bid (ρ)	0.0719	0.0036	0.0000	***
Mean WTP (α/ρ)	57.97	1.129		
Number of observations	553			
Log likelihood function	807.6581			
Chi squared	1615.316			
Degrees of freedom	2			

To analyze the impact of different factors on WTP, the full equation with consumer characteristics (15) was estimated (Table 5). Marginal effects were then calculated to determine the effect of each variable on WTP. Results show that whether consumers were aware of GM crops before the survey or not, did not influence their WTP. This implies that the information provided to the non-aware did not unduly influence their WTP. The perceptions, as measured by the different indices, were major factors influencing the WTP. Health risk perception, ethical and equity concerns and trust in government to ensure food quality were all significant in determining WTP for GM maize meal. However, benefit perception did not have a significant effect.

The marginal effects are calculated at the mean of the explanatory variables (last column in Table 5). An increase in health risk perception index by one unit decreases the percentage of the people willing to pay at the mean price by 19%. For the ethical and equity perception index, an increase in the index by one reduces the percentage of people willing to pay at the mean price by 13%. At the mean price of GM crops, 18% more of those who have a trust in the government to ensure food quality are willing to pay.

There is no influence of age, gender and the presence of children on WTP. People with some secondary schooling have significantly higher WTP than those with either less or more education. From the marginal effects, we find that 14% more of those with some secondary are willing to pay for GM maize meal at the mean price. Income influences WTP positively, with WTP substantially higher in the highest income category (>KShs 50,000). There are 30% more of people in this income category willing to pay at the mean price than the non-students with zero income.

Table 5. Parameter estimates for WTP model with consumer characteristics

	Variable	Estimate	Standard error	p-value		Marginal effects
	Constant	3.47590919	0.500831	0.0000	***	
	Bid	0.07993253	0.004132	0.0000	***	-0.01855445
Perceptions	Awareness about GM crops	0.0008	0.2044	0.9969		0.000187009
	Benefit perception index	0.0059	0.2825	0.9835		0.001355596
	Health risk perception index	-0.8417	0.2358	0.0004	***	-0.194715009
	Ethical and equity concerns index	-0.5939	0.2848	0.0370	*	-0.137373605
	Government	0.7589599	0.201956	0.0002	***	0.181496783
Demographic	Age	-0.0031	0.0106	0.7699		-0.000720528
	Gender	0.0389	0.1825	0.8311		0.147121242
	Children	0.0186	0.1940	0.9238		0.004300124
	Secondary	0.6530	0.2328	0.0050	***	0.147121242
	Tertiary	0.2772	0.2718	0.3079		0.06293313
	University	-0.1240	0.3465	0.7205		-0.029032984
Income	Income 1(0-students)	0.1019	0.3209	0.7508		0.02330071
	Income 2 (KShs 0 -15,000)	0.1492	0.2336	0.5231		0.03448056
	Income 3 (15,001-50,000)	0.4432	0.2817	0.1156		0.098422854
	Income 4 (over 50,000)	2.0258	0.6118	0.0009	***	0.300652372
Statistics	Number of observations	553				
	Log likelihood function	765.6063				
	Chi squared	1531.213				
	Degrees of freedom	17				

Single (*), double (**) and triple (***) asterisks denote statistical significance at the 10%, 5% and 1% levels respectively

4. Conclusions and recommendations

4.1. Conclusions

The study reveals that more than a third (38%) of the respondents are aware of GM crops. The better educated and the higher income groups are more aware of GM crops. Generally, people are appreciative of the positive benefits of the technology but are also concerned about the potential negative effects, especially on the environment and on biodiversity.

That 68% of the respondents would buy GM maize meal at the price of their favorite maize meal brand indicates general acceptance of the technology by urban consumers. Nairobi consumers are willing to pay KShs 58 for a 2kg packet for GM maize, which is a 13.7% premium over average current maize meal prices (KShs 51), confirming acceptance of the use of GM technology. Among socio-economic factors, only income and education significantly influence WTP. People with some secondary as highest level of education have higher WTP for GM maize meal than those with some primary as highest level, while those with over KShs 50,000 level of income/month have higher WTP than non-students with zero income. Subjective elements come out as the main determinants of WTP. Health risk perception and ethical and equity concerns influence WTP negatively, while trust in government to ensure food quality has a positive influence on WTP.

4.2. Recommendations

It is important that people be informed about GM technology for them to participate effectively in the debate. Therefore, awareness should be monitored regularly, and if need be increased through educative efforts by the government and other stakeholders. A majority of respondents would buy GM maize at the price of their favorite brand, and even at a premium, indicating that there is high potential demand for Bt maize in Kenya. Hence the technology can be tapped to play a role in food security in Kenya. The government can go ahead in investing in biotechnological research and encouraging other players.

Perceptions are major factors influencing WTP. Unfortunately, certain perceptions are clearly not based on scientific evidence. In particular, health risks associated with consumption are not substantiated (FAO, 2004). Similarly, the new GM maize varieties do not use antibiotics markers anymore, so the transformed plants cannot generate resistance to antibiotics. Proper attention should be given to communicate this information to the consumer community. Hence, for scientists and media to be aware and to be able to respond to such misconceptions, (as well as follow the levels of awareness) consumer surveys should be carried out regularly. This may save a country from investing in programs and technologies that might not be acceptable to the consumer. The results have shown that consumers generally have a positive perception of the production enhancing characteristics of GM crops. Unfortunately, these positive perceptions do not seem to matter much towards acceptance, which is much more influenced by negative perceptions, several of which are not based on scientific evidence. The scientific community, in collaboration with the media, therefore has a very important role in educating the public, so that consumers can distinguish between real and unsubstantiated risk, and make a more informed decision whether to accept GM food or not.

Given the experience of this survey, some methodological improvements can be suggested for future studies. Now that the range of possible answers is more or less known, it is possible to ask people about the reasons for their opinion or perceptions. Some important questions are, for example, why people are willing to pay a premium for GM crops, or why they think GM food can be dangerous for human health or for the environment. This will help to clarify the misconceptions among consumers. This would add extra information on their opinion on the products. Further, the results show that consumer characteristics, as well as perceptions and attitudes, differ between socioeconomic groups, and that different groups buy their maize at different points of sale. Therefore, it would be wise to use household studies in the future; although more expensive, they would yield more representative results. Finally, although CV methods have been widely used in the past, recent papers suggest new methods, in particular experimental auctions where consumers actually participate in an experimental, but still real market.

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References

Arrow, K., Solow, R., Leamer, E., Portney, P., Radner, R. and Schuman, H. (1993). *Report on the NOAA Panel on Contingent Valuation. Federal Register, 58:10*, Department of Commerce, USA

Carlsson, F., Frykblom, P. and Lagerkvist, C. J. (2004). Consumer benefits of labels and bans on genetically modified food - An empirical analysis using Choice Experiments. Paper presented at the American Association of Agricultural Economics Annual Meeting, Denver, Colorado, August 1-4, 2004.

Chen, H. and Chern, W. S. (2002). Consumer Acceptance of Genetically Modified Foods. Paper presented at the The Annual Meeting of the American Agricultural Economics Association (AAEA). Long Beach, California, July 28-31, 2002.

Chern, W. S., Rickertsen, K., Tsuboi, N. and Fu, T.-T. (2002). Consumer Acceptance and Willingness to Pay for Genetically Modified Vegetable Oil and Salmon: A Multiple-Country Assessment. *AgBioForum*, 5 (3):105-112.

Curtis, K. R., McCluskey, J. J. and Wahl, T. I. (2004). Consumer Acceptance of Genetically Modified Food Products in the Developing World. *AgiBioForum*, 7 (1/2):70-75.

De Groote, H., Mugo, S., Bergvinson, D., Owuor, G. and Odhiambo., B. (2004). Debunking the myths of GM crops for Africa: the case of Bt maize in Kenya. Paper presented at the American Association of Agricultural Economics Annual Meeting, Denver, Colorado, August 1-4, 2004.

De Groote, H., Overholt, W., Ouma, J. O. and Mugo, S. (2003). Assessing the impact of Bt maize in Kenya using a GIS model. *Paper presented at the International Agricultural Economics Conference, Durban, August 2003.*

De Groote H., Mugo, S., Bergvinson, D., Owuor, G. and Odhiambo., B. (2004). Debunking the myths of GM crops for Africa: the case of Bt maize in Kenya. Paper presented at the American Association of Agricultural Economics Annual Meeting, Denver, Colorado, August 1-4, 2004.

FAO. (2004). *The state of food and agriculture 2003-2004. Agricultural Biotechnology: Meeting the needs of the poor.* Food and Agriculture Organization of the United Nations: Rome, pp.

Ganiere, P. and Chern, W. S. (2004). Consumer Acceptance of Genetically Modified Foods : A Profile of American Consumers. Paper presented at the American Agricultural Economics Association (AAEA) Annual Meeting, Denver, Colorado, August 1-4, 2004.

Greene, W. H. (2002). *Limdep Version 8.0. Reference Guide*. Econometric Software, Inc: New York, pp.

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

Hanemann, W. M. and Kanninen, B. (1998). *The Statistical Analysis of Discrete-Response CV Data. Working Paper No. 798*. Department of Agricultural and resource Economics and Policy. University of Carlifornia: Berkeley, 1-123 pp.

Hossain, F., Onyango, B., Adelaja, A., Schilling, B. and Hallman, W. (2003). Nutritional benefits and consumer willingness to buy genetically modified foods. *Journal of Food Distribution Research*, 34 (1):24-29.

James, C. (2004). *Preview: Global Status of Commercialized Biotech/GM Crops: 2004. ISAAA Briefs No. 32.* . ISAAA: Ithaca, NY.

Kaneko, N. and Chern, W. S. (2003). Consumer Acceptance of Genetically Modified Foods : A Telephone Survey. Paper presented at the The American Agricultural Economics Association Annual Meeting, Montreal, Canada, July 27-30, 2003.

Kim, H. S. and Kim, K. (2004). A multi-country assessment of consumer attitudes of genetically modified foods and the implications for new labeling system. Paper presented at the The American Agricultural Economics Association Annual Meeting, Denver, Colorado.

Kimenju, S. C., De Groote, H., Karugia, J., Mbogoh, S. and Poland, D. (2004). Consumer awareness and attitudes toward GM foods in Kenya. Nairobi: CIMMYT: *mimeo*.

Li, Q., Curtis, K. R., McCluskey, J. J. and Wahl, T. I. (2002). Consumer Attitudes Toward Genetically Modified Foods in Beijing, China. *AgiBioForum*, 5 (4):145-152.

Lusk, J. L., House, L. O., Valli, C., Jaeger, S. R., Moore, M., Morrow, J. L. and Trail, W. B. (2004). Effect of information about benefits of biotechnology on consumer acceptance of genetically modified food: evidence from experimental auctions in the United States, England, and France. *European Review of Agricultural Economics*, 31 (2):179-204.

Lusk, J. L. and Hudson, D. (2004). Willingness-to-Pay Estimates and Their Relevance to Agribusiness Decision Making. *Review of Agricultural Economics*, 26 (2):152-169.

McCluskey, J. J., Ouchi, H., Grinsrud, K. M. and Wahl, T. I. (2001). Consumer response to genetically modified food products in Japan. *AgBioForum*, 7 (1&2):70-75.

Mitchell, R. C. and Carson, R. T. (1989). *Using Surveys To Value Public Goods: The Contingent Valuation Method. Resources for the Future*. Resources for the future: Washington DC, 463 pp.

Moon, W. and Balasubramanian, S. K. (2001). Public perceptions and willingness to pay a premium for non-GM foods in the US and UK. *AgBioForum*, 4 (3&4):221-231.

Moon, W. and Balasubramanian, S. K. (2004). Public Attitudes toward Agrobiotechnology: The Mediating Role of Risk Perceptions on the Impact of Trust, Awareness and Outrage. *Review of Agricultural Economics*, 26 (2):186-208.

Moon, W., Rimal, A. and Balasubramanian, S. K. (2004). Willingness-to-Accept and Willingness-to-Pay for GM and Non-GM Food: UK Consumers. Paper presented at the Annual Meeting of American Agricultural Economics Association, Denver, Colorado, August 1-4, 2004.

Mugo S., De Groote, H., Songa, J., Mulaa, M., Odhiambo, B., Taracha, C., Bergvinson, D., Hoisington, D. and Gethi, M. (2002). Advances in Developing Insect Resistant Maize Varieties for Kenya within the Insect Resistant Maize For Africa (IRMA) Project. In *Integrated Approaches to Higher Maize Productivity in the New Millenium. Proceedings of the 7th Eastern and Southern Africa Regional Maize Conference, Nairobi, Kenya, 11 - 15 February 2002*, edited by Palmer, A. F. E. Mexico, D. F: CIMMYT.

Springer, A., Mattas, K., Papastefanou, G. T. and Tsioumanis, A. (2002). Comparing Consumer Attitudes Towards Genetically Modified Food in Europe. Mimeo.

Verdurme, A. and Viaene, J. (2002). Consumer Beliefs and Attitudes Towards Genetically Modified Food: Basis for Segmentation and Implications for Communication. Belgium: Ghent University.

Zhang, C., Bai, J., Huang, J., Hallman, W. K., Pray, C. and Aquino, H. L. (2004). Consumer Acceptance of Genetically Modified Foods: A Comparison between the US and China. Paper presented at the The American Agricultural Economics Association Annual Meeting, Denver, Colorado, August 1-4, 2004.