ECONOMIC EVALUATION OF CONSUMER AWARENESS, ATTITUDES AND WILLINGNESS TO PAY FOR GENETICALLY MODIFIED FOODS IN KENYA: THE CASE OF MAIZE MEAL IN NAIROBI

BY

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A Thesis submitted in partial fulfilment of the requirements for the degree of Master of Science in Agricultural Economics of the University of Nairobi.

DECLARATION

This thesis is my original work and has not been presented for a degree in any other university.

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To all members of my family

ACKNOWLEDGEMENTS

I wish to greatly acknowledge the great role played by my supervisors, Dr. Joseph T. Karugia and Prof. Stephen G. Mbogoh of the University of Nairobi and Dr. Hugo De Groote of CIMMYT in this work. Their advice, guidance and support enabled me to get this far.

I also appreciate the support and cooperation of the staff and students of the Department of Agricultural Economics, University of Nairobi. Special thanks to my classmates who made the stay enjoyable.

I am grateful to all members of staff at CIMMYT, Nairobi, for taking me as one of their own and ensuring my smooth stay within their premises. I appreciate the assistance they accorded me.

A vote of thanks goes to consumers who took their time to complete my questionnaire. The permission granted by managements of various supermarkets, kiosks and posho mills to use their premises is highly appreciated. Thanks also to the 5 enumerators who collected the data for their good work.

Last but not least I am grateful to the University of Nairobi for awarding me a scholarship that facilitated my postgraduate studies. I am also greatly indebted to CIMMYT, Nairobi for supporting my thesis research work through the IRMA project.

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ABBREVIATIONS

Bt = *Bacillus Thuringiensis*

CBS = Central Bureau of Statistics

CV = Contingent Valuation

GM = Genetically modified

GoK = Government of Kenya

IRMA = Insect Resistant Maize for Africa

KShs = Kenya Shillings

WTP = Willingness to Pay

ABSTRACT

In light of the proposed introduction of *Bt* maize in Kenya, a consumer survey was conducted with 604 urban respondents in Nairobi, Kenya, in November and December 2003 to determine consumers' awareness, attitudes and willingness to pay (WTP) for GM foods in three points of sale namely supermarkets, kiosks and posho mills. WTP for GM maize meal was estimated using the Contingent Valuation method, with a dichotomous choice framework and a double-bounded logit model. The model was further expanded to analyze the factors that influence WTP. The results show that 38% of the respondents are aware of GM crops. Newspapers are the main sources of information about GM crops, followed by schools/colleges. Most consumers believe in the technology's positive impacts, with more than 80% agreeing that it increases productivity and offers a solution to the world's food problem. However, consumers are concerned about environmental and health risks, as well as ethical and equity issues. Half of the respondents agree that the technology leads to a loss of original varieties, and that insect resistant GM crops could have an effect on untargeted insects. About a third fear that consumption of GM foods can damage one's health while' 40% fear it could cause allergic reactions. Half of the respondents perceive GM food as artificial, and 36% are of the view that GM products are being forced on developing countries.

Most consumers (68%) would be willing to buy GM maize meal if it were offered at the same price as their favourite maize meal brands. Nairobi consumers are willing to pay KShs 58 for a 2kg packet for GM maize meal, which is a 13.7% premium over average current maize meal prices (KShs 51), confirming acceptance of the use of GM technology. Cognitive

factors come out strongly as the main determinants of WTP. Health risk perception and ethical concerns have a negative influence on WTP, while trust in government to ensure food quality has a positive influence. People with monthly incomes of over Kshs. 50,000 have higher WTP than students with zero income, while those with some secondary as highest education level are willing to pay more than those with just some primary level. Those interviewed in the supermarket are willing to pay more than those interviewed in the posho mills.

There is high acceptance implying that the technology can be tapped to play a role in addressing food insecurity in Kenya. The government and other stakeholders ought to carry out educative campaigns to further inform on the technology through revealed sources of information. Factual information should be given to dispel suspicion and myths. Consumer surveys should be done regularly to determine awareness and capture changing perceptions. This should be expanded to other towns and to rural areas. In order to reap benefits of the technology, the government should invest in biotechnology research, encourage participation but at the same time ensure compliance with bio safety regulations.

CHAPTER ONE: INTRODUCTION

1.1 Background information

The world population has continued to grow by about 80 million people each year. It reached 6 billion in the second half of 1999 and projections indicate that it will grow by at least 3 billion in the next 50 years. Though the annual population growth rate of the world is 1.2 %, Africa has the highest rate of growth at 2.4% (Leisinger et al., 2002). At the same time, food insecurity levels continue to increase in the globe. Today, 824 million people are food insecure, and Sub-Saharan Africa has the highest proportion with about 180 million people.

Experts believe that cereal production needs to increase by 35% between 1997 and 2020 to 2,497 million tons to meet global food demand (Pinstrup-Andersen et al., 2001). Cereal production increase can occur through expansion in area planted with cereals and improvements in crop yields. Due to pressure on natural resources, improvements in crop yields will be required to bring about the necessary production increase. Among the cereals, maize is of special importance in addressing food insecurity in Sub-Saharan Africa. It is the dominant staple food throughout Eastern and Southern Africa as evidenced by annual consumption levels of 81 kg per capita. In Kenya, about 80% of the population rely on maize as a staple diet. The annual consumption level is 103 kg per capita (Pingali, 2001). Maize meal is the predominant form in which maize is consumed throughout Eastern and Southern Africa (Jayne et al., 1995).

Modern biotechnology is widely considered as having great potential in contributing towards global food security. Conventional crop breeding programmes, though important for the

foreseeable future, have a competitive disadvantage compared to modern biotechnology in that they must proceed in small steps towards single targets. Hence they are time consuming. Quaim and Von Braun (1998) observe that unlike Green Revolution technologies, biotechnology is not merely focussed on increasing yields of important cereals, but also has production-stabilizing and input-reducing effects and can be applied to any crop species. A major advantage is the fact that the technology is incorporated in the seed - a traditional, divisible and reproducible farm input – and does not presuppose the adoption of complementary technology components, such as irrigation or the use of agro-chemicals.

As one of the components of modern biotechnology, genetic engineering is used to develop Genetically Modified Organisms (GMOs). These are living organisms into which foreign genes have been inserted (Feldmann et al., 2001). This method is used to create Genetically Modified (GM) plants, which are then used to grow GM food crops. Genetic modification has led to the development of insect-resistant plants, herbicide-tolerant plants, higher yielding plants varieties and plants with in-built resistance to viruses (which has not been possible using conventional breeding). Insect-resistant maize, herbicide-tolerant cotton and soybean, sweeter tomatoes, potatoes with higher starch content, and Vitamin A enriched rice have been developed. Research is also underway in creating plants with vaccines against common children diseases, and plants that can grow in harsh conditions like salty farmlands. One of the greatest advantages of this technology is the ability to find solutions for pressing farmer problems.

Farmers in developing countries face a variety of problems and constraints. In Kenya, insect pests are one of the major constraints to maize production. Of special significance are the maize stem borers. These are estimated to cause crop losses of 13.5% per year nationwide, amounting to 0.4 million tonnes with an estimated value of US$ 80 million (De Groote, 2002). The significance of this crop pest has led to research in developing insect resistant crop varieties. One such effort is the Insect Resistant Maize for Africa (IRMA) project, which is a joint venture between the International Maize and Wheat Improvement Centre (CIMMYT) and the Kenya Agricultural Research Institute (KARI) with funding from the Syngenta Foundation for Sustainable Agriculture. This project responds to the need to feed Africa's rapidly increasing population by reducing the damage incurred by the region's major insect of maize, stem borer. IRMA is being implemented initially in Kenya, but the results will be made available to other African countries (KARI and CIMMYT, 2003) .The overarching goals of the project are to develop insect resistant maize varieties for the major Kenya growing environments and to establish procedures to provide insect resistant maize to resource poor farmers in Kenya. The specific objectives of the project are;

a) Product development

   To develop insect resistant maize varieties for the major insect pests found in the Kenyan maize production systems.

b) Product Dissemination

   Establish procedures for providing insect resistant maize to resource poor farmers in Kenya.

c) Impact assessment

   Assess the impact of insect resistant maize varieties in Kenyan agricultural systems.

d) Technology transfer

Transfer technologies to KARI and Kenya to develop, evaluate, disseminate, and monitor insect resistant maize varieties.

e) Documentation and Communication

Plan, monitor, and document processes and achievements for dissemination to the Kenyan public and developing countries.

The project aims at developing stem borer resistant maize using both conventional and the *Bt* technology, the latter of which will be known as *Bt* maize.

Despite the controversy on genetic modification, millions of large-scale and small-scale farmers (about 8.25 million in 2004) in seventeen industrial and developing countries continue to increase their plantings of GM crops in consecutive years because of the significant multiple benefits they offer (James, 2004). The total hectarage allocated to GM crops in the year 2004 was 81 m hectares, with the five leading countries growing GM crops being USA (47.6 million hectares, 59% of global total), Argentina (16.2 m ha, 20%), Canada (5.4 m ha, 6%)) Brazil (5 m ha, 6%) and China (3.7 m ha, 5%)). The leading GM crops grown were Soybean (48.4m ha), Maize (19.3m ha), Cotton (9m ha) and Canola (4.3m ha).

Much as farmers continue to grow GM crops, the eventual success of this technology will depend on public acceptance. Studies have shown that many consumers in the European Union and Japan have difficulties accepting GM products. Verdurme and Viaene (2002) observed that consumers (especially in the EU and Japan) oppose the use of GM technology in food production. Moon and Balasubramanian (2001) found that UK consumers were

willing to pay a significantly higher premium to avoid GM foods than their US counterparts. Notable differences also exist in acceptance of GM foods within Europe itself. Springer et al. (2002) found important differences among countries in the European Union. 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 were found not to regard GM food as being equivalent to conventional food (Carlson et al., 2004). Consequently, the Swedish consumers support mandatory labelling and are willing to pay higher prices to ensure a total ban on the use of GM in animal fodder. The concerns arise mainly due to uncertain effects of GM foods on human health, religious and ethical reasons, and concerns about their effect on the environment.

On the other hand, Kaneko and Chern (2003) found that Americans are generally accepting GM foods if sufficient price discounts are made on them. In a study comparing US and Chinese consumers, Zhang et al. (2004) found that, although the overall knowledge of GM food is low, attitudes of the majority of American and Chinese consumers are generally supportive of the new technology. Consumers in China and other Asian countries (apart from Japan and Korea) have positive attitudes towards GM foods. Li et al. (2003) observed that Chinese consumers were willing to pay premiums for GM rice and soybean oil, signifying their acceptance of these foods. Thus, Chinese consumers appear to favour the use of biotechnology to grow pest-resistant crops requiring fewer chemicals. In Korea, Kim and Kim (2004) found a large number of consumers who are willing to buy GM products, if the products are offered at a discount. Therefore 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 be explained by the more urgent food needs that these countries face along with malnutrition problems. 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. However, analysis for WTP in developing countries does not clearly establish the extent to which their WTP is a careful consideration of the attributes (benefits versus risk) or whether it is merely motivated by the realization that the technology would make food available.

Consumer acceptance or rejection towards GM foods is affected by risk and benefit perceptions. Chen and Chern (2002) found that the main hindrance to the consumers' acceptance of GM foods is the high-perceived risk associated with them. Consumer organizations and other nongovernmental organizations (NGOs) have expressed concerns regarding likely development of anti-biotic resistance, potential allergic reactions, ethical and religious concerns, and the lack of consumer choice due to inadequate labelling (Chern et al., 2003). Countries such as Japan, Russia, South Korea and the European Union alert consumers of genetic modification by labelling food products. Uncertainties of consumer

acceptance have increased in many parts of the world, especially in Europe and Japan. In particular, the imposition of mandatory labelling of GM foods in many agricultural importing countries has intensified the debate on the future of biotechnology in agricultural production. Consumer acceptance has become a key for success in marketing of GM foods in the global agricultural market.

1.2 Problem statement

Studies have found that compared to other production technologies, genetic modification is superior. Halford (2004) observes that among other advantages, the technology allows genes to be introduced into a crop plant from any source, it is relatively precise in that single genes can be transferred (which is not possible in conventional breeding), and genes and their products can be tested extensively in isolation before use to ensure their safety. There is great potential for the application of the technology in developing more insect and herbicide resistant plants, increased nutritional value in foods, stress tolerant plants, fungal resistant crops and vaccines within plants.

The greatest arguments in favour of GM crops is their contribution to alleviation of poverty and hence their potential in solving food insecurity problems in developing countries. Biotechnology is being advanced and directed towards resource-poor farmers and locations. McGloughlin (1999) points out that there has been a tremendous increase in net returns to farmers and reduced chemical loads in the environment as well as in food. He further observes that over half of all economic benefits generated by these technologies have gone to

farmers, more than what has been appropriated by biotechnology and seed companies combined. Beyers and Thirtle (2003) observed increased yield for adopters of the technology.

Many studies have been done to determine consumers' acceptance or rejection of GM products. Most of these studies however are done in the western world and in most cases where GM products have already been commercialised. As observed by Feldman et al. (2001), many developing countries still depend heavily on agriculture and stand to benefit disproportionately more from any technology that increases food production, lowers food prices and improves food quality. Consumer acceptance of these technologies has been a major factor in determining whether such benefits will be available for developing countries. In some cases, it is unfortunate that the negative attitudes of the public have denied nations the benefits that would have accrued from the adoption of these technologies.

Assuming the success of the IRMA project in developing *Bt* maize in Kenya, and that the new *Bt* maize varieties will be efficient against all stem borers, and that at least two thirds of the farmers who adopt other technologies will also adopt the new *Bt* varieties, the yearly benefits are expected to be $49 million, of which two thirds go to the consumers. Discounted benefits over 25 years reach $208 million, compared to discounted costs of $6.8 million. This produces a benefit/cost ratio of 31:1, and an internal rate of return of 83% (De Groote et al., 2002). However, these benefits will only be realized if consumers accept the *Bt* maize. Currently, there is no information about the degree of acceptability of GM crops to consumers in sub-Saharan Africa, thus we cannot know whether these potential benefits will

be realized. It is therefore important to elicit the concerns of African consumers and farmers before GM crops are developed for African markets.

Understanding the Kenyan consumers' willingness to accept GM foods and the use of biotechnology in food development will be important in understanding the potential of the Kenyan market for GM food products. More importantly, the information will help in understanding the potential of genetic modification in contributing towards addressing food insecurity in the country. The study will seek to determine the Kenyan urban consumer acceptance or rejection of GM food. This information is unavailable currently, despite the fact that GM products are being developed for the country, and bearing in mind those consumers will be the final determinants of their success with their acceptance or rejection.

In light of the proposed introduction of *Bt* maize in Kenya, a consumer survey was conducted in Nairobi to elicit consumers' awareness, attitudes, and Willingness to Pay (WTP) for GM crops.

1.3 Objectives

The general objective of the study was to determine consumer acceptance for GM maize meal in Kenya. The specific objectives were:

1. To determine consumer's awareness and knowledge on biotechnology in general and GM crops in particular.
2. To determine consumers' attitudes towards GM foods.
3. To determine consumers' mean WTP for GM maize meal.

4. To identify consumers' characteristics that influence

1.4 Hypotheses

The following hypotheses were tested

1. Awareness significantly affects consumers' WTP for
2. Benefit perception has a significant positive effect on
3. Health risk perception has a significant negative effe
4. Income significantly affects consumers' WTP for GM
5. Level of education has a significant effect on WTP.
6. Respondent age significantly affects WTP.
7. WTP for GM maize meal is positively affected by food quality.

Literature guides on the expected signs of the factors tha WTP. Benefit perception and trust in government to ensure f a positive influence. Li et al. (2003) found that Chinese co GM soybean oil were positively affected by respondents' levels of self-reported knowledge for soybean oil. On the con expected to influence WTP negatively. Level of education, influence WTP either way. Consumers who are better inf more likely to perceive the risks of genetic modification, b perceive the benefits (Loader and Spenser, 1998). Awarene hence education can influence WTP either way.

1.5 Justification

The success of any biotechnology program will depend on whether consumers will accept its products. Springer et al. (2002) observed that consumers would be the final judges of emerging technologies in agricultural production. In a continent where food production per capita has difficulties keeping up with population growth, facing serious food shortages, Africa might not have the option of rejecting food with GM content (De Groote et al., 2004).

African policy makers face a dilemma of whether to embrace the technology to feed its hungry people or whether to protect them from its potential dangers. Since many developing nations have not formed their stand on genetic modification, they may end up adopting the positions of developed countries as their own. However, it is only logical that they should assess the potential benefits that biotechnology offers them before forming policies on agricultural technology. Without sound national technology policies on agriculture, there is the risk that these potential benefits may bypass them, and particularly so with respect to the small farm sector.

To give African farmers and consumers a voice in the debate, their concerns need to be known. Yet the debate has been conducted in complete exclusion of the developing country consumers and producers. Pinstrup-Andersen and Schioler (2000) observe that the agenda should be set by those people who have to live with the consequences of the action, in this case African farmers and consumers. De Groote et al. (2002) observe that in order to help make decisions in this heated debate, it is important that scientists contribute their objective analysis to the debate.

This study reveals important information that will help the Kenyan government and other developing countries set informed agendas concerning food security, food self-sufficiency and biotechnological research and development. Information on awareness, attitudes and WTP for various groups of people will be revealed. Factor that affect WTP will be realized. This information is important in formulating an effective public communication program that can educate the public on GM foods by providing them with unbiased scientific information. From the results, various effective channels for such a campaign are revealed, and the factors that can be addressed to increase acceptance. Of greater importance, acceptance of the technology is determined which further determines the potential of the technology in addressing food insecurity in the country.

CHAPTER TWO: LITERATURE REVIEW

There are relatively few studies on consumer acceptability of GM food in the developing world and more so in Africa. Without this information, assumptions are bound to creep in. Generally, people in these regions are assumed to be less aware of biotechnology as compared to their counterparts in the developed world. They are also assumed to be as cautious of the technology as consumers in the developed world. Despite the fact that the debate on genetic modification has contributed a lot in raising public awareness on biotechnology, it has also resulted to confusion and it is not uncommon to find people confusing biotechnology to mean genetic modification. This is despite the fact that genetic modification is just one component of biotechnology as shown in the definitions of scientific terms and concepts as they apply to biotechnology

The concepts and development of Contingent Valuation (CV) method are also presented. This is because the methodology applied in this study is an application of CV, which necessitates some background on the methodology.

2.1 Definitions

Biotechnology:

According to Pinstrup-Andersen et al. (2001), the term biotechnology is used to refer to all techniques that use living organisms to produce or alter a product, cause changes in plants or animals, or develop micro-organisms for specific purposes. It has also been defined as "the application of biological organisms, systems or processes to the manufacturing and service

industries". According to Pinstrup-Andersen et al. (2001), the key components of modern biotechnology are:

- Bio-informatics – the assembly of data from genomic analysis into accessible forms.
- Diagnostics – the use of molecular characterization to provide more accurate and quicker identification of pathogens.
- Gene splicing/gene transformation/genetic engineering – the introduction of genes conferring potentially useful traits into plants, animals and other organisms.
- Molecular breeding – the identification and evaluation of desirable traits in breeding programmes with the use of marker-assisted selection.
- Tissue Culture – the growing of tissues from single cells, and manipulating them in various ways to produce the desired end products.
- Vaccine Technology – the use of modern immunology to develop recombinant DNA vaccines for improving control of lethal diseases.

Genetically Modified Organisms (GMOs):

According to Feldmann et al. (2001), GMOs are living organisms into which foreign genes have been inserted. Other authors have defined GMOs as "organisms in which the genetic material has been altered in a way that does not occur naturally". This technology of transferring genes is known as genetic engineering. It also referred to as "gene technology", "modern biotechnology" or "recombinant DNA technology". It allows selected individual genes to be transferred from one organism into another, between related or non-related species.

_Bt_ Maize:

_Bt_ maize, an example of GMO, is a new technology developed to protect plants against insect attack by enabling the plant to produce its own insecticide – specific proteins that prevent certain insects from feeding on the maize plant (CIMMYT, 2001). The term '_Bt_' stands for _Bacillus thuringiensis,_ the soil bacterium that has the _Bt_ gene that produces these proteins.

Food security and insecurity:

Food security refers to access to food required for a healthy life by all people at all times (Leisinger et al., 2002). Achieving food security has 3 dimensions:

- Enough high-quality food must be available,
- Households and individuals must have access to this food,
- People must be able to make use of this nourishment with the help of clean water, adequate sanitation and health care.

Any deviation from this situation is referred to as food insecurity. According to Leisinger et al. (2002), there are two types of household food insecurity:

- Chronic food insecurity – a persistently inadequate diet caused by the continual inability of households to acquire needed food by either buying it or producing it themselves. This problem is rooted in poverty.
- Transitory food insecurity – a temporary decline in a household's access to needed food due to factors such as instability in food prices, production or incomes.

2.2 Contingent Valuation (CV) method: approaches and concepts

Contingent Valuation is a survey-based method used to elicit consumers' valuation of goods and services not sold in the market place, by calculating their WTP. The method has extensively been used in the valuation of non-marketed resources such as recreation, wildlife and environmental quality. In this method, the researcher creates a hypothetical market in a non-market or new good, invites a group of subjects (survey respondents or experimental 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 (hence the name contingent valuation) (Mitchell and Carson, 1989).

Lusk and Hudson (2004), show the importance of CV for agribusiness firms in assessing consumer demand for novel products and attributes. To estimate consumer demand, or WTP, for these novel goods or services, economists must turn to hypothetical contingent or experimental markets.

Bishop and Heberlein (1990) and Mitchell and Carson (1989), argue that a good CV must address the following;

1) The population of people whose values will be estimated.

Most past studies have dealt with obvious user groups such as people affected by pollution or park visitors. More recently, there has been growing interest in the "nonuser" or "intrinsic" values in recognition that those who are not current users of the resource may still place some value on the option to use the resource in the future or on the knowledge that the resource

will continue to exist. Once the population has been defined, satisfactory sampling strategies must be designed. Ideally, the sample should be randomly selected.

2) Definition of the item to be valued.

Good studies involve carefully presented description of the resources or changes in the good or quality to be valued. Product definition involves compromises between detailed presentation of technical information, on one hand, and the need to convey information in a form that is understandable to the respondents, on the other. That is, people need as complete a concept of what they are valuing as possible in order to come up with realistic values, but there is also a need to present the information in simple, understandable terms.

3) Payment vehicle definition

In order for respondents to express valid values, some specific mechanism for payment, called the "payment vehicle" must be specified. CV researchers have reasoned that the more realistic the hypothetical market and the mechanism for payment, the easier it will be for people to respond accurately.

4) Alternative ways of asking the valuation questions.

These are the various ways in which the survey may elicit respondent's WTP. These are

1. Bidding games, which is the traditional way of eliciting WTP. In this technique, the first step is to ask a respondent whether he or she is willing to pay a specified amount, known as the "starting point". If the result is affirmative, the amount is increased to successively higher amounts until a maximum WTP is reached. Likewise, if the

starting point elicits a negative response, the amount is lowered in predetermined increments until the respondent indicates an acceptable amount. This technique has been criticized as resulting to "starting point" bias, which happens if the initial bid as stated by the interviewer, affects the final bid stated by the respondent. This happens since an uncertain respondent is likely to regard the proposed starting amount as an approximate of the true value of the good.

2. Open-ended approach where the respondents are left to devise their maximum values without the aid of additional information, bidding or other processes. The respondent is asked the maximum amount she would pay for the service or good rather than go without it. Most researchers have been reluctant to use this method because of the fear that such questions do not give the respondent sufficient stimuli and information to thoroughly consider the values they would attach to such good if a market were to exist. Expecting respondents to come up with accurate values out of the blue may be expecting too much. This method has been criticized as lacking realism since respondents are rarely asked or required in their day to day life to place a monetary value on a particular good or service (Arrow et al, 1993). Secondly, it has been criticized as inviting strategic overstatement.
3. Payment card approach, which was developed as an alternative to the bidding game (Mitchell and Carson, 1989) involves showing the respondent a card that depicts a variety of payments and asking her which one she would pay. The question posed to the respondent is "What amount on this card or any amount in between is the most that you would be willing to pay".

4. Contingent ranking where participants are asked to compare and rank alternate program outcomes with various characteristics, including costs, from most preferred to least preferred. The characteristics are assembled into various bundles, which the respondent ranks. By statistically analysing these rankings, the WTP for any changes in any significant attribute can be inferred.
5. Dichotomous choice format, also known as take-it-or-leave-it or referendum approach, where the respondents are given specific monetary values and are asked whether they are willing to pay those amounts or not. The respondents answer with a "no" or a "yes". The yes-no answers are then used along with the required payment to estimate a discrete model from which the samples mean WTP is calculated. This method has the chief advantage in that it considerably reduces strategic bias (Arrow et al., 1993; Mitchell and Carson, 1989). Strategic bias arises when a respondent attempts to influence the results of a WTP survey by answering in such a way as to serve her own interest rather than reveal her true valuation of the good or service. For instance, the respondent might give very low amount of WTP if she felt that the answer would influence by lowering the amount she would be charged once the good or service is provided.

This format can either use a single-bounded design (where only one bid is presented) or the double-bounded design (where two bid values are tested- an initial and a follow-up one). The first bid is externally determined in both these designs and thus termed exogenous. However the second bid is endogenous as it is determined on the basis of the respondent's response to the first bid. If the response to the first bid is

affirmative, then the second bid is higher than the first. If the response is negative, then the second bid is an amount lower than the initial one. Hanemann et al. (1991) found that asking each respondent a second dichotomous choice question increases the statistical efficiency of conventional dichotomous choice valuation surveys.

5) Supplementary data needs

Most contingent valuation studies go beyond simply asking valuation questions and seek to determine factors influencing WTP. The questionnaires may be expanded to satisfy several objectives. In case "bid equations" are to be estimated, the questionnaire will have to collect data on variables hypothesized to influence WTP.

6) Analysis

Econometric methods for estimating WTP depend on the type of bidding approach taken in the interview. The Ordinary Least Square (OLS) is appropriate for bidding games, open-ended equations, and payment card formats analysis (Ozuna and Stoll, 1991). Analysis for responses to dichotomous choice questions uses dichotomous choice estimation methods, the most common of which are the probit and the logit methods (Ozuna and Stoll, 1991; Bishop and Heberlein, 1990).

2.3 Past studies on consumer attitudes and acceptance of GM products

Various studies have been carried out to determine consumer attitudes and acceptance of GM foods. Moon and Balasubramanian (2004) in determining public attitudes toward agro biotechnology proposed that the impact of trust, awareness, sense of outrage, and socio-demographic variables on attitudes are mediated by risk perceptions. They used a conceptual

frame work based on the premise that the overall attitude toward an object is determined by the beliefs about its attributes, and the evaluation of those beliefs. The survey was administered by mail to a sample of 3,060 U.S. households and 2,600 U.K. consumers by Internet. They found out that influence of negative attributes dominates attitude formation in both the U.S. and U.K., and this reflects failures on the part of the agro biotech industry in that few GM food products present direct tangible benefits like improved nutrition and taste, and the lack of effective information/education programs that promote positive attributes of agro biotechnology. In general, attitudes of U.K. consumers were more susceptible to negative attributes when compared with U.S. consumers. Results also showed that beliefs play an important role in shaping public attitudes toward agro biotechnology, largely via their links to risk perceptions. Their study focussed more on attitude formation on the assumption that the general attitudes for these regions are known. The current study aimed at determining such attitudes, as they are not known apriori, and to determine whether they have an influence on WTP for GM foods.

Hallman and Aquino (2003) used telephone surveys to track the strength, extent and persistence of consumers' attitudes towards GM food in the US. They found that most Americans had heard and read little about biotechnology, and few had talked about it more than once or twice. Most Americans are unaware that GM food products are already on supermarket shelves and thus they are currently eating them. The results further reveal that Americans express greater support for genetic modification of plants than they do for animals. This study sought acceptance or rejection by use of direct questions without

capturing characteristics like price. Such a situation does not give the respondent a chance to consider choices under incentives like price discounts.

Lusk (2003) did a large-scale, cross-Atlantic study to analyse consumer demand for genetically modified food in a non-hypothetical market environment. They carried out a food preference study in female respondents using experimental sessions. The subjects were endowed with a non-GM food and were asked to bid, in an incentive compatible auction, the minimum amount they had to be paid to exchange their non-GM food for a GM food, with full knowledge that that consumption of the food was required at the end of the auction. They found out that consumers in England and France demanded much greater compensation to consume a genetically modified food than did United States consumers, and that these results had important implications for the US and EU positions in international trade negotiations. The study is different from the current one as it is non-hypothetical, where an actual GM food (cookie) is used, which was not possible in the current study as the GM product of concern was not available in the Kenyan market.

Chern et al. (2003) estimated the consumer WTP for selected GM foods in Japan, Norway, Taiwan, and the US using university students as the respondents. Notable differences in the attitude and perception on GM foods across these countries were found. Norwegian consumers were willing to pay 55-69% premiums for non-GM foods in order to avoid their GM counterparts, Americans 50-62%, Japanese 33-40%, and Taiwanese consumers 17-21%. By considering only university students as the respondents, influence of such factors as age, income and the presence of small children in the household on WTP can not be captured. In

the current study, respondents were randomly selected in the points of sale in an attempt to adequately represent urban consumers.

Chen and Chern (2002) used CV to estimate WTP for three selected products: vegetable oil, salmon and cornflakes in the US. Their study revealed that variables related to attitude, perception, labelling, and price have significant effect on consumers' choices between GM and non-GM food products. Income and number of children in the household were found to have a significant negative effect on respondents' willingness to consume GM food products. The respondents were willing to pay a premium of 5-8% for non-GM vegetable oil, 15-28% for non-GM salmon, and 12-17% for non-GM cornflake breakfast cereal. Female respondents, middle-aged consumers and non-white respondents were willing to pay a higher premium for non-GM food products. That study contributes to the current study in that it uses dichotomous choice questions to determine WTP. However, the current study uses dichotomous choice with a follow-up question which is known to be more efficient (Hanemann et al., 1991).

Verdurme and Viaene (2002) carried out a study to determine consumer beliefs and attitudes towards GM food in Belgium. They hypothesised that consumer attitudes towards GM food are determined by risk and benefit perception. Based on these, they identified four consumer segments namely: the green opponents (those with most negative attitudes); the enthusiasts (those with most positive attitudes); the balancers (those with neutral attitudes); and the half-hearted (those with slightly negative attitudes). They found the percentages to be 15.5%, 23.5%, 26.5%, and 34.5% respectively. Based on these they recommended a communication

strategy for each of the consumer segments, depending on their information needs, consulted and trusted information sources and channels. Their study focused on consumers' perception and attitude formation. In the current study an actual product (maize meal) was considered and mean WTP calculated to determine potential demand.

Springer et al. (2002) found important differences of consumer attitudes towards GM food among countries in the European Union. The mean rejection rate for the 15 countries was 73%. Greece had the highest rejection rate of 85%, followed closely by Denmark and France. Netherlands had the lowest rejection rate (57%) followed closely by Great Britain with 58%. The results showed that most of the differences between the countries emerge from the differences in the population composition or behaviour. Cognitive factors, such as beliefs, risk perception, knowledge, and trust in government, emerged as the most important factors explaining the differences between the countries. Thus the socio-demographic factors by themselves are not sufficient to explain the differences. Springer et al. (2002) contributes to the current study by showing the importance of cognitive factors in explaining choice. In the current study, influence of such cognitive factors towards WTP is determined.

Moon and Balasubramanian (2001) determined public perceptions and WTP a premium for non-GM foods in the UK and the US using the probit model. They found that while UK consumers were more willing to pay a premium to avoid GM foods than the US consumers, risks and benefits clearly translated into behavioural intentions as measured with WTP in both countries. More importantly, they established that risk perception exerts a greater impact on WTP than benefit perception. That study used the single-bounded dichotomous choice CV

method, where only one bid was used. The current study used double-bounded CV method as it is shown to be more efficient since it gathers more information pertaining to respondents WTP.

Burton et al. (2001) carried out a study to determine consumer attitudes to GM food in the United Kingdom, and the extent to which these attitudes translate to WTP to avoid GM products. They found that GM food is only one element amongst a number of concerns in the food system. Moreover, attitudes differ significantly between GM technology in which plants are modified by the introduction of genes from other plants and that into which they are modified by the introduction of genes from plants and animals. The results also showed that attitudes towards organic food might be taken as a useful indicator of attitudes towards GM technology since the consumers of organic products had a higher WTP for a GM free diet. In this study, the authors conducted a conjoint analysis survey, where they used a reduction in weekly food expenditure as payment vehicle, with respondents being asked to choose between different commodities called "food futures". This design poses a substantial difficulty on the respondents in that they need to consider various trade-offs among characteristics. In the current study, the payment vehicle was the price of the product, and the respondents considered a discount or a premium in determining their decision to buy in the same way they do in points of sale.

Kim and Kim (2004) conducted a student survey in Korea to analyze consumer's attitudes and WTP for non-GM vegetable oil and tofu using CV method, and compared this with results from other countries as presented by Chern et al. (2003). A high percentage of Asian

respondents including Korean students were well informed about GMOs, but relatively low percentage of Asian students ranked GM foods as "very safe". Especially, Korean and Japanese students had relatively negative attitude to GM foods. Student respondents in all five countries (Korea, Japan, Taiwan, U.S., and Norway) viewed GM food labelling as an important policy measure. Korean students were willing to pay price premiums of 54.2% for non-GM vegetable oil and 81.2% for non-GM tofu. Comparing with other countries, the WTP for non-GM vegetable oil in Korea was similar to the U.S. (50-62%) and Norway (55-69%). In other Asian countries, the WTP for non-GM vegetable oil were relatively low, ranging from 17-21% in Taiwan to 33-40% in Japan.

2.4 Past studies that have used CV with a follow-up question in estimating WTP for GM foods

Recently, CV method has shifted more to dichotomous choice surveys with a follow-up question. This is because of the generally assumed view that the method gives more efficient results. This shift is also found in studies on preference for GM products. Li et al. (2003) conducted a survey in Beijing, China to determine consumer attitudes towards GM foods. Although the majority of surveyed consumers reported they had little or no knowledge of biotechnology, their attitudes toward GM foods was generally positive. Using dichotomous choice CV, Chinese consumer's WTP for GM rice and GM soybean oil were found to be positively affected by respondents' positive opinion, and by higher levels of self-reported knowledge for soybean oil. WTP was negatively affected by the respondent's age. Their results indicated that unlike Europe or Japan, there is a potential market for GM foods in China. Consumers were willing to pay a 38.0% premium for GM rice and 16.3% premium

for GM soybean over their non-GM counterparts. Similar to the current study, the double-bounded logit model was used to determine mean WTP and in both cases the survey was carried out at points of sale.

McCluskey et al. (2001) sought to estimate WTP for GM-free food products and analyse the factors that induce Japanese consumers to choose GM-free food products. They built "semi-double-bounded" logit model, in which individuals who responded with a yes to the first question, implying that they were willing to purchase the GM food product at no discount, were not asked a follow-up question because of the assumption that people would not be willing to pay a premium for GM food. The results indicate that customers in Seikyou, Japan, are willing to purchase GM noodles with a 60% discount and GM tofu with a 62% discount. 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. Also, female consumers with larger families were more willing to pay for GM foods. In avoiding to ask whether consumers would buy the GM product at a higher price, the methodology leads to loss of information as one can not place the WTP bound on those people particularly supportive of the technology.

Kaneko and Chern (2003) used dichotomous choice based CV to determine WTP for non-GM vegetable oil, salmon fillets and cornflakes. To counter the problem of awareness, they provided a basic definition of genetic modification along with pros and concerns. They found that consumers do care about the price even when the choice involves such controversial products as GM foods. Among the determinants of choice, risk perception stands out. The

mean WTP to avoid the GM alternative were 41.2% for vegetable oil, 31.4% for cornflake cereal, 40.9% for GM-fed salmon and 52.5% for GM salmon. The WTP for GM salmon is the highest and significantly different from that of GM-fed salmon, implying that respondents feel a weaker aversion to GM foods involving only modification of plant genes as opposed to animal genes or a combination of plant and animal genes. The current study used a similar methodology by asking a follow-up question on the dichotomous choice question, and in offering information to non aware respondents on genetic modification.

2.5 Other studies that have used CV with a follow-up question

Hanemann et al. (1991) conducted a survey on WTP for protecting wildlife and wetland habitats in California's San Joaquin Valley. They used mail-out questionnaires to collect the responses to the initial bids, and a telephone interview to collect the responses to the follow-up bids. WTP was estimated using both the single and double bounded logit models, yielding a mean WTP of US$257 and US$152 respectively, for the wetland maintenance program. Comparing the two, they found an increase in statistical efficiency in the double-bounded method, since it yields tighter confidence intervals and lower point estimates for mean WTP.

Cameron and Quiggin (1994) employed the double bounded model to the data collected by the Australian Resource Assessment Commission, which was part of an evaluation of alternative proposals for the management of the Kakadu region (an important wilderness area with significant mineral deposits) in Australia.. They used the bivariate normal probit to capture the independence of errors from the two response equations. By testing different restrictions in estimating mean WTP, they concluded that that it is critically important when

analysing responses to acknowledge the imperfect correlation of the errors between the responses to the first and the second valuation questions.

Hadker et al. (1997) in determining the WTP for Borivli National Park (BNP) in Bombay, India applied the double bounded dichotomous choice by assuming the log normal distribution of the total WTP. They found that people were aware and were willing to pay for BNP.

Corsi and Norvelli (2002) estimated the maximum price consumers are willing to pay for organic beef meat in Europe using the double bounded probit. The results showed that consumers maximum WTP is quite high, thus suggesting that organic beef meat might gain an appreciable market share in the region.

Abou-Ali (undated) used both CV and Choice Experiments (CE) to value the benefits of enhanced water quality to a sample of 1500 households living in Cairo, Klyubia and Giza governorates in Egypt. For the CV method estimation, the double-bounded format was applied using the spike logit model, to determine the mean and median WTP. They concluded that the households living in Metropolitan Cairo have a positive WTP for reducing health risks owing to water quality.

CHAPTER THREE: METHODOLOGY

3.1 Conceptual framework

When investigating the viability of a new venture, production costs and consumer demand for the new product need to be considered. To determine consumer demand or WTP for such products, economists create hypothetical markets (Lusk and Hudson, 2004), typically using CV to ask consumers to value a new product. 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 existence of the hypothetical market. These surveys only give meaningful results if they are properly grounded in a consumer maximization framework (Hanemann and Kanninen, 1998). It is therefore assumed that consumers 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 CV, WTP can be estimated using questions that are open-ended, that is, 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 is inefficient in that such questions do not give the respondent sufficient stimuli and information to thoroughly consider the values they would attach to such good if a market were to exist. Expecting respondents to come up with accurate values out of the blue may be expecting too much. This method has been criticized as lacking realism since respondents are rarely asked or required in their day to day life to place a monetary value on a particular good or service (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 his 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 CV. This method yields more efficient estimates and tighter confidence intervals since it incorporates more information about an individual's WTP (Hanemann et al., 1991).

The random utility model is the basic model for analysing dichotomous choice CV responses. This model arises from the assumption that while the individual knows her preferences with certainty and does not consider them stochastic, they contain some components that are unobservable to the econometric investigator and are treated by the investigator as random (Hanemann and Kanninen, 1998). These components are captured by the random term. In this case individuals are expected to maximize their utility. The indirect utility function for an individual may be expressed as;

(1) $U = f(y,z,e)$

where:

U represents individual's utility

y is the individual's income

z is a vector of respondent's characteristics and other demographic variables

e is the random term

Given this utility function, the individual answers "yes" to the offered price if the utility with the proposed change is greater than the utility without the change. Since, however, U is observable to the respondent but not to the researchers, one can make only the probabilistic statements about the response.

The probability that the respondent will answer yes and hence be willing to pay is the probability that their utility with the proposed change is greater than that without the change, represented by the equation:

(2)

$$P_j = P\{U_{j1}(y_j - b, z, e_{j1}) > U_{j0}(y_j, z_j, e_{j0})\}$$

where:

P_j is the probability that the j^{th} respondent will answer "yes" to an offered price of b

U_{j1} is the respondent's utility with the change

U_{j0} is the respondent's total utility without the change

y_j is respondent's income

z_j is a vector of the respondent's characteristics and other demographic variables

e_{j1} *and* e_{j0} are random components with and without change, respectively.

The deterministic part of the utility function can be represented by a preference function that is maximised by the decision maker, called the index function (v), which is assumed to be linear in parameters

(3) $v = \alpha - \rho\beta$.

Different people have different WTP for a particular good. 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).

WTP can be assumed to have a particular probability density function (pdf) around a mean, in function of the price, with the logit and the probit distributions being the most common. The logistic model is commonly used in applied research because its estimation is relatively simple and it usually provides a good approximation to the probit model (Sellar et al., 1986). This model follows the assumption that the error terms and hence true WTP for the sample are independently and identically distributed with Weibull density functions (Greene, 2002; Sellar et al., 1986). The pdf of the WTP is then presented by:

(4) $P(WTP = B) = \exp(v)/(1+\exp(v))$

Where α is the constant and β is the price coefficient.

The logistic function also 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,

(5) $G(B) = P(WTP < B) = 1/(1+\exp(v))$

Where G is the logistic cdf

People who would accept an offer of value B are those whose WTP is higher than or equal to B, therefore the probability of someone accepting to pay at price B is the opposite of the above function:

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

Where π^{y} = probability of a positive answer

This is an upward sloping S-shaped function, starting at 0 in function of the price of the good. 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 $\pi(B)$. The probability of accepting an offer of B would then be

(7) $\pi^{y}(B) = 1 - G(B) = 1 - 1/(1+\exp(\alpha - \rho B))$ (with $\rho > 0$ and $B > 0$)

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

(8) $\pi^{n}(B) = G(B)$ (where π^{n} = probability of a negative answer)

In the simple model of a single dichotomous choice (where only one bid is presented), the likelihood function can be derived from equations (7) and (8):

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

Where d_i^y is 1 if the ith response is "yes" and 0 otherwise, and d_i^n is 1 if the ith 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 cdf is calculated by α/ρ (Hanemann et al., 1991).

In this study, 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 where both answers are "no" (π^{nn}). To receive information on a wider range of values, the bids differ between respondents i.

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

$$(10) \quad \pi^{yy}(B_i, B_i^u) = \Pr\{B_i^u \leq WTP_i\} = 1 - G(B_i^u)$$

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

$$(11) \quad \pi^{yn}(B_i, B_i^u) = \Pr\{B_i \le WTP_i \le B_i^u\} = G(B_i^u) - G(B_i)$$

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

$$(12) \quad \pi^{ny}(B_i, B_i^d) = \Pr\{B_i^d \le WTP_i \le B_i\} = G(B_i) - G(B_i^d)$$

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

$$(13) \quad \pi^{nn}(B_i, B_i^d) = \Pr\{B_i > WTP_i \text{ and } B_i^d > WTP_i\} = G(B_i^d)$$

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

$$(14) \quad \ln L^D(\theta) = \sum_{i=1}^{N} \{d_i^{yy} \ln \pi^{yy}(B_i, B_i^u) + d_i^{nn} \ln \pi^{nn}(B_i, B_i^d) + d_i^{yn} \ln \pi^{yn}(B_i, B_i^u)$$

$$+ d_i^{ny} \ln \pi^{ny}(B_i, B_i^d)\} \qquad \text{(Hanemann et al., 1991)}$$

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, a cdf G (•) has to be specified. The logistic function with an index function linear in parameters is used. 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 (Hanemann et al., 1991).

WTP varies among individuals. This is influenced by the price faced (bid), socioeconomic factors and subjective (cognitive) elements. Therefore, the probability that a consumer is

willing to pay for a product at a certain price B is a function of a vector of cognitive and socioeconomic factors, Z. This can be specified as:

(15) $\pi(B, Z) = \pi(v)$

where v = index function, which gives the already predetermined relationship between B and Z. Assuming the index function linear in parameters,

(16) $v = \alpha - \rho B_i + \lambda' Z_i$

Similar to the simple model above, the probability of WTP for a bid, taking into account other consumer characteristics becomes

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

where B_i is the bid individual i faces, Z_i is a column vector of individual characteristics (both socioeconomic and cognitive) and ε_i is a random term.

3.2 Sampling procedures

3.2.1 Area of study

The study was carried out in the city of Nairobi. Being the capital city of Kenya, Nairobi represents a large cosmopolitan area of residence, which can be taken to represent people of diverse social status and races from all over the country. As the financial and academic capital of Kenya, it is hypothesised to have a larger proportion of its population being aware of GMOs than other regions in the country, since higher incomes enable people to have access to more information sources. It is also hypothesized to have a high proportion of its population having high education (some secondary schooling and above), which would go well with the technical nature of the topic and questions.. Being a city, it represents a region

where consumers are used to buying maize meal from the supermarkets, shops and kiosks as opposed to consumers in rural areas who consume mostly from their own production or buy from their neighbours. This goes well with the CV exercise, as the residents are familiar with the payment vehicle used in the exercise (price of the good).

Nairobi is the Capital City of Kenya and covers 696 square kilometres. According to the 1999 Population and Housing Census (GoK, 2001), this city has a population of 2,143,254 persons, hence a density of 3,079. It has a total of 649,426 households. The city is considered both a province and a district, and is further divided into 8 administrative divisions.

3.2.2 Points of sale

The study was carried out in three points of sale namely the supermarkets, kiosks (small road side shops) and posho mills (hammer mills). These points of sale are the main outlets from which urban consumers do their purchases. The purpose was to represent all categories of consumers in the place where they implemented their purchase decisions and intentions. A total of 15 supermarkets were selected using systematic sampling from a list of supermarkets obtained from Kenya's Central Bureau of Statistics (CBS), which included 10 large ones (with more than 3 branches within the city), and 5 small ones. From each of the selected large supermarkets, 16 customers were approached for possible interview. For the small supermarkets, 10 consumers were approached. In the end, a total of 183 respondents were interviewed in the supermarkets.

For the kiosks, a list of city estates obtained from CBS 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. A total of 10 consumers were interviewed from each of the selected kiosks bringing the number of respondents in kiosks to 210.

Finally, the city was toured in order to establish the number of posho mills in each estate, identifying 16 estates with different number of posho mills. 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 leading to a total of 211 respondents. In total there were 604 respondents: 183 from supermarkets, 210 from kiosks and 211 from posho mills.

It is important to note that the results can not be taken to be completely representative of the city since it was not known apriori the proportion of people that patronise the different points of sale.

3.3 Questionnaire design

The data needed for this study was primary, hence could only be collected in a survey using questionnaires. A structured questionnaire consisting seven parts was developed.

The first part contained questions on awareness, sources of information and knowledge about biotechnology in general and GM crops in particular. The second part contained an information text on GM crops, meant for those unaware of GM crops since it is widely accepted that people can't have perceptions nor can they place realistic values on what they don't know. Arrow et al. (1993); Swallow and Woudyalew (1994) observe that when valuation entails a complex good that the respondents are not familiar with, specific

information about the nature of the good should be provided in the questionnaire. The information should be provided in a way that might not bias their attitudes and valuations upwards or downwards. They further observed that people can't be expected to assimilate and understand complex information, hence it should be kept as simple as possible.

The text gave a definition of GM crops, the reasons why they are grown, Kenya's position on this research, current and potential benefits of GM crops, potential risks and perceived concerns, biosafety measures and examples of countries growing GM crops and the leading GM crops being grown. In order to control for possible order effect, two formats of the questionnaire were developed. All the questionnaires were the same apart from the fact that half of them presented benefits on GM crops first, while the other half presented risks first. Hanley and Splash (1994) observe that supplying individuals with increasing amounts of "good" information (information relating to desirable characteristics) will increase their true WTP and vice versa.

Part three had statements on variables aimed at capturing consumer attitudes about GM crops. These were benefit perception, environmental risk perception, health risk perception and ethical, religious and economic concerns. Within each perception, there were statements that were supposed to be completed by the respondents. Socio-economic information was collected in part four of the questionnaire. Part five had general questions on consumer maize consumption habits, while part six, the stated choice experiment part, contained the dichotomous choice questions. Finally, part seven had questions on sources of general information sought and how often they were sought.

3.4 Data collection

Five enumerators were hired specifically for this survey, and received appropriate training. Following this, the questionnaire was pretested in the three points of sale and relevant adjustments made accordingly. For example, effort was made to make the questionnaire shorter without loss of information since supermarket patrons had less time to spare and complete the questionnaire than the kiosk and the posho mill ones. The enumerators approached every third consumer that came along for a possible interview. In the supermarkets, the enumerators were stationed at the maize meal corner and hence approached every third consumer that came to that section. Every third consumer was approached in the kiosks and the posho mills irrespective of what they were buying or milling.

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. This was also done by Kaneko and Chern (2003), since people can not be expected to value a good they do not know. After this presentation, their opinions on GM crops were then sought. This group was not asked to answer questions on knowledge about GM crops.

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"). This was adopted from Verdurme and Viaene (2002), who used the same method to determine consumer awareness and calculate consumer's knowledge score on biotechnology.

In order to determine consumer attitudes on GM crops, respondents were asked if they agreed with statements on genetic modification concerning 5 perception 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 a solution to world food problem". For each type of perception category, several statements were read, and respondents were asked their opinion, on a 5 - point scale from 1= 'totally disagree' to 5= 'totally agree', with 3 as a neutral mid point. Verdurme and Viaene (2002) and Moon and Balasubramanian (2001) emphasize the importance of attitudes in determining WTP. However, they concur that a person's attitude is as a result of perceptions on different issues. Verdurme and Viaene (2002) categorised attitudes into five perceptions as adopted in this study.

For the WTP questions, respondents were first asked if they would be willing to pay for GM maize meal if it were offered at the same price as their favourite non-GM maize meal brand in a hypothetical situation where GM maize meal is assumed to be available in the market.

Following Hanemann et al. (1991), if the respondent's answer to this question was a "no", a follow-up question was asked, where the respondent was offered a percentage discount on the GM product relative to the non-GM product. Li et al. (2003) also used percent discount or premium to determine the second. Just like in Li et al. (2003), if the respondent's answer to the first question was "yes," a follow-up question was asked where the respondent was offered a percentage premium on the GM product relative to the non-GM product. This is unlike the method adopted by McCluskey et al. (2001) where respondents were not asked if they can buy GM food at a premium, and which may lead to loss of information. The discount and premium levels used were 5, 10, 20, 30 and 50 percents. These were equally distributed across the sample, with each level going to equal proportions of the sample.

As might be expected, a study of this nature is likely to face some limitations. The technical nature of the topic was not easy to simplify, especially for low educated respondents in the posho mills. Similarly, due to the relatively new nature of the issues, there were instances where it was not possible to translate some technical terms to Kiswahili, the national language, or to local languages. Hence the ability of some of the low educated people to receive technical information and process it to form perceptions in a few minutes, and then be able to truthfully place their valuations may come into question. This is especially so for the people who were unaware of GM before the survey and who had to receive an information text, and immediately afterwards were asked their opinions and valuation questions. However, every effort was made to obtain as reliable data as is possible under the circumstances. A good indication of data reliability is in the results, where, for example, it is shown that previous awareness of GM crops did not influence WTP.

3.5 Data analysis

3.5.1 Descriptive analysis

In order to achieve objective 1and 2, that is, to determine awareness and attitudes about GM crops, descriptive analysis was used. This was done by summarizing the variables of interest in order to determine interrelationships among them. It entailed computation of measures of central tendency, frequencies and cross-tabulation using the SPSS software. Ms Excel was used in formatting tables and figures. Cross-tabulations were particularly helpful in determining how awareness, sources of information, and attitudes varied by point of sale, gender, income and other variables of interest.

3.5.2 Econometric analysis

3.5.2.1 Mean WTP

In order to estimate mean WTP and determine the factors that influence it, the double-bounded CV approach was used. The model was estimated using LIMDEP 8.0 software following the maximum likelihood module and applying the minimize command.

The index function for GM maize meal model is specified as:

(18) $v = \alpha - \rho B_i + \lambda' Z_i + \varepsilon_i$

Where B_i is the ultimate bid individual i faces, Z_i is a column vector of socioeconomic and cognitive characteristics of the individual, and ε_i is a random term.

Following Hanemann et al. (1991), the mean and median WTP is given by α/ρ, obtained from the restricted model without consumer characteristics, i.e., by restricting $\lambda = 0$. The confidence interval for mean WTP was estimated using bootstrapping method contained in the Nlogit procedure of LIMDEP. This method can be used to determine asymptotic variances where the distribution is not certain (Greene, 2002). This was done by estimating mean WTP a specified number of times from subsets of the dataset obtained by sampling, with replacement, *m* observations and estimating mean WTP. The variation was 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 found to be sufficient, since more than that did not improve the estimation.

3.5.2.2 Factors influencing 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 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 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 food and also WTP. Negative perceptions were found to have a particularly negative effect on WTP. Chinese consumer's positive opinion towards biotechnology positively affected respondents' WTP for GM rice and soybean oil, 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 influenced 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, awareness and perceptions on GM crops and individual characteristics of age, gender, education and income were considered, and the presence of children in the household. Trust the respondent has in the government to ensure food quality was also included as was also point of sale where the interview was conducted.

The empirical representation of the unrestricted model with consumer characteristics, assuming a linear index function can be expressed as

WTP = f (BID, AWR, I_{BP}, I_{ERP}, I_{HRP}, I_{EREC}, AGE, GENDER, EDUC, INCOME, CHDN, GOVT, PTSALE)

Where:

a) BID is random bid value offered to the respondent

b) AWR= Dummy variable for previous awareness about GM crops; 1 if previously aware of GM crops, 0 otherwise

c) 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 environment risk perception index I_{ERP}, a health risk perception index I_{HRP}; and an index for ethical, religious, and equity concerns I_{EREC}).

d) AGE = age of the respondent in years

e) GENDER = Dummy for gender of the respondent; 1 for female, 0 otherwise

f) EDUC= Highest education level attained

Dummy variables were developed for the four levels of highest education attained as follows;

SECNDRY	1 if highest education level is some secondary, 0 otherwise
TERTRY	1 if highest education level is some tertiary college, 0 otherwise

UNIVRSTY	1 if highest education level is some university, 0 otherwise

With base for education level dummies being some primary level

g) INCOME= respondents reported monthly income

For the purpose of estimation, dummy variables were developed for each category of monthly income level as follows;

INC0_ST	1 if monthly income is none/0 (students), 0 otherwise
INC0_15	1 if monthly income is between Kshs0-15, 000, 0 otherwise
INC15_50	1 if monthly income is in the range of Kshs.15,000-50,000 0 otherwise
INC_OV50	1 if monthly income is over Kshs 50,000, 0 otherwise

Base for monthly income is 0 (non-students).

h) CHDN= Dummy for the presence of children below 18 years in the household; 1 if yes, 0 otherwise

i) GOVT= Dummy for trust in government to ensure food quality; 1 if the respondent trusts the government to ensure food quality, 0 otherwise

j) PTSALE= Point of sale

Dummies were developed for points of sale as follows:

SPMKT	1 if the respondent was interviewed in a supermarket, 0 otherwise.
KIOSK	1 if the respondent was interviewed in a kiosk, 0 otherwise

(Base for point of sale was posho mill)

The unrestricted model was also estimated with LIMDEP 8.0 software using the minimize command.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Consumer characteristics by point of sale

Data from a total of 604 respondents were used in descriptive analysis. The reason for targeting three points of sale was based on the need to incorporate views of all categories of consumers based on the assumption that there are differences in socio-economic characteristics that may influence awareness and attitudes towards GM crops in consumers who patronize different points of sale. Table 1 shows that respondents in different points of sale had distinct socio-economic characteristics. Fifty nine percent of the maize buyers in posho mills were women, while more than half of the maize buyers in the supermarkets were male. Supermarkets had the highest percentages of formally employed clients, highest percentage of those with university education, and also the highest percentage of those with high income levels (above Kshs. 15,000 per month). This indicates that people in the high social status shop relatively more from the supermarkets. Kiosks' clients represented a more diverse group because kiosks are found everywhere, in well to do estates and low income ones. Posho mills were characterized by clients with the highest percentage of the unemployed, those with the lowest education and income levels. Posho mills also had the highest percentage of non-students with zero income (26%) and lowest percentage of consumers with an income of above Kshs. 15,000 per month (only 16%). This can be

explained by the location of the posho mills as most of them are found in low income residential areas including slum dwellings.

Table 1. Consumer's socio-economic characteristics by point of sale (%)

Variable	Category	Point of sale			% respondents
		supermarkets	kiosk	posho mill	
Gender	female	40	35	59	45
	male	60	65	41	55
Employment status	formally employed	54	37	35	41
	self employed	23	35	28	29
	unemployed	14	17	25	19
	student	9	11	12	11
Highest level of education	none	1	1	1	1
	some primary	14	16	30	20
	some secondary	34	46	40	40
	some tertiary college	27	29	25	27
	some university	25	9	4	12
Income level per month (Kshs)	0(student)	8	11	12	10
	0(non-student)	10	16	26	18
	0 to 15,000	51	46	47	48
	15,000 to 50,000	27	26	15	22
	over 50,000	5	1	1	2
Sample size (number)	No.	183	210	211	604

Source: Author's survey, 2003

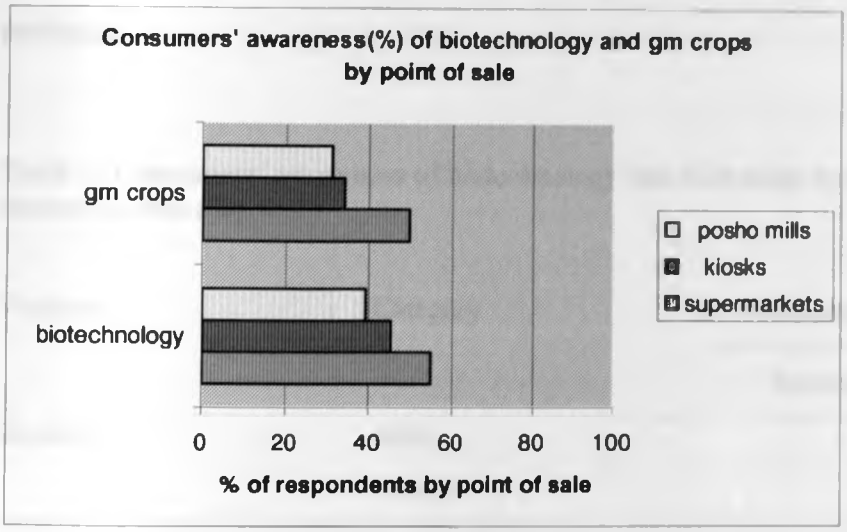
The last column shows the percentage over the whole sample. These concur with the city's figures (GoK, 2001) in that the highest proportion for the city is formally employed (39%), and most people report secondary as the highest education level attained (44%). Income figures for the city are calculated per household hence it was not possible to compare with the samples. The mean age for the sample was 30 years.

4.2 Consumer awareness of GM crops

The results showed that 38% of all the respondents had heard of or read something about GM crops before this survey. Awareness about biotechnology was also high at 46%. Of those aware of GM crops before this survey, 65% were also aware of virus resistant sweet potato, 54% of *Bt* maize, and 21% of *Bt* cotton. This is not surprising since Kenya has been conducting research on virus resistant sweet potato and lately on *Bt* maize.

Awareness about GM crops and biotechnology differed by points of sale. Awareness about biotechnology and GM crops was highest in the supermarkets and lowest in the posho mills (Figure 1). Half of the supermarket respondents were aware of GM crops, while 34% of kiosk and 31% posho mills respondents were aware. Awareness about particular GM crops, which was only asked of those aware of GM crops in general, did not differ by points of sale.

Figure 1. Consumers' awareness of biotechnology and GM crops by point of sale (%)



Awareness also differed by socio-economic characteristics (Table 2). At 45%, men were more aware of GM crops than women (29%). It also differed by employment status, from 28% on the unemployed to 35% in the self-employed and 43% in the formally employed category. Awareness clearly rose with education and monthly income. Only 17% of those with no education were aware while 90% of those with university education were aware. Excluding students with zero income, awareness increased with income from 28% for those with 0 income to 92% for those with above KShs 50,000 per month. Awareness about particular GM crops did not differ by socio-economic characteristics.

At 38%, awareness about GM crops was high for a developing country, considering that the debate has mostly taken place in the developed world. Chern and Rickertsen (2002), in a survey to determine WTP for GM foods in Japan, Norway, Taiwan and the U.S. found that 45% of the respondents considered themselves not informed about GM foods or organisms (hence awareness level of 55%). Verdume and Viaene (2002) found out that 69% of

Belgium consumers were aware about genetic modification in general and GM foods in particular.

Table 2. Consumers' awareness of biotechnology and GM crops by socio-economic characteristics (%)

Variable	Category	% of respondents aware of:	
		biotechnology	GM crops
Gender	Male	53	45
	Female	38	29
Employment	Student	62	42
	formally employed	52	43
	self employed	39	35
	Unemployed	35	28
Highest education level	None	17	17
	some primary	19	10
	some secondary	32	26
	some tertiary college	68	53
	some university	93	90
Income/month (KShs)	0(student)	60	42
	0(non-student)	35	28
	0 to 15,000	37	28
	15,000 to 50,000	64	59
	over 50,000	100	92

Source: Author's survey, 2003

4.3 Sources of information

Those who had heard or read something about GM crops were asked about their source of information. In most cases newspapers were by far the most important source of information mentioned (17-34%) followed by schools and colleges (13-30%) (Table 3). Television was the third largest source of information as far as GM crops were concerned and also for virus-resistant sweet potato (11% and 8% respectively). However, television was a minor source when it came to *Bt* maize (3 %). The case of *Bt* cotton is different as schools and colleges were the main sources of awareness (30%) followed by newspapers (17%). Media in general (newspapers, media, television, radio and press) was the main source of awareness in all cases (39-73%). This shows that the media is playing an active role in the debate about GM crops in Kenya since it is the main source of information for those particular GM crops whose research is ongoing in the country; *Bt* maize and virus-resistant sweet potato. For *Bt* cotton (whose research is not ongoing in the country), schools and colleges were the main sources of awareness and the media sources were just minor. Friends and other people were also a major source of information in all cases (7-9%), followed by radio (4-7%). Other important sources of information were books and journals and articles. Farmers and agricultural institutes were an important source of information, but only about specific GM crops. Little importance of seminars and conferences/workshops as sources of information may indicate little if any official efforts to raise awareness about GM technology.

The importance of media as a major source of information is collaborated by similar studies in other places. Verdume and Viaene (2002) found that television, newspapers and

journals/magazines are by far the most consulted information sources in that order. Amongst these, television was the most trusted source followed by newspapers.

Table 3. Sources of information about GM crops (by crop) as a % of respondents aware of particular GM crop

Source	GM crops	Virus-resistant sweet potato	Bt maize	Bt cotton
Newspapers	34	24	29	17
School/college	21	16	13	30
Media	15	11	16	4
Television	11	8	3	7
Friends/other people	9	7	9	9
Radio	7	4	6	7
Press	5	4	6	4
Books	3	3	1	4
Journals/articles	2	3	2	
Place of work	2	1	3	2
Agricultural institutes	1	4	2	2
Farmers	1	6	6	9
Magazines	1	1	1	0
Seminars	2	1	0	0
While visiting/travelling	1	1	0	0
Agricultural show	0	1	2	0
Baraza/meetings	1	1	1	0
Conferences/work shops	1	2	0	2
Internet	1	1	2	2
Agrochemical shops	0	1	1	0
Scheme/project	0	2	1	0

Source: Author's survey, 2003

4.3.1 Sources of information by socio-economic characteristics

Sources of awareness differed by socio-economic characteristics (Table 4). Newspapers were a source of information to a higher percentage of men (36%) than women (29%). They were also a larger source of information to the self and formally employed (33% and 38% respectively), and also largest source to those with the highest levels of income and education. Their importance as a source of information increases strongly from people without income (17%), to those in the highest income bracket (82%). Similarly, the importance of newspapers increases from none for those without education to almost half for those with university educated. The same trend is observed with television as a source of information. The importance of the two sources of information clearly increases with education and income.

The reverse is observed with friends/other people and radio. The radio was a larger source of information to the low educated and those with lower incomes. The radio was also an important source of information to the self-employed (15%) than to those in other employment categories. For those with no income, the main source of information was schools/colleges (38%), followed by newspapers (17%). Though a good proportion of the students mentioned television as a source of information (20%), only a minority mentioned radio (4%).

Newspapers importance as a source of information decreased from 42% in the supermarkets to 26% in the posho mills. This trend is observed with television, which decreases from 16% in the supermarkets, then to 13% in kiosks and 3% in posho mills. The trend is reversed

where schools/colleges are considered, as their importance increases from 10% in the supermarkets, to 32% in the posho mills. Books were only a source of information to respondents in the supermarkets (8%) and not to those in other points of sale.

The media come out as the most important source of information about GM crops. Newspapers were the main source of information for most people and especially supermarket patrons, the formally employed, students, and those with the highest education and income levels. Television was also a major information source to the same groups. Schools and colleges were also a major source of information and especially to the students. Other sources of information like conferences and seminars, books and agricultural institutes were only playing a minor role and efforts to intensify their use may be called for.

Table 4. Major sources of information about GM crops by socio-economic characteristics as a % in that category

Source	Gender		Highest level of education					Employment status				Income level per month(Kshs 000)				
	Male	Female	None	Pri	Sec	Tertiary	Univ	Formall	Self	Unempd	Student	0 (stdnt)	0(non-stdnt)	0 -15	15-60	Over 50
Newspapers	36	29	0	25	22	36	45	38	33	22	32	28	17	26	42	82
School/ colleges	17	29	0	17	25	24	14	17	13	38	36	40	38	21	12	9
Media	16	14	0	0	10	20	19	16	17	13	14	16	10	20	14	9
Television	12	10	0	0	8	13	16	14	8	3	18	20	7	5	16	27
Friends/other people	10	6	0	25	14	7	3	7	15	6	7	8	3	11	9	0
Radio	9	4	100	25	13	3	3	6	15	3	4	4	7	11	6	0
Press	5	5	0	0	2	8	5	6	7	3	0	0	3	8	5	0
Books	3	4	0	0	0	1	9	2	0	6	11	4	7	1	1	0
Journals/ articles	2	1	0	0	0	1	3	3	2	0	0	0	0	1	3	9
Place of work	2	1	0	0	0	3	2	4	0	0	0	0	0	0	5	0
Number	149	78	1	12	63	87	64	107	60	32	28	25	29	80	77	11

Source: Author's survey, 2003

4.4 Depth of knowledge about genetic modification for respondents aware of GM crops

To determine the depth of knowledge about GM 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, which ranged from 1 to 5. Respondents' depth of knowledge about genetic modification is above average. The mean knowledge score was 3.3, and 55% in percentages, indicating that people aware of GM crops were well informed on the issues involved in the technology.

This is further corroborated by the answers to various statements given by respondents on risk and benefit statements. The percentage of people completing the statements correctly is above half (51-94%) (Table 5). The statement with the highest number completing correctly was "Crops can be made resistant to certain diseases and pests through genetic modification" implying that people agreed that the technology has the potential of addressing farmers' problems. Some answers raise concern however. On the statement "GM plants are always larger than ordinary plants", more than half (57%) completed wrongly with true, which may imply that a lot of people view genetic modification as aimed at only increasing size. Completion with don't know reflect uncertainty about the answers. This is especially observed on statements on health effects of GM foods, which also exhibited high percentages of people completing wrongly.

Table 5. Knowledge statements as completed by aware respondents (%)

Statement	Correct Answer	% of respondents completing with		
		TRUE	FALSE	Don't know
Crops can be made resistant to certain diseases and pests through gm	TRUE	94	2	4
Biotechnology refers to all techniques that use living organisms to produce or alter a product...	TRUE	89	1	10
Genetic modification is also used in medicine	TRUE	86	3	11
The Kenyan government has allowed growing of gm crops in confined greenhouses for research purposes	TRUE	84	3	13
Gm crops refer to crops into which foreign genes have been inserted	TRUE	84	7	9
The US government has allowed commercial growing of gm crops	TRUE	83	3	14
Ordinary food does not contain genes	FALSE	15	72	12
It is not possible to transfer bacteria genes into plants	FALSE	19	65	16
A persons genes can be altered after eating gm foods	FALSE	27	53	20
The Kenyan government has allowed commercial of gm crops	FALSE	32	51	17
Gm plants are always larger than ordinary plants	FALSE	57	31	12

Source: Author's survey, 2003

A fifth of the respondents were not sure whether their genes could be altered on consumption of GM foods. Only slightly above half (53%) answered correctly that their genes could not be altered on consumption of GM foods, while 27% thought that their genes could be altered. Almost a third (32%) thought that the Kenyan government has allowed commercial growing of GM crops, which is not true.

These results seem to contradict many other studies that found people's knowledge on genetic modification as being quite low, most of which have been done in developed countries. However, it should be noted that these questions were only asked to those aware of genetic modification, or 38% of the sample. Hallman and Aquino (2003) found that in consistency with the fact that few US consumers had heard or read, or discussed much about biotechnology or genetic modification, most of them said they knew very little about these technologies (55%), with only 2% saying they knew a great deal about these technologies. Verdurme and Viaene (2002) used the same format where only the aware respondents were required to complete statements with the same answers. The average knowledge score was 44%, which is lower than the 55% for this study. However, the time difference in which these studies were done may explain the differences. In China, Li et al. (2003) found the following percentages of self-reported knowledge about biotechnology; 54%, 45% and 1% for no knowledge, little and high knowledge respectively.

4.5 Consumers' attitudes on GM technology

Consumer attitudes on GM technology were determined using 5 variables representing perception on benefits, environment risk, health risk, ethical and equity concerns. Attitudes of maize consumers towards GM crops were generally positive, although many had some important concerns, especially on their effect on the environment. Respondents generally had

a positive perception of the benefits of the technology: 73 % agreed and 9% strongly agreed that GM technology increases productivity and offers a solution to the world food problem (Table 6). Giving each response a score (from -1 for strongly disagree to +1 for strongly agree), the scores can be averaged for each question. This statement on productivity has the highest score at 0.38 (if everybody would agree, the score would have been 0.5, and 1 if everybody would have strongly agreed). Similarly, respondents were generally positive about the benefits of GM crops on reducing pesticides on food (72% agreed and 7% strongly agreed, with an average score of 0.37). Averaging the scores over all four questions on perceived benefit gives the Benefits Perception Index (I_{BP}) of 0.36. Consumers also agreed with the statement that genetic modification can create foods with enhanced nutritional value (69% agreed and 9% strongly agreed)

On the negative points respondents agreed most with the environmental risk statements. More than half of the consumers agreed or strongly agreed that GM crops can cause death of untargeted insects (a score of 0.11), and can lead to the loss of original plant varieties (a score of 0.07). However, more than half of the respondents disagreed or strongly disagreed with the general statement that GM threatens the environment (a negative score of -0.09). The index of environmental risk perception is slightly positive (0.03)

On average, less than half of the consumers have strong health risk perceptions. More than one third (those who agreed plus those who strongly agreed) of all consumers had fears on the health effects of consuming GM foods. Over a third (40%) thought that people could suffer allergic reactions after consuming GM foods (score of 0.02) and 35% thought that consumption could lead to an increase in anti-biotic resistance diseases. A larger group (15-

22%) had no opinion on the effect of GM foods on human health, and more people disagreed than agreed, leading to a slightly negative index of health risk perception (-0.02).

On equity and ethical issues, the average concern was not very high and the perception index was negative (-0.10). About half the consumers agreed that GM crops mean tampering with nature and that GM food is artificial. Only 23% thought that GM makers are playing god. On equity issues, 36% thought that GM products are being forced on developing countries while 54% disagreed with this. Less than a third (30%) thought that GM products only benefit multinationals while 65% disagreed. A majority of the people (71%) disagreed with the statement that GM products do not benefit small-scale farmers.

The core of the debate on GM technology is how people perceive benefits and risks associated with it, which will lead to acceptance or rejection of the technology. The urban consumer has strong benefit perception on the technology, not only in addressing farmers' constraints, but also on tangible benefits to the consumer herself. The majority agree on the technology's potential in reducing pesticides in food, creating more nutritious food crops and reducing pesticide residues in the environment. Given this faith in the potential of the technology, it is not surprising to find high acceptance and hence high WTP figures for GM products.

Certain perceptions, however, 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.

In comparing these results with those of Moon and Balasubramanian (2004), the Kenyan urban consumers had higher benefit perceptions than both US and UK consumers. On benefits, 61% and 47% of UK and US consumers respectively agreed that GM technology increases yields (reduction in food shortages), while 63% and 42% respectively agreed that it leads to reduced chemical use in farming. On health risks, the UK consumers have the highest (40%), while US consumers have less than ones found in this study. This is the same case with environmental hazards as the UK consumers have very high perceptions (65%), while the US ones have only 30%. On the image of multinationals as the primary beneficiaries of biotechnology, 71% of UK and 53% of US consumers agree. These are higher than the results of this study.

Table 6. Consumers' perception on GM technology (%)

Perceptions on	Statement	Responses (% of respondents) 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	
	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	I_{BP}=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	
	GM can lead to a loss of original plant varieties	2	39	8	43	8	0.07	I_{ERP}=0.03
	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	
	Consuming gm foods can damage ones health	4	44	15	30	7	-0.04	I_{HRP}= -0.02
	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	
	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	I_{ERBC} = -0.10
	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	

Source: Author's survey, 2003

There were differences in benefit perception by awareness about GM crops. Respondents initially unaware of GM crops had slightly higher benefit perceptions (80-89%) than those initially aware (62-74%). This implies that the information text given to the non-aware respondents may have tilted their benefit perception slightly upwards. Other perceptions did not differ between the initially aware and the unaware respondents.

Attitudes differed by points of sale (Table 7), with supermarket clients having the lowest benefit perception and highest environmental risk perception. Both strongly agree and agree, and strongly disagree and disagree have been combined in this table. There was little difference on benefit perception between clients in the kiosks and posho mills. Supermarket clients had the highest equity and ethical concerns, followed by kiosk clients, and then posho mill clients.

There were small differences in perception by income group, with students and consumers with monthly income higher than KShs. 50,000 having higher environment risk perception than the other groups.

Table 7. Consumers' attitudes by point of sale

Type of perception	Statement	Supermarkets		Kiosk		Posh mill	
		Agree	Disagree	Agree	Disagree	Agree	Disagree
Benefit	GM can reduce pesticides on food	74	12	81	11	81	10
	GM technology increases productivity and offers solution to world food problem	73	21	86	8	84	8
	GM can create foods with enhanced nutritional value	70	21	80	10	83	10
	GM has potential of reducing pesticide residues in the environment	60	19	81	12	76	13
Environment risk	GM can lead to a loss of original plant varieties	62	26	46	45	45	51
	Insect resistant GM crops may cause death of untargeted insects	54	28	49	37	49	40
	GM threatens the environment	39	48	35	54	30	56
Health risk	People could suffer allergic reaction after consuming GM foods	41	40	39	38	41	41
	Consuming GM foods can damage ones health	40	47	38	46	35	51
	Consuming GM foods might lead to an increase in antibiotic-resistant diseases	34	47	40	38	31	44
Ethical concerns	GM food is artificial	57	30	49	43	43	48
	GM is tampering with nature	51	46	51	41	41	50
	GM technology makers are playing god	35	60	19	78	17	76
Equity concerns	GM products are being forced on developing countries by developed countries	45	42	34	58	30	61
	GM products only benefit multinationals making them	44	53	23	71	26	70
	GM products don't benefit small-scale farmers	32	60	20	72	15	79

Source: Author's survey, 2003

4.6 Consumers' willingness to pay for GM maize meal

4.6.1 Consumer characteristics

The double bounded logit model was used in estimating mean WTP and the factors that influence it. The model is known to be more efficient and it adequately addresses the objectives of the study. A total of 581 data cases were used in this section after dropping 23 cases with missing values on the bid questions. Table 8 presents the variables used in the regression.

The mean age of the respondents was 30 years. The number of men was slightly higher than that of women (55% vs. 45%). Most of the respondents had some secondary school level of education and above (79%). Almost three quarters (72%) of them lived in households where there were children below 18 years, and above three quarters (76%) had trust in the government to ensure food quality. In addition to these variables, perception indices were also included in the regression since attitudes are also hypothesized to influence WTP.

Table 8. Consumer characteristics data used in the regression analysis

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

Source: Author's survey, 2003

4.6.2 Consumers' responses to respective bids

Consumers were first asked if they would be willing to buy GM maize meal at the same price as their favourite maize meal brand. Of all consumers, 68% were willing to do so (Table 9). Those who accepted were further asked if they would be willing to pay for GM maize if the price were higher (if they would be willing to pay a premium). The average price of the preferred brand of maize meal was KShs 51 for a 2 kg packet. Different premium levels were assigned randomly to different respondents (5% of the price of their favourite brand, 10%, 20%, 30% or 50%), but they were only offered one second bid. Slightly more than half of those who accepted to pay at the first bid 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, while only 39% of those offered a premium of 50% would be willing to pay. Those who refused the first bid (32%) were offered a discount, again at different percentages (5%, 10%, 20%, 30% or 50%) of the price of their preferred brand. Acceptance to pay at discounts clearly increased with the level of discount. Of those offered a discount of 5%, only 28% were willing to pay, while 56% of those offered a discount of 30% were willing to pay.

Table 9. Consumers' response to bid offers by % of discount or premium

			Percentage of discount or premium					Total No.
First response	%	Second response	5%	10%	20%	30%	50%	
Y	68	Y	74	63	38	50	39	20
		N	26	38	62	50	61	18
N	32	Y	28	35	44	56	41	7
		N	72	65	56	44	59	11
Total No.			106	115	111	110	111	5

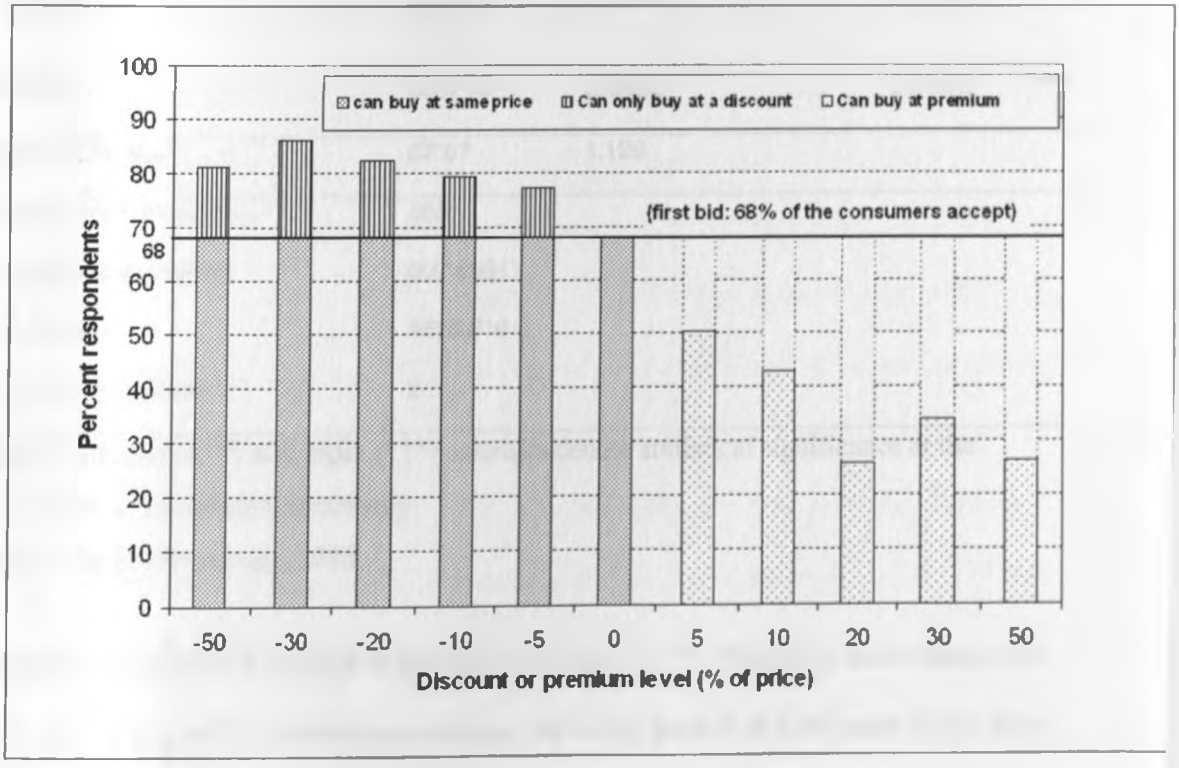
Source: Author's survey, 2003.

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 people willing to pay at different prices (Figure 2). Half of the sample (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% (0.68 x 0.39) of the respondents (last bar in Figure 1). Of those offered a discount of 5%, 28% were willing to pay. Hence, at a discount of 5%, an additional 9% of the sample (0.32 x 0.28) would be willing to pay (first bar on the left of the middle bar in Figure 2). This gives a total of 77% of the sample. At a discount of 50%, a total of 81% of the sample would be willing

to pay ((0.68 + (0.32 x 0.42)). The percentage of those accepting to pay at a discount increases with the percentage, and 41% of those offered a discount of 50% accepted.

As expected, the percentage of people willing to buy at a certain price decreases as the price increases. At the highest discount of 50%, 81% of the respondents are willing to buy, but at 5% discount, 77% are willing to buy. This further reduces to 50% when the price increases to 5% premium and to only 26% at a 50 % premium.

Figure 2: Consumers' willing to buy GM maize meal at different prices (%)



4.6.3 Consumers' mean WTP

Out of a total of 604 data cases, only 553 were used in the estimation of WTP. This was arrived at after dropping 23 cases with missing values on the bid questions and a further 28 cases that had missing values in any explanatory variable used in this analysis. To calculate the mean WTP, the coefficients of the restricted equation without consumer characteristics first need to be estimated (Table 10). The mean WTP can then be calculated as α/ρ (Hanemann et al., 1991).

Table 10. 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			

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

Source: Author's survey, 2003

Consumers' mean WTP for GM maize meal was Kshs.57.97. Therefore, these consumers were willing to pay this amount, on average, for a 2kg packet of GM maize flour. This was a 13.7% premium over non-GM maize meal since the average price for favourite

brand (initial bid) was Kshs. 50.90. This percentage of premium is higher than the level in Figure 2 (where 50% of the population are willing to pay 5% premium on average), since, more consumers in the higher income groups are willing to pay a premium, and they buy at more expensive places.

The confidence interval for mean WTP was estimated using the bootstrapping method with Nlogit procedure in Limdep. The standard error of the mean WTP is 1.129 so the 95% confidence interval is KShs 55.75 - 60.18.

The attained mean WTP is different from those of many studies, most of which have been done in the developed world with consumers only willing to buy GM products at discounts. However, similar studies on consumer acceptance of GM crops in the developing world have found that consumers are willing to pay more for GM products than their counterparts in the developed world. Li et al. (2003) found that Beijing consumers were willing to pay a 16.3% premium for GM soya bean oil and 38% premium for GM rice. Curtis (2003) found out that Chinese consumers were willing to pay on average 35% premiums for GM processed potato products. Curtis et al (2004) sought to find the motivations for positive consumer attitudes towards GM foods in developing nations. They concluded that the generally positive perception towards genetically modified foods in developing nations stems from more urgent needs in terms of food availability and nutritional content. Additionally, perceived levels of risk may be smaller due to trust in government, positive perceptions of science, and positive media influences. This is contrary to the smaller benefits and higher perceived risks found in

many developed countries, and hence, the rationale for low or non-acceptance of GM foods in those countries. Since these attitudes translate to WTP, we can expect higher WTP for developing countries.

Like their counterparts in China, Nairobi urban consumers are willing to pay higher prices for GM food. It appears that these consumers have great support for efforts to increase food security, to the extent that they are willing to pay more for GM food, which has been touted as having a great potential in solving food security problems. If this is the case, then this result can be interpreted to mean that Kenyan consumers are highly supportive of measures aimed at increasing food security, even in cases where such measures mean that they have to pay more. This is consistent with their long-run interests of sustained domestic food production, a trend that is observed in other countries. In addition, a high proportion of the respondents (76%) have trust in government to ensure food quality, which would make them more supportive of GM crops with the trust that the government is putting in place the relevant regulatory mechanisms.

Despite these possible reasons, this analysis does not unambiguously explain exactly why the consumers are willing to pay a premium for GM food. It can not be known with clarity whether this reflects their true valuation after careful consideration of benefits and risks, or whether they value the technology's potential in addressing food insecurity, or whether the premium merely stems from a sense of urgency in addressing food availability problems. It is also not clear how valuation would change with increased food access.

Respondents who indicated that they would not buy GM maize meal even at a discounted price were asked to provide reasons for their unwillingness to buy it. Most of them (28%) said that consumption was dangerous to human health, that they feared for health risks or that they were not sure of the side effects of consuming GM foods. Other minor reasons included not being used to the products, brand royalty, GM foods being unnatural, uncertainty of composition, religious concerns and lack of trust in the technology.

4.6.4 Characteristics of consumers' that influence WTP

In order to determine factors that influence WTP, the model was estimated with consumer characteristics hypothesised to influence WTP (Table 11). Variables in table 8 together with perception indices were entered in the model. Socioeconomic variables are however bound to be interrelated. Since the results reveal that supermarket patrons were mostly those with higher income and education levels, and also the formally employed, there was a possibility of multicollinearity in the estimation. Hence partial correlations were done for the variables to determine which ones should be removed from the estimation if any. Following this, employment category dummies were omitted as they were correlated amongst themselves and with income dummies.

Results show that whether consumers were previously aware of GM crops before the survey or not did not influence their WTP. This implies that the information provided to those who were not 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. While health risk perception and ethical and equity concerns had a negative effect on WTP, trust in government had a positive effect. This implies that people who felt that government controls were in place to ensure food quality had a higher WTP for GM maize meal than those who felt otherwise. However, benefit perception on increased food production did not have a significant effect on WTP.

There was no influence of age, gender and the presence of children on WTP. Respondents with some secondary schooling had significantly higher WTP than those with either less or more education. Income influenced WTP positively, with WTP substantially higher in the highest income category (>KShs 50,000). Therefore, all other things remaining constant, respondents with monthly income levels of over Kshs. 50,000 had higher WTP for GM maize meal than those with zero income. People with some secondary as highest level of education had higher WTP for GM maize meal than those with some primary as highest level.

Table 11. Parameter estimates for WTP model with consumer characteristics

	Variable	Estimate	Standard error	p-value	
	Constant	3.270137	0.507703	0.0000	***
	Bid	0.082083	0.004427	0.0000	***
Perceptions	Previous aware about GM crops	0.000089	0.204218	0.9997	
	Benefit perception index	0.151492	0.284214	0.5940	
	Health risk perception index	-0.690108	0.256568	0.0072	***
	Ethical and equity concerns index	-0.640051	0.305191	0.0360	**
	Environment risk perception index	-0.247304	0.283390	0.3828	
	Trust in Government	0.754569	0.202679	0.0002	***
Demographic	Age	-0.002076	0.010702	0.8462	
	Gender	0.065162	0.184512	0.7240	
	Children	0.044625	0.193818	0.8179	
	Secondary	0.615129	0.232254	0.0081	***
	Tertiary	0.238467	0.272092	0.3808	
	University	-0.436035	0.348258	0.2106	
Income	Income 1(0-students)	0.101323	0.325670	0.7567	
	Income 2 (KShs 0 - 15,000)	0.016371	0.236640	0.9446	
	Income 3 (KShs 15,000 - 50,000)	0.313306	0.281690	0.2660	
	Income 4 (over KShs 50,000)	1.682022	0.655032	0.0102	**
Point of sale	Supermarket	1.003895	0.225854	0.0000	***
	Kiosk	0.276675	0.212008	0.1919	
	Number of observations	553			
	Log likelihood function	755.1398			
	Chi squared	1510.28			
	Degrees of freedom	20			

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

Source: Author's survey, 2003

Supermarket patrons had a higher WTP than those in the posho mills. This may be related to earlier results showing that supermarkets are patronized by people who are more educated and have higher monthly incomes compared to the kiosks and posho mills

In consistency with other such studies, cognitive (subjective) variables came out as the main determinants of WTP compared to socio-economic characteristics. As observed by Springer et al (2002), socioeconomic factors by themselves are not sufficient to explain WTP. Risk perceptions influenced WTP while benefit perceptions did not. Moon and Balasubramanian (2004) concurred when they established that risk perception exerts a greater impact on WTP than benefit perception. Concern about food safety comes out as a strong determinant of WTP. McCluskey et al. (2001) also found that consumers who are less concerned about food safety (most likely because they trust their government to ensure it, are more willing to choose GM food products when they are offered.

In this study however, benefit perceptions do not have a significant influence on WTP for GM maize meal. However, the majority (76%) have trust in government to ensure food quality, which has a positive effect on WTP. Since respondents were told that research on GM crops was ongoing, they may express strong support for these efforts to address food insecurity, considering that majority have high trust in government to ensure food quality, and the touted potential of GM crops to address food insecurity. Those with secondary school education (40% of all respondents) are willing to pay more for GM maize meal compared to those with lower or higher education. It is interesting that people with higher levels of education (tertiary and university) were willing to pay less for GM food than

those with some secondary schooling. It is unclear whether it is their higher education that makes them more able to perceive risks, hence willing to pay less for GM.

CHAPTER FIVE: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

The study had the objectives of determining consumer awareness, attitudes and WTP for GM maize meal in Nairobi. This information is important since it is only with consumer acceptance that a region can gain from GM technology. Before GM products are developed for the African market, it is important to determine consumer acceptance of these products. A total of 604 consumer data was collected from three points of sale namely supermarkets, kiosks and posho mills so as to include the views of all categories of consumers. Data was collected using structured questionnaire by 5 adequately trained enumerators in November and December 2003. For the analysis, both descriptive statistics and estimation of a regression were used. The double bounded logit model was estimated using Limdep 8 software in order to determine mean WTP and the factors that influence it.

The results reveal that slightly more than a third (38%) of the respondents were aware of GM crops before the survey and that the media, especially the newspapers, was the major source of information. The better educated and the higher income groups were more aware of GM crops.

Most consumers believe in the technology's positive impacts, with more than 80% agreeing that it increases productivity and offers a solution to the world's food problem. However, consumers are concerned about environmental and health risks, as well as ethical and equity issues. Half of the respondents agree that the technology leads to a loss

of original varieties, and that insect resistant GM crops could have an effect on untargeted insects.

Sixty eight percent (68%) of the respondents would buy GM maize meal at the price of their favourite maize meal brand. On average, Nairobi consumers were willing to pay KShs 58 for a 2kg packet of GM maize, which is a 13.7% premium over average current maize meal prices (KShs 51). Among socio-economic factors, only income and education significantly influence WTP. Subjective elements came 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. Supermarkets patrons are willing to pay more than their counterparts in other points of sale.

5.2 Conclusions

At 38%, awareness about GM crops was high for a developing country, considering that the debate has mostly taken place in the developed world. The media is playing a great role as a source of information implying that it can also be used to further educate the public on GM technology.

Generally, consumers were appreciative of the positive benefits of the technology but were also concerned about the potential negative effects, especially on the environment and on biodiversity. The urban consumer showed strong benefit perception on the technology, not only in addressing farmers' constraints, but also on tangible benefits to

the consumer herself. The majority agree on the technology's potential in reducing pesticides in food, creating more nutritious food crops and reducing pesticide residues in the environment. However, these benefits perceptions did not have a significant effect on WTP.

The fact that 68% of the respondents would buy GM maize meal at the price of their favourite maize meal brand indicates general acceptance of the technology by urban consumers. This is further corroborated by the fact that 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. This is despite the fact that one of the stated benefits of GM foods is reduced consumer prices due to reduced use of inputs (pesticides) by farmers. Kenyan urban consumers seem to express great support to measures that are aimed at addressing food insecurity in the country, even to an extent of being willing to pay a premium for GM food. They appear to be willing to forego one of the benefits (low prices) in order to achieve food security. However, it does not come out clearly from the analysis whether the responses on valuation questions were motivated by lack of access to food or it is the respondents' true valuation of GM maize meal after careful consideration of potential benefits and risks, and whether these valuations might change with increased food availability. As in many other studies on WTP for GM food, subjective elements come out as the main determinants of WTP compared to socio-economic factors. Acceptance however is much more influenced by negative perceptions than positive ones, since the benefit perceptions did not influence WTP. Trust in government to ensure food quality,

secondary school level of education and high income levels have a positive influence on WTP. Those interviewed in supermarkets were willing to pay more for GM foods

5.3 Recommendations

It is important that people be informed about GM technology for them to participate effectively in the debate, since effective participation can only happen when people have factual information on the technology. Therefore, awareness should be monitored regularly, and increased through educative efforts by the government and other stakeholders. Such campaigns can be done through the revealed main sources of information established; newspapers, television, radio, and schools/colleges, and should give people factual information on GM to counter biased campaigns (positive or negative that may be advanced by interested groups.

The urban consumer has shown acceptance to the technology. Therefore 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, but at the same time regulate the playground to ensure that such research is done within biosafety regulations. The government should also invest resources in biotechnology infrastructure and human capital for effective participation and regulation as far as the technology is concerned.

Given the experience of this survey, some methodological improvements can be suggested for future studies. It is important 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, whether their valuations may change with increased food access, , or why they think GM foods can be dangerous for human health or for the environment. This would avoid second guessing on the reasons for their opinions. Future studies should strive to separate the issue of valuation and food access or availability.

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, since although more expensive, they would yield more representative results.

Finally, although CV methods have been widely used in the past, recent studies suggest new methods, in particular experimental auctions where consumers actually participate in an experimental, but still real market.

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APPENDICES

Appendix 1: Loglikelihood functions for the double bounded logit model

a) Without consumer characteristics

```
MINIMIZE;LABELS=A,C;
    START=-5,0.1;
    FCN=-(YES_YES*LOG(1/(1+EXP(-A+C*BID_HIGH)))
    + NO_NO*LOG(1/(1+EXP(A-C*BID_LOW)))
    + YES_NO*LOG(1/(1+EXP(A-C*BID_HIGH))
    -(1/(1+EXP(A-C*BID_INTL))))
    + NO_YES*LOG(1/(1+EXP(A-C*BID_INTL))
    -(1/(1+EXP(A-C*BID_LOW)))))$
```

b) With consumer characteristics

```
MINIMIZE;LABELS=A,C,d,e,f,g,h,i,j,l,m,o,t,u,v,w,y,z,r,k;
    START=-5,0.1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0;

    FCN=list=d*AW02_GM+e*BP_INDX+f*ERP_INDX+g*HRP_INDX+h*ERC
    _INDX+i*GENDER+j*AGE+l*SECNDRY+m*TERTRY+o*UNIVRSTY+t*INC
    0_ST+u*INC0_15+v*INC15_50+w*INC_OV50+y*CHLDRN+z*GOVT+r*P
    T_KIOSK+k*PT_SPMKT
    |-(YES_YES*LOG(1/(1+EXP(-A+C*BID_HIGH-list)))
    + NO_NO*LOG(1/(1+EXP(A-C*BID_LOW+list)))
    + YES_NO*LOG(1/(1+EXP(A-C*BID_HIGH+list))
    -(1/(1+EXP(A-C*BID_INTL+list))))
    + NO_YES*LOG(1/(1+EXP(A-C*BID_INTL+list))
    -(1/(1+EXP(A-C*BID_LOW+list)))))$
```

Appendix 2: Questionnaire

(Type A (b) as the information text has benefits first)

A (b) **STUDY INSTRUMENT**

CONSUMER AWARENESS, ATTITUDES AND WILLINGNESS TO PAY FOR GM FOODS IN KENYA: THE CASE OF MAIZE MEAL IN NAIROBI

Place_____ Date_____ Time_____

Point of sale _____

Questionnaire number_____

Enumerator name_____

Percentage of discount or premium_____

Introduction

(Appropriate greetings) My name is _____ and I am carrying out a survey on behalf of a student at Kabete campus, University of Nairobi on consumer preference for different types of maize meal. I would like to ask you some questions that will take a few minutes.

Part 1: Awareness and knowledge about biotechnology and GMOs.

1.1.Have you ever heard or read something about biotechnology?

(1) Yes (2) No *(circle the response)*

1.2. Have you ever heard or read something about genetically modified (GM) crops?

(1) Yes (2) No *(circle the response)*

(If yes go to question 1.3 below. If no, tell the person; I will explain to you what GM crops are and then ask you some questions about them, which may take an extra few minutes. ***If the person agrees, then give the information text in Part 2) and continue with the rest of the questionnaire. If the person says he/she is in a hurry, then give the short questionnaire on part 4 alone).***

1.3.Where did you hear or read from? _____

1.4.Indicate whether you have heard/read of the following and where you heard/read them from:

a) Bt maize _____(Y/N) Source_____

b) Bt cotton _____(Y/N) Source _____

c) Virus resistant sweet potato _____(Y/N) Source _____

1.5. Complete the following statements with TRUE, FALSE or DON'T KNOW and indicate how certain you are of your answer with: (1) Not sure at all (2) Slightly sure (3) Somewhat sure (4) Sure (5) Very sure

a) Biotechnology refers to all techniques that use living organisms to produce or alter a product, cause changes in plants or animals, or develop microorganisms for specific purposes _____(T/F/DK) Certainty_____(1-5)

b) Crops can be made resistant to certain diseases and pests through genetic modification _____(T/F/DK) Certainty_____(1-5)

c) Genetically modified crops refer to crops into which foreign genes have been inserted _____(T/F/DK) Certainty_____(1-5)

d) GM plants are always larger than ordinary plants _____(T/F/DK) Certainty_____(1-5)

e) It is not possible to transfer bacteria genes into plants _____(T/F/DK) Certainty_____(1-5)

f) Genetic modification is also used in medicine _____(T/F/DK) Certainty_____(1-5)

g) Ordinary food does not contain genes_____(T/F/DK) Certainty_____(1-5)

h) The Kenyan government has allowed growing of GM crops in confined greenhouses for research purposes _____(T/F/DK) Certainty_____(1-5)

i) The Kenyan government has allowed commercial growing of GM crops_____(T/F/DK) Certainty_____(1-5)

j) A person's genes can be altered/changed after eating GM foods _____ (T/F/DK) Certainty_____(1-5)

k) The United States government has allowed commercial growing of GM crops _____(T/F/DK) Certainty_____(1-5)

Part 2: Information text (*Only for respondents unaware of GM crops*)

a) Transgenic crops (generally referred to as Genetically Modified Crops)

Transgenic crops contain genes that have been artificially inserted by scientists instead of the plant acquiring them from pollination. The inserted gene may come from plants of the same species, another unrelated plant, or from other organisms such as bacteria.

b) Why GM crops are made

Traditional breeding takes a long time to achieve desired results and frequently fails. GM technology enables scientists to bring useful genes from a wide range of living sources to a crop plant, not just from within the plant species or from closely related plants. This allows scientists to generate superior plant varieties quickly and with precision, and add traits that are not possible through conventional breeding.

c) Traits that are the targets of the plant breeders

Traits targeted by plant breeders for genetic modification include plant characteristics such as increased yields, disease resistance and pest resistance; plus consumption traits such as food colour, size, shape, nutrition and taste.

d) Kenya's position on this research

Kenya Agricultural Research Institute (KARI) together with international research organizations is undertaking research on GM maize and sweet potato. This is aimed at developing insect resistant maize (Bt maize) and virus resistant sweet potato. Insect resistant maize will enable the maize plant to protect itself against insects (in particular stem borers) by producing its own insecticide.

e) Current and potential benefits of GM crops

The use of GM crops has resulted in significant benefits where these crops are grown. These are

1. Higher yielding crops that address food shortages,
2. Reduced losses from insect pests and diseases,
3. Reduced pesticide costs,
4. Reduced pesticide residues in the environment,
5. Lower food prices for the consumers because of lower production costs,
6. Ability of plants to grow in harsh and stressful conditions,
7. Reduced toxic health effect on farmers.

Future GM crops will have traits that will benefit consumers. Their potential benefits include

1. Nutritionally enriched foods that help alleviate malnutrition,
2. Edible vaccines for children diseases (e.g., polio) in food crops and fruits,
3. Foods that stays fresh for longer periods.

f) Potential risks and perceived concerns about GM crops

1. The danger of unintentionally introducing allergic substances or toxins to foods,
2. The possibility of these genes escaping from cultivated crops into wild relatives,
3. The possibility that transgenic crops carrying antibiotic genes will generate antibiotic resistance in livestock and humans after eating food from these crops,
4. The potential for pests to develop resistance to the pesticide produced by GM crops,
5. The risk of substances from these crops affecting non-target and beneficial insects.

g) Bio safety measures

Generally after genetic modification, seeds are tested to ensure their safety for human consumption. Then plants are tested in a special biosafety green house to check their effectiveness such as insect resistance. If these trials proceed without problems, the authorities may give permission for trials on test plots in quarantine stations. If these trials go well, scientists may seek permission to try the varieties on the farm. After successful trials for several years, authorities can grant permission to commercialize and sell these varieties to farmers.

h) Countries that are currently growing GM crops

Most GM crops are grown in the developed countries especially the United States of America and Canada. Some developing countries, such as China and India, have adopted the technology. In Africa, commercial growing is taking place in South Africa only. These crops have, however, not generally been accepted in Europe. Kenya is not growing them commercially but is doing research in order to develop insect-resistant maize and virus-resistant sweet potato.

i) Examples of GM crops that are being grown commercially in these countries

The leading GM crops grown in the world are soybean (herbicide resistant), maize and cotton (both insect and herbicide resistant).

Part 3: Attitudes toward GM crops

Indicate your agreement or disagreement to the following statements with: (1) Strongly disagree (2) Disagree (3) Neutral (don't know) (4) Agree (5) Strongly Agree

Benefit Perception (BP)

3.1. Use of GM technology in food production increases productivity and offers a solution to the world food problem_____

3.2. GM technology has the potential of creating foods with enhanced nutritional value_____

3.3. GM technology has potential of reducing pesticide residues on food_____

3.4. GM technology has potential of reducing pesticide residues in the environment _____

Environment Risk Perception (ERP)

3.5. The use of GM technology in food production threatens the environment_____

3.6. Genetic modification can lead to a loss of original plant varieties_____

3.7. Insect resistant GM crops may cause death of untargeted insects_____

Health Risk Perception (HRP)

3.8. Consuming GM foods can damage ones health _____

3.9. People could suffer allergic reactions after consuming GM foods _____

3.10. Consuming GM foods might lead to an increase in antibiotic-resistant diseases in human beings_____

Ethical/Religious/Economic Concerns (EREC)

3.11. Genetic modification is tampering with nature_____

3.12. GM technology-makers are imitating God_____

3.13. GM products only benefit multinational companies that make them_____

3.14. GM products do not benefit small-scale farmers_____

3.15. GM products are being forced on developing countries by developed countries _____

3.16. GM food is artificial_____

Part 4:Demographic/Socio-economic information

4.1. Gender: (1) Male (2) Female *(circle the response)*

4.2. Estate of residence_____

4.3. Age in years_____

4.4. Are you married? : (1) Married (2) Single (3) Other _____ *(circle)*

4.5. Position in the household (1) Head (2) Member_____ (3) Househelp

4.6. If Househelp where do you consume most of your meals?

1. At home 2. With employer

4.7. Highest level of education attained: 1. None 2. Primary 3. Secondary

4. Tertiary college 5. University

4.8. Number of people in the household you are living in _____

4.9. Presence of children below 18 years at home living with you 1. Yes 2. No

4.10. Religious affiliation: 1. Atheist 2. Christian 3. Moslem 4.Buddhist 5. Traditional 6. Other_____

4.11. Race: 1. White 2. African: Tribe_____ 3. Indian 4. Other_____

4.12. Who does most food purchases in your household? 1. Me 2. Somebody else

4.13. Employment status: 1. Formally employed 2. Self employed 3. Unemployed 4. Student 5. Other _____

4.14. Profession_____

4.15. Income level per month: 1.None 2. Lower (≤ Kshs.15, 000) 2. Medium (Kshs. 15,001 - 50,000) 3. Upper (≥Kshs. 50,001)

Part 5: Maize Consumption

5.1. Is maize important in your daily diet? _____ (Y/N) *(if no go to part 6 below)*

5.2. How do you normally eat it during these meals (1.Ugali 2. Githeri 3. Porridge 4. Not applicable 5. Other _____)

- Breakfast _____ or _____, _____
- Lunch_____ or _____, _____
- Dinner_____ or _____, _____

5.3. In which forms do you mostly buy maize? (1) Grains (2) Grains to be milled in posho mills (3) Maize meal from posho mills (4) Sifted and prepackaged maize meal (5) Sifted and prepackaged maize meal fortified with nutrients and vitamins *(circle response)*

If more than one, rank the 3 most preferred maize forms

1_____

2_____

3_____

5.4. Why do you prefer this form? (1) Price (2) Time saving (3) Cleanliness

(4) Nutrient quality (5) Other_____ *(circle response)*

5.5. Where do you usually buy maize meal? _____

(5.6. below is for supermarkets and kiosks/shops alone)

5. 6. Which brand of maize flour do you prefer? (1) Hostess (2) Pembe (3) Jogoo (4) Jogoo Extra (5) Ugali (6) Pendana (7) Shujaa (8) Ndovu (9) Soko (10)Annapurna (11) Other_____ (12) Not applicable *(circle response)*

If more than one, rank the three most preferred maize meal brands

1_____ Reason _____

2_____ Reason _____

3_____ Reason _____

(5.7 to 5.10 below are for posho mills alone)

5.7. Which type of milling do you prefer? (1) Grade 1 (2) Ordinary

(3) Muthokoi (4) Other _____ *(circle the response)*

If more than one, rank the three most preferred milling types

1_____ Reason _____

2_____ Reason _____

3_____ Reason _____

5.8. How do you usually acquire maize meal? (1) Takes own grain for milling (2) Buys grain from posho mill and mills there (3) Buys already milled maize flour from posho mill *(circle response)*

5.9. If (1), how do you usually obtain your maize grains? (1) From own farm

(2) Buying (3) Other _____ *(circle response)*

5.10. Do you buy the prepared mixtures for making porridge? _____ (Y/N)

If yes, rank the three most preferred mixture types and the reason

1. _____ Reason _____

2. _____ Reason _____

3. _____ Reason _____

5.11.How important to you are the following in choosing maize meal? 1. Not important 2. Slightly Important 3. Medium 4. Important 5. Very important

- Taste_____
- Price_____
- Brand_____
- Color_____
- Smell_____
- Freshness_____
- Texture_____
- Nutritional value _____
- Packaging _____
- Other_____ _____

5.12. Do you think government controls are in place to ensure food quality? _____(Y/N) If No, why: _____

_____

Part 6: Stated Choice Experiments

6.1. GM maize meal (Note: For all respondents)

Discount or premium %_____

(Price of respondents favorite brand in Kshs_____)

a) Scientists in Kenya are doing research to develop GM maize that is resistant to maize stem borer. Would you be willing to purchase maize meal made from this maize if it were offered at the same price as your favorite brand? 1. Yes (go to b) 2. No (go to c)

(For b and c below, obtain the correct percentage and tell respondent in terms of Kshs)

b) Would you be willing to buy this maize meal if it were offered at a price of Kshs_____ *(% premium)* (1) Yes (2) No *(circle response)*

c) Would you be willing to buy this maize meal if it were offered at a price of Kshs_____ *(% discount)* (1) Yes (2) No (go to d) *(circle response)*

d) Why aren't you willing to buy GM maize meal at a lower price?

_____

_____

_____