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Assessment of Kenyan public perception on genetic engineering of food crops and their products

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ABSTRACT

Objectives: To assess public perceptions towards Genetically Modified (GM) Crops and foods in Kenya. Specifically, to: (1) find out Kenyans' level of awareness and knowledge of GM crops and foods; (2) find out the attitudes of Kenyans' towards GM crops and foods in relation to their demographics (age, gender, educational qualifications and their agro-ecological regions and (3) give suitable recommendations from the findings on the future of GM crops/foods in Kenya.

Methodology and Results: A survey was carried out in Kenya covering all the country's 8 provinces between November 2007 and June 2008, targeting the adult civilian population (aged 18 years or older). The objective was to attain a sample size of over 700 subjects so as to achieve a sampling error rate of ±3.7 percent. Four clusters were set to ensure a balanced representation of all stakeholders in the country; A (general consumers), B (farmers), C (academia), D (resource persons). In addition, efforts were made to ensure that the sample drawn for this study was representative of the Kenyan population through Simple Random Sampling, Systematic Sampling, Convenient and Snowball Sampling as was appropriate. The data was obtained via self completion questionnaires. Specifically, the survey instrument was designed to gather information on the public's general awareness, knowledge and attitudes on various issues pertaining to the use of genetic engineering on crops and food production, public approval of the use of genetic engineering and public views about various private, foreign and public institutions associated with biotechnology research and product development. The survey also sought some information on the respondent's economic demographic and value attributes, including respondent's views about scientists, companies and government regulators associated with genetic engineering products. The response/cooperation rate was 68%. Overall, 58%, of the respondents had positive perceptions and believed that genetic engineering of crops would alleviate hunger and malnutrition and reduce poverty in Kenya.

Conclusions and recommendations: Results of the study indicate that acceptance of genetically engineered food crops is related not only to the public's demographic characteristics but also to their value attributes. Younger people were generally more optimistic about GM crops/ foods. However, female respondents were clearly less supportive of GM crops/ foods than were their male counterparts. More-educated individuals and those with higher levels of scientific knowledge were more optimistic about introduction of GM crops and foods in Kenya. The results suggest the need for a well designed and effective program to educate the public about various issues relating to the use of genetic engineering in agricultural and food production. Scientists need to communicate with the public at large with complete information and in a proactive way. In order to enhance public trust, all interested parties, including those opposed to GM foods, should be

involved in the decision making process surrounding the issues or concerns associated with genetic engineering.

Key words: Biotechnology, genetic engineering, genetically modified crops, Kenya, perceptions.

INTRODUCTION

A large number of genetically modified crops and foods have been developed to address hunger and malnutrition. These include maize and cotton cultivars modified with the *Bacillus thuringiensis* gene for insect resistance (FAO, 2008), herbicide tolerant canola and soybean (FAO, 2008 and Rowe 2004), and "Golden rice" that has increased Vitamin A content (Bonny, 2003 and WFP, 2004). However, persistent controversy and claims that these products may be wanting and harmful to humanity and the environment has created considerable concern. Public perception of biotechnology/genetic engineering/genetically modified organisms (GMOs) has been thoroughly investigated in industrialized countries (Loureiro and Bugbee, 2005 and Eurobarometer 2002). However, not much is known about public attitudes to GM technology in developing countries.

Most people in developing countries are hardly informed about the advent of GMOs and probably more concerned about risks in everyday life rather than potential long-term hazards of new technologies. The few countries in the developing world that have chosen to embrace the technology have welcomed the benefits it has offered. This research study aimed at extending the knowledge base that currently exists in the field of GM technology in Kenya, which is still in its infancy stage. It was expected that the findings of this study would impact positively on current debate and policy direction regarding the future development of transgenic crops and foods in Kenya. This research also aimed to expand the general knowledge of GM crops and foods and their perception in Kenya. It was also anticipated that conclusions and recommendations of this research would complement other work done on GM crops in the country.

A rich body of literature regarding consumer perceptions of genetic modification has emerged in recent years. The present study contributes to the existing knowledge by extending the understanding of how risk/benefit perceptions differ across agro-ecological regions, age groups, academic qualifications and gender. This knowledge will aid government agencies in developing new or revising existing crop and food policies as they make more informed and effective decisions on genetic engineering and agriculture

MATERIALS AND METHODS

Research design: A cross-sectional survey design was used for this study. Participants (N=702) drawn from the country's 8 provinces were administered with a self-completion questionnaire from which quantitative and qualitative data on individual perceptions on GM crops and foods was generated.

Inclusion and exclusion criteria: Adult Kenyans (aged ≥ 18 years), literate and who had some knowledge of Genetically Modified Organisms (GMOs) were sampled. For convenience of analysis, the respondents were divided into 4 perception groups, Cluster 1 (group A) mainly consisted of consumers in general including NGOs, churches (religious organizations), businessmen, government departments and agents. Cluster 2 comprised chiefly of farmers sampled from the 3 Agro-ecological regions; High potential regions including Central Province, parts of Eastern, Rift Valley, some areas of Nyanza and Western Province; Medium potential areas- most of Eastern Province, Coast, Rift Valley and North Nyanza; Low potential areas- all the parts of North Eastern Province, parts of Eastern and Rift Valley; Cluster 3 contained predominantly representatives from academia-students, teachers, lecturers and other scholars. Cluster 4 is the smallest perception group and contains mainly resources persons /scientists from academic, government and private research institutions and representatives from producer organizations knowledgeable in GM work for scientific and technological advice or opinion.

Instrumentation: This research study utilized a self-completion questionnaire to collect data. In this case, lists of questions on itemized scale were presented to the respondents. Respondents were asked if, according to their opinion different statements on risks and benefits of GM crops are true or false and to indicate on a table if they agree, disagree or do not know. The questionnaire had 3 main sections. The first section consisted of personal information including sex, age, occupation and awareness of GM crops or food. The next two sections were used to examine public perceptions of GM crops and food in general. In addition to perceptions of GM crops and foods, these sections were aimed at capturing possible shifts in public sensibilities, awareness and knowledge of risk issues in relation to GM crops and foods. The sections also contained questions specifically designed to measure risks and benefits associated with GM crops and food. The additional open-ended questions in the third section referred more widely to attitudes to GM crops and foods, ethical and moral as well as economical and political issues, besides peoples' views and understanding of the value and impact of the global GM debate. The statements were positively or negatively worded regarding the potential risks and benefits of GM crops and food. The specific questions and summarized demographic variables are captured in Appendix A and B respectively.

RESULTS AND DISCUSSION

Gender and Perception of Genetic Modification Technology: Consumers' personal attributes have significant influence on their views about various Genetic Modification issues. Although there is broad support for crop biotechnology for health benefits, opinions differ on the issue of animal genetics for pure economic benefits Fischhoff, B. and I. Fischhoff. (2002).

Table 1: Respondents Gender and Perception towards GM crops and foods

Perception	Gender		
	Male (%)	Female (%)	Average
Positive	68	47	58
Negative	17	29	23
Neither	15	25	19
Total	100	100	100

An average of 58% of the respondents had a positive perception of Genetic Modification (Table 1). These comprised of 68% of the sampled male population and 47% of the females. Only 17% male were negative towards GM crops and foods but a higher number of females (29%) had a negative perception, possibly because men dominate the fields of science and technology in developing countries as opposed to women who often shy away from these fields or are culturally disadvantaged from tribal customs. An average of 19% of the respondents were undecided, of whom, 24% were female and 15% males. Drawing from previous studies, men have been found to have more positive attitudes to science and technology than women (Hoban, 2004). Females, particularly from developing countries are generally less interested, less knowledgeable and less supportive of science and technology than males (www.agbioworld.org.2002).

A further analysis was done on gender perception (negative or positive) towards genetic engineering of crops and foods using Chi-square statistic. To prevent type 1 error Yate's correction (-0.5) was applied.

With (d.f. =1, X^2 at 0.05 level of confidence =3.841) for the nominal variables of gender and perception towards GM crops and food one finds a significant relationship (X^2 = 13.46) between gender and perception towards GM crops and foods. These results indicate that a significant divergence exists between men and women regarding their opinions about genetic modification of crops and foods. Kendal's tau-c is an appropriate measure of association, for this test, based on the number of concordant and discordant pairs, and with correction for ties, Kendal's tau-c also will indicate the direction of the relationship as it assumes values between -1 and +1, and a value of 0 denotes a complete absence of association, while -1 denotes a perfect decreasing relationship and +1 a perfect increasing relationship. In this case, the value of Kendal's tau-c is 0.207 which is a small positive, but a significant measure of association (i.e. a modest presence of association) indicating that an individual's gender could be associated with his/her perception of

GM technology. These results are consistent with similar studies done in the US over the past seven years (IFIC, 2002). Females were clearly less supportive of genetic modification of crops and foods than their male counterparts, probably because they are less interested, "less knowledgeable and less supportive of science and technology" (Hossain et al, 2002).

Educational Levels and perceptions on GM crops and foods: Both opponents and proponents of GM technology argue that one of their goals is to educate the public so that they can make informed decisions. While opponents generally focus on educating people about the risks of the technology, proponents focus on the benefits. Yet when public education is considered as an objective, neither group has been decidedly successful (Aerni, 2001). Against this background the current study hypothesized that public perceptions on GM crops and food may be influenced by an individual's education and knowledge level. The responses are summarized in Table 2.

Table 2: Respondents' education and perception towards genetically modified crops and foods.

Perception	Academic qualification			
	Primary	Secondary	Tertiary	Average
Positive	33[a]	57	83	58
Negative	39	28	4	23
Neither	28	15	13	19
Total	100	100	100	100

[a] =values are %

A large number of respondents (83%) who have some tertiary level of education were positive towards GM crops and foods compared to 4% with negative feelings and 13% who were undecided (Table 2). Respondents with secondary level of education had 57% with a positive perception, 28% against and 15% undecided about GM crops and foods. Of the respondents with primary level of education only 33% had positive perception of GM crops and foods. It is clear that the level of education influences attitudes to science and technology (www.gmwatch.org 2008). This is aptly captured in the relationship between educational qualifications and perception towards GM crops and food using Chi-square statistic. Chi-square statistic test at 2 d.f. and 0.05 level of confidence was performed giving X^2=42, which indicates a very significant relationship between genetic modification of crops and public perceptions. The tabular X^2 is 5.99, much lower than the calculated value. It is therefore interpreted that respondents/individuals with higher educational qualifications tend to have a positive perception towards GM crops and foods, and vice versa. To determine the strength of association in this relationship, Cramer's V statistic was performed; the V test is an appropriate measure of association with values ranging from 0 for no association, to 1 for perfect positive association. In this study, Cramer's V was 0.73, which is very close to 1. This further confirms a strong relationship between education of a respondent and perception towards GM crops and foods.

This differential acceptance of GM crops and foods (on education and knowledge) can be attributed to the different ways in which individuals process information about genetic engineering. While more educated individuals carefully weigh potential benefits and risks before making a decision, less educated individuals form their attitudes based on "sound bites" heard on TV or at work, or based on positions of opinion formers in society (Wohl, 1998). These findings are consistent with that of Moon and Balasubramanian (2004), showing that public acceptance of GM products is significantly related not only to the perceptions of risks and benefits, but also to the level of an individual's education and knowledge.

Age of respondents and perceptions on GM crops and foods: Public perceptions of GM technology have multiple dimensions and are likely to be influenced by multiple forces, preferences and events (Barker and Burnham, 2001). An individual's age is likely to affect their perceptions and hence acceptance of GM food products (Kim, 2001). The results of the analysis are given in Table 3. The table shows that young respondents (18-26 years old i.e young adults, the youth in senior high school or college or those who have just completed school waiting to get employment) had a higher positive perception (65%), compared to 57% (aged 27-55 years i.e the working class), and 51%

for respondents older than 56 years. The results indicate that the more senior one becomes in age, the more negative he/she is likely to be towards GE. Most of these senior citizens are retired public or private personnel who are often less interested in new technologies and are reluctant to change, hence are often ignored in decision making.

Table 3: Age of respondents and perception towards genetically modified crops and foods.

	Age bracket			
Perception	18-26	27-55	≥ 56	Mean
Positive	65[a]	57	51	58
Negative	18	24	27	23
Neither	17	19	22	19
Total	100	100	100	100

[a] = values are %

Chi-square statistic test was done to validate the preliminary findings on the relationship between individual respondents' age and perception towards GM crops and foods. The analysis yielded a Chi-square test (X^2 = 14.36 at 2 d.f, level of confidence at 95%; tabulated X^2 = 3.842), which confirmed that a significant relationship exists between age of respondent and perception towards GM crops and foods. To test the strength of the association, between the two variables, Kruskal's gamma statistic proofed useful as it is suited to computations of the same coefficient value regardless of the independent variable and its measures vary from -1 to +1 (for negative or positive relationships; (Gamma = – 0.210).

Since Gamma is negative, slightly below 0 (-0.210) the relationship is negative, indicating that an increase in age leads to negative perception towards GM crops and foods. This can be explained by the fact that young people are more receptive to new technologies, than older ones (Sraughan, 1991).There is therefore considerable evidence to indicate that younger people are more supportive of the use of GM technology in food production. Similar results were reported by Grimsrud et al (2000) in a study in Nordic countries. Additionally, perceived levels of risk by the younger respondents may be smaller due to their trust in government institutions, positive perceptions of science and positive media influences. This is contrary to the smaller benefits and higher perceived risks among the elderly people and hence the rationale for low or non-acceptance of GM crops and foods.

Perception of GM crops and foods in different agro-ecological regions: Public attitude on genetic modification of crops and food may depend significantly on an individual's geographical area of residence (Loader and Henson, 2000) Compared to their more urban compatriots, members of the public in less developed areas of China have more optimistic attitudes, perceive more benefits and are more risk tolerant in relation to GM foods and agricultural biotechnology (AFIC, 2002). This study collected data on farmers' perceptions of GM crops and foods from three agro-ecological zones in the country. These were the high potential, medium potential and low potential areas. The findings are summarized in Table 4.

Table 4: Respondents' perception on GM crops and foods per agro - ecological zone.

	Perception					
Ecological area	Positive		Negative		Neither	
High potential	46[a]	39	37	32	34	29
Medium Potential	67	57	33	28	17	15
Low Potential	86	74	13	11	18	16

[a] = value is frequency %.

Respondents in high potential regions (areas with high rainfall, fertile soils and good infrastructure) were more negative towards GM crops and foods than those from medium and low potential regions (arid / semi arid

areas with poor soils). This maybe explained by the fact that people in high potential regions usually have enough food, as they receive more reliable rainfall and rarely experience famine, thus do not perceive the need for GM crops, compared to individuals in arid and semi arid regions who often require food aid.

The relationship between an individual respondent's agro-ecological zone and perception to GM crops and food was further analyzed by Chi-square test. Chi-square statistic at 2 d.f, and 0.05 level of confidence was 6.98 which are lower than the tabulated value of 5.991. This outcome show that the response of an individual is not independent of his / her agro-ecological zone i.e. people's perception to GM crops and food depend on their agro-ecological region. To determine the strength of the association between the respondent's agro-ecological zone and perception to GM crops and foods, Kendall's Tau – C was performed.

Tau – C = (P + Q)* $2M/N^2$ (M-1), where

M=the number of rows or columns, whichever is smaller; N=the sample size; P=concordant pairs and Q=discordant pairs.

The calculated Tau C = 0.67, which indicates a fairly strong association between an individual's perception and ecological region. It is interpreted therefore that the generally positive perception towards GM crops and foods by respondents from low and medium potential regions stems from more urgent needs in terms of food availability and nutritional content. People in these regions urgently need food to survive irrespective of the source/origin.

CONCLUSION and RECOMMENDATION

Results of the study indicate that public acceptance of food crops genetically engineered is related not only to their demographic characteristics but also to their value attributes. Although a number of surveys have been undertaken in the industrialized countries, (involving between 500 – 1,500 respondents per country) to measure public perceptions, attitudes and levels of understanding on specific controversial GE issues such as GM crops and foods, little or none have been done in Kenya. In addition, none of these surveys reviewed had taken into consideration the agro – ecological aspect on assessing public opinions on GM crops or foods. While most of Europe remains negative to Genetic Engineering of crops and foods, the US leads industrialized countries in support of GMOs. Overall, people in the developing countries tend to be quite supportive of GM crops and foods. The present study contributed to this growing body of literature by assessing the understanding of how risk/benefit perceptions differ across agro-ecological regions, individual ages, academic qualifications and gender in Kenya. This will aid government agencies in revising crop and food policies to better make informed and effective decisions on Genetic Engineering in agricultural and food production in Kenya. The results suggest the need for a well designed and effective program to educate the public about various issues relating to the use of genetic engineering in agricultural and food production using various media in schools, villages, market places, and provincial administration by scientifically credible people. The present study therefore provides a baseline to be used for comparison to future repeat of similar surveys. While this study / survey do not claim to be faultless, it is recognized that it is a positive step towards building a comprehensive, reliable data set on GE on public perceptions in Kenya.

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APPENDIX A

QUESTIONNAIRE

ASSESSMENT OF KENYAN PUBLIC PERCEPTION ON GENETIC ENGINEERING OF FOOD CROPS AND THEIR PRODUCTS

BACKGROUND:

Genetic modification (GM) refers to all modern techniques in cellular and molecular biology used to alter the genetic composition of crops or foods including in vitro nucleic acid, recombinant DNA (rDNA) and genetic engineering. GM is different from traditional breeding techniques in three principal ways: (i) It reduces the random nature of classical breeding; (ii) It accomplishes the desired results much more quickly and predictably; and (iii) It makes it possible to cross the species barrier. GM crops have provided producers with opportunities to lower production costs, enhance crop production, and increase profits by using inputs more efficiently. However, there are concerns over health, environment and long term unknown risks that have generated a furious debate which have led to the abandonment of some GM products. The purpose of the survey is to determine your perception regarding the GM of crops and foods and their introduction in Kenya.

SECTION A:

DEMOGRAPHIC INFORMATION

Your sex Male Female

Occupation _____ Highest educational qualification _____.

Are you aware of GMOs (Genetically modified crops, foods)?

Yes ☐ No ☐

SECTION B:

Perception 1: Benefits

Statement	Yes (Agree)	No (Disagree)	Don't know
Genetically modified crops (GMCs) will increase yields and offer a solution to Kenya's food problem			
Genetically modified crops will reduce pesticides on food			
Genetically modified crops have the potential of reducing pesticides residue in the environment			
Genetically modified crops should be legalized in Kenya and farmers allowed to grow them immediately			

Perception 2: Environmental Risk

Statement	Yes (Agree)	No (Disagree)	Don't know
Genetically modified crops that are insect resistant may cause death of useful insects / non pests and other non – targeted insects e.g. bees, even birds.			
Genetic modification of crops can threaten the environment, besides poisoning wildlife.			

Genetic modification of crops can lead to loss of original plant species and biodiversity reduction.			

Perception 3: Environmental Risk

Statement	Yes (Agree)	No (Disagree)	Don't know
Genetically modified crops can lead to allergenicity (allergies) from food in people.			
Foods from genetically modified crops can damage people's health.			
Eating of foods from genetically modified crops may lead to human and animal disease that are antibiotic resistant.			

Perception 4: Ethical / Moral Concerns

Statement	Yes (Agree)	No (Disagree)	Don't know
Food from genetically modified crops is artificial.			
Genetically modification of crops is interfering / tampering with nature.			
Genetic modification of crop plants is an act of "Playing God".			

Perception 5: Equity / Economic Concerns / Other

Statement	Yes (Agree)	No (Disagree)	Don't know
Genetically modified crops, foods are being forced to African countries by US and other allied countries for their own benefit.			
Genetically modified crops, foods only benefit multinational companies that make them.			
Crops genetically engineered don't benefit small – scale farmers peasants.			
Kenya should take time to test, study do enough research on genetically modified crops before they are released to farmers and consumers.			
If you or your relative / friend develop diabetes, would you accept to use genetically modified insulin drug for treatment?			
If there is famine in Kenya and there is hunger, would you accept to eat genetically modified food from US or South Africa or you'd rather die of hunger than eat them?			
If a vaccine for AIDS or Malaria were developed would you use it, if it were genetically modified?			
A composite vegetable has been produced through genetic manipulation. It provides a balanced diet. Would you prefer to grow it or grow maize, beans, groundnuts and carrots separately to make a meal?			
78% of Kenya is arid / semi arid. A strain of beans which is drought resistant has been produced through genetic manipulation and is intended for introduction to arid / semi arid areas. Would you recommend the introduction?			
In your view, should research in the improvement of crops and livestock through genetic manipulation with the aim of achieving Kenya's goal of food security be legalized?			

Do you know of any diseases (s) that have been contracted by eating GM foods? If yes which ones...
……
Any other information / comment you may wish to add here on genetically modified crops, foods for Kenyan? _____

Thank you for your understanding and co – operation.

APPENDIX B

TABLES OF RESPONDENTS VALUE ATTRIBUTES

Table 5a: Respondents numbers per gender

	Gender		
	Male	Female	Total
Frequency	442	260	702
%	63	37	100

Table 5b: Number of respondents per educational level

	Educational level			
	Primary	Secondary	Tertiary	Total
Frequency	98	253	351	702
%	14	36	50	100

Table 5c: Number of respondents per age-group

	Age-group(years)			
	18-26	27-55	55>	Total
Frequency	246	386	70	702
%	35	55	10	100

Table 5d: Number of respondents per agro-ecological zone

	Agro-Ecological zone			
	High potential	Medium Potential	Low Potential	Total
Frequency	234	234	234	702
%	33.33	33.33	33.33	100