



## Public perception of genetic engineering and the choice to purchase genetically modified food in Jamaica

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### Abstract

Since the release of the first genetically modified (GM) crop into the marketplace in the 1990's, there has been continuing debate over the acceptability of such products. Today, GM crops are extensively grown in Argentina, Canada and the United States. However, these crops have not made similar inroads into Europe or Japan where regulations governing GM crops and food products are more restrictive. Moreover, a highly precautionary approach to food safety and environmental protection is promoted in these regions. International pressures including the precautionary tone of the 2000 Biosafety Protocol governing transboundary movements of GM crops and media campaigns out of Europe appear to have influenced the adoption of preventative or precautionary policies which are restricting, if not prohibiting, the availability of GM crops to farmers in several developing countries. Studies in developed countries suggest that acceptance of GM crops and food products is influenced by awareness and knowledge of the technology and confidence in the food system and regulatory bodies. With such studies limited in developing countries, this paper presents the results of a survey conducted on public perception of genetic engineering and GM products in Jamaica. In this developing country, a National Biosafety Committee was established in 1997 and regulatory guidelines for the release of genetically modified organisms drafted in 2000; the importation of GM crops is approved for research purposes only and there is no commercial importation or plantings of GM crops. Survey data were analysed using summary statistics and a logistic model framework was used to investigate the relationship between consumer's willingness to buy GM product on one hand and (1) knowledge of genetic engineering, (2) awareness of regulatory bodies, (3) perception of GM foods, and (4) demographic characteristics on the other. Our findings suggest that the Jamaican consumer is fairly knowledgeable of the technology and overwhelmingly supports mandatory labeling of GM products. Safety of GM crops and food products remains a major concern for the consumer and the perception of the prospects for genetic engineering to improve the quality of life represents a major factor in a consumer's decision to purchase GM products.

**Key words:** Genetic engineering, genetically modified organisms, genetically modified food, public perception, awareness, choice to purchase, Jamaica, National Biosafety Committee, consumers, logit model, ordered logit model, national policy.

### Introduction

Recent advances in biotechnology involving the genetic manipulation of crop plants have resulted in the development of new plant varieties that resist pests, diseases and herbicides. These plants, referred to as genetically modified organisms (GMOs) or transgenic plants are presently being grown on some 90 million hectares<sup>1</sup>; representing over 35-fold increase in acreage devoted to GM crops between 1996 and 2002<sup>2</sup>. Fewer projects have focused on the development of transgenic livestock. Projects in the pipeline include pigs engineered for increased sow milk production resulting in faster growing, healthier piglets, cattle capable of resisting mastitis infection and transgenic fish with enhanced growth characteristics<sup>3-5</sup>.

In general, the technology offers opportunities to complement traditional techniques and improve the agricultural systems in developing countries where crop yields are significantly lower than in developed countries because of pests, diseases, soil problems and climatic conditions. While the technology shows potential for solving various productivity problems in agriculture, it also carries with it new concerns. Among these concerns are the

introduction of new allergens into the food supply chain and the ecological as well as genetic effects on populations in the environment. Overall awareness and acceptance of genetic engineering is high among American consumers<sup>6</sup> but there appears to be considerable skepticism among the general public in Europe despite a positive perception of science held by the European society<sup>7</sup>. In developing countries, various surveys have documented public opinion of GM products in Brazil, Mexico, The Philippines and Zambia, and studies of consumers' willingness to buy GM products have been carried out in China and Colombia. These surveys have reported public opinions ranging from low public awareness in Zambia<sup>8</sup> and requests for a ban on the use and commercialization of GM crops in Brazil<sup>9</sup> to optimism about biotechnology and acceptance of the technology where conventional methods are not applicable in The Philippines and Mexico<sup>10</sup> but with the awareness and concerns for the requirement of safe guards in these two countries. When it comes to purchase decision, consumers in China were on average willing to pay as much as 38% more for GM rice compared to the non-GM

alternative<sup>11</sup> while 66% of respondents in a survey of consumers in Colombia were willing to try GM foods<sup>12</sup>. These diverse findings do not support a generally positive perception towards GM foods in developing countries as concluded in an earlier study<sup>13</sup>.

Jamaica, a developing country with exceptional biodiversity and rich biological resources, has been involved in biotechnology since the 16th century (that is, the production of rum and vinegar). In recent years, however, researchers at government institutions and universities are being trained and engage in research and developmental activities involving modern biotechnology. A National Biosafety Committee (NBC) was established in 1997 and regulatory guidelines for the release of GMOs drafted in 2000. There is presently no commercial importation or plantings of GM crops; the importation of GM crops is approved by the NBC for research purposes only. In 2001, the NBC launched a public education programme aimed at informing students, teachers, farmers, seed importers and the general consumers about biosafety issues. Two surveys were subsequently carried out to identify any gains in knowledge about biosafety issues between the surveys. Although the outcome of these surveys gave an indication of general increases in level of awareness, there was no application to the drafting of a national policy on GMOs. Along the policy line, a recent study<sup>14</sup> established relationships between consumers' perception and knowledge about GMOs and their disposition to the introduction of GM crops in Jamaica. The study showed that the belief of the relative benefits and risks of GM foods as well as the perception on the availability of GM foods in the domestic market significantly influence consumers' preference for the introduction of GM crops in Jamaica. It was specifically noted that those who believed that the benefits out-weigh the risks were more receptive to the introduction of GM crops. Likewise, those who were of the opinion that GM crops were already in the domestic market were receptive to the introduction of GM crops.

It is interesting that despite the imminent introduction of GM products into the marketplace, there is little information on the perception of the Jamaican public on the technology and its regulation, as well as the acceptability of GM products. This is particularly worrisome given that the United States is at the forefront of the commercialization of GM foods and occupies a dominant trading position with Jamaica. Moreover, research is being conducted in the country as well. Field testing of GM papayas has been in progress since 1998. The transgenic papayas carry genes that confer resistance to *Papaya ringspot virus* which devastated Jamaica's papaya crop in the mid-1990's. The development of transgenic papaya capable of fighting the disease holds promise of reviving the papaya industry<sup>15,16</sup>. Other crops such as pepper and tomato have developed resistance against other plant diseases on the island. This being the case, our study assesses public perception of GM technology in Jamaica and the impact that an individual's perception of the technology might have on his or her decision to purchase GM food items. Recommendations on drafting a national policy, based on the study findings, are discussed.

### Methods

A telephone survey was carried out among 170 individuals randomly selected from the telephone directory in the Kingston Metropolitan Area of Jamaica between May and October 2002. A

structured questionnaire to measure the image and awareness of genetic engineering, levels of acceptance of various GM products and perceived risks and benefits of GM products was administered during this survey. Closed-end and Likert scale questions were used with provision for a "Don't know/not sure" response. Each interview lasted between 15 and 20 minutes.

A key question was included on the questionnaire to ascertain the likelihood that a respondent will purchase produce known to have been developed by genetic engineering. Post-survey evaluation showed that some respondents did not answer this key question. Since this represents a critical variable in our analysis, those individuals who did not provide a response to the question were excluded from the dataset. This resulted in a total of 127 observations suitable for further analyses.

Responses to the Likert scale questions were analyzed using summary statistics in order to assess the level of knowledge and perception of consumers of genetic engineering as well as any convergence or spread in perception among consumers. In addition, an ordered logit model was specified to predict the probability that an individual, given his or her characteristics, knowledge and perception of genetic engineering, will be willing to buy GM farm produce. This model assumes that, in making such a decision or commitment, an individual derives a utility ranking ( $y^*$ ), which is unobserved, and that the individual will be willing to buy genetically modified farm produce if his or her utility from doing so surpasses a threshold level. If it does, we then observe a highly likely-type response; otherwise we observe a hardly likely-type response. This model is stated as:

$$Y_i = \beta_0 + \beta_1 AGE_i + \beta_2 NBC_i + \beta_3 GENDER_i + \beta_4 LABEL_i + \beta_5 RELIG_i + \beta_6 EDU_i + \beta_7 EDD_i + \beta_8 EFFECT_i + \varepsilon_i \quad (1)$$

The definitions of the model variables are given in Table 1. The  $\beta$ 's represent model coefficients,  $\varepsilon$  is a random error term, and the index  $i$  represents an individual respondent.

In an ordered dependent variable specification of Equation 1, the observed dependent variable  $Y_i$  is determined as follows:

$$Y_i = \begin{cases} 0 & \text{if } y_i^* \leq \gamma_1 \\ 1 & \text{if } \gamma_1 < y_i^* \leq \gamma_2 \\ 2 & \text{if } \gamma_2 < y_i^* \leq \gamma_3 \\ 3 & \text{if } \gamma_3 < y_i^* \end{cases} \quad (2)$$

where  $\gamma_m$ 's are threshold values used to distinguish among ordered preferences. By specifying a logistic distribution for  $\varepsilon_i$ , the particular model becomes an ordered logit model. To complement the ordered logit model described above, a binary dependent variable or logit model was also specified. The only difference between the two models is the definition of the  $Y$  variable. In order to generate a binary dependent variable for the logit model,  $Y_i$  is redefined to have a value of 1 for those respondents answering 'very likely' or 'somewhat likely' and to have a value of zero for those answering 'hardly likely' or 'not at all' to the question defining the  $Y$  variable in Table 1.

After estimating the ordered logit and logit models, the estimated coefficients for both models were then used to forecast the probability that a particular respondent will belong to one of the identified preference groups.

**Table 1.** Definition of model variables.

Variable	Definition
Y	How likely would it be for you to buy produce if it had been developed by genetic engineering to taste better or stay fresher for longer periods? Very likely=3, Somewhat likely=2, Hardly likely=1, Not at all=0
AGE	Age of respondent 18-24 yrs=1, 25-29 yrs=2, 30-39yrs=3, 40-49yrs=4, 50-59yrs=5, 60+yrs=6
NBC	Have you ever heard of the National Biosafety Committee in Jamaica? yes=1, no =0
GENDER	Male =1, Female=0
LABEL	Foods produced through genetic engineering should be labeled that it contains biotechnology ingredients. Strongly agree=5, Agree=4, Neutral=3, Disagree=2, Strongly disagree=1
RELIG	Religious affiliation=1, No religious affiliation=0
EDUC	Less than high school=1, High school graduate=2, Some college=3, College/University graduate=4, Postgraduate qualification=5
EDD	Do you approve of scientists using genetic engineering to enhance crop plants to have their own defenses against diseases and pests? yes=1, no=0
EFFECT	What effect do you feel genetic engineering will have on the quality of life? Much better=3, A little better=2, Better in some instances=1, No effect=0, Worse=-1

### Results and Discussion

Results of our data analyses indicate that the respondents were evenly distributed along the gender line with 54% being females. The age distribution shows that respondents were relatively young with a little over three-quarters (78%) being 39 years of age or younger. The respondents were fairly knowledgeable about genetic engineering with only 30% of the sample indicating that they had no idea whatsoever about what genetic engineering is. The level of awareness about genetic engineering was observed to be positively correlated with the level of education. More than 92% of respondents indicated that their first thoughts or image of genetic engineering was that it was unsafe while 42% thought that it was progressive. More than three-quarters of respondents favored the use of genetic engineering to create or enhance new drugs. About 62% of respondents were against the use of genetic engineering to create or enhance the taste of fruits and vegetables. About 59% were in favor of using genetic engineering to create or enhance crop plants to have their own defenses against diseases or pests. In the case of livestock, 69% were against the use of genetic engineering to enhance livestock animals. As for the decision to buy produce developed by genetic engineering, the respondents were fairly uniformly distributed with just less than 25% each indicating that they were “not at all” and “hardly likely” to buy GM produce, respectively. On the other hand, about 30% indicated that they were “somewhat likely” to buy while about 21% indicated that they were “very likely” to buy GM produce. On the effect of genetic engineering on quality of life, 11% of respondents thought genetic engineering would worsen the quality of life and 12% believed it would make the quality of life much better. About 88% of respondents agreed or strongly agreed that strict regulations should be put in place during the development and testing of genetically engineered products. In a similar manner, about 97% of respondents agreed or strongly agreed that foods produced through genetic engineering should be labeled to indicate that it contains GM ingredients.

In evaluating the awareness of and trust in institutions involved in handling GMOs (developing or monitoring use), only 17% of respondents indicated that they have heard of the National Biosafety Committee. About 12% of respondents indicated that they have no confidence in local university scientists on

statements made about genetic engineering compared to 29% indicating that they have a high level of confidence in this group of professionals. In the case of local farmers, 26% of respondents indicated that they have no confidence in them compared to 18% indicating a high level of confidence in them. When asked about their level of confidence in the Jamaican Government, 42% of respondents indicated no confidence in the government compared to 11% indicating high level of confidence in the government.

The ordered logit and logit models were estimated using EVIEWS<sup>17</sup>. The results of the estimated ordered logit model are reported in Table 2 and indicate that the coefficients of AGE, LABEL and RELIG have negative signs while the remaining coefficients have positive signs. A positive sign on a coefficient implies that the probability that a particular respondent will indicate that they are “very likely” to buy GM produce increases as the numeric value of the corresponding variable increases

while the probability that the respondent will choose a “not at all” response decreases, and vice versa for a negative sign. Out of the eight explanatory variables in the model, EDD and EFFECT are statistically significant at the 1% level, EDU at the 5% level and NBC at the 10% level. All the significant variables carry positive coefficients, suggesting that those respondents who support the use of genetic engineering to enhance plants defense against diseases and pests, and who are aware of the NBC are more likely to have a strong preference for purchasing GM produce. Likewise, the higher the level of education of respondents and the more positive their opinions are about the effect of genetic engineering on quality of life, the stronger their likelihood of buying GM produce.

**Table 2.** Parameter estimates of ordered logit model for consumers’ choice to buy genetically modified food in Jamaica.

Variable	Coefficient estimate†	Asymptotic standard error	P-value
AGE	-0.055	0.131	0.676
NBC	0.903*	0.501	0.072
GENDER	0.572	0.354	0.106
LABEL	-0.460	0.309	0.137
RELIG	-0.148	0.543	0.785
EDU	0.315**	0.137	0.022
DD	1.145***	0.366	0.002
EFFECT	0.857***	0.190	0.000
Threshold coefficients			
$\gamma_1$	-0.045	1.667	0.531
$\gamma_2$	0.388	1.667	0.816
$\gamma_3$	2.315	1.670	0.166
Log-Likelihood = -146.579			
Pseudo R <sup>2</sup> = 0.163			
AIC = 2.482			
Sample size = 127			

Note: \*\*\*, \*\*, and \* indicates statistical significance at the 1%, 5% and 10% significance level, respectively. † Eviews does not report a separate constant term from the threshold coefficients.

In order to judge the predictive ability of the ordered logit model, the probability that a respondent will fall into each of the ordered preference groups was calculated and each respondent predicted

to belong to the group for which the model forecast him or her to have the highest probability. The predictions were then compared to the actual responses of the respondents, enabling us to find the prediction accuracy reported in Table 3.

**Table 3.** Prediction accuracy for the ordered logit model.

Ordered preference group	Actual count	Predicted count	Percentage error (%) <sup>a</sup>
Not at all	31	33	6.45
Hardly likely	31	16	-48.39
Somewhat likely	38	59	55.26
Very likely	27	19	-29.63

<sup>a</sup> A negative figure indicates under prediction while a positive figure indicates over prediction.

A glance at the prediction accuracy table shows that apart from the “not at all” preference group, the percentage prediction error is very high, well in excess of 25% and as much as 55%. Additionally, a closer look at the estimated threshold coefficients indicates that none was significant even at 10% level, implying that the ordered grouping may not after all be quite distinctive. This finding could justify the use of a logit model instead wherein only two groups of “likely” and “not likely” to purchase GM produce are identified. The results of this alternative logit model are presented in Table 4. These results, consistent with those of the ordered logit model, show that AGE, LABEL and RELIG have negative coefficients in addition to the constant term. EDD and EFFECT are still statistically significant at the 1% level while the statistical significance of NBC improves from 10% to 5% level. However, EDU has become an insignificant variable. Therefore, as before, the current results suggest that a respondent who supports the use of genetic engineering to enhance plants’ defenses against diseases and pests and who is aware of the NBC is more likely to choose to buy GM produce. Also, the more positive a respondent’s view of the effect of genetic engineering on quality of life is, the more likely he or she is to buy GM produce.

**Table 4.** Parameter estimates of logit model for consumers’ choice to buy genetically modified food in Jamaica.

Variable	Coefficient estimate	Asymptotic standard error	P-value
CONSTANT	-0.712	2.407	0.767
AGE	-0.070	0.171	0.681
NBC	1.297**	0.660	0.049
GENDER	0.453	0.467	0.333
LABEL	-0.326	0.431	0.449
RELIG	-763	0.744	0.305
EDU	0.145	0.176	0.410
DD	1.321***	0.462	0.004
EFFECT	1.356***	0.347	0.000

Log-Likelihood = -62.230

McFadden R<sup>2</sup> = 0.293

AIC = 1.122

Sum of squared error = 21.002

Sample size = 127

Note: \*\*\* and \*\* indicates statistical significance at the 1% and 5% significance level, respectively.

In terms of predictive ability, the logit model performed significantly better compared with the ordered logit model. Table 5 shows the prediction accuracy for the logit model with 43 out of the 62 respondents indicating a “not likely” to purchase preference and 52 out of 65 indicating a “likely” to purchase preference predicted correctly. These figures represent percentage prediction error of 30.65 and 20.00%, respectively. The overall

model also implies a prediction accuracy of 74.8% with the stated purchasing preference of 95 out of 127 respondents predicted correctly.

**Table 5.** Prediction accuracy for the logit model.

Actual group	Predicted group		Total
	Not likely	Likely	
Not likely	43	13	56
Likely	19	52	71
Total	62	65	127
Percentage incorrect (%)	30.65	20.00	25.20

In a nutshell, the level of awareness about issues surrounding genetic engineering and the perceived benefits of this revolutionary technology are the major factors influencing the willingness of Jamaican consumers to buy genetically modified farm produce. This finding emanates from our analyses that show that level of education and knowledge about the National Biosafety Committee are good measures of level of awareness of issues surrounding the GMO debate and both of these variables indicate that the more educated and more aware a respondent is, the more likely the respondent would be willing to buy GM produce. As would be expected, the more strongly a respondent feels that genetic engineering would improve the quality of life, the more likely the respondent is to buy GM produce. Rather surprisingly, demographic and socio characteristics have no significant effect on the Jamaican consumer’s decision to purchase or not to purchase GM produce with age, gender and religion having no statistical significance in our models.

### Conclusions

This paper is focused on a topical issue in food safety; that of consumers’ awareness and perception of GM crops and food products. In as much as little is known about the long-term health and environmental consequences of genetic engineering, consumers are faced with the reality that GM foods are in the market and must choose, when such opportunity exists, between purchasing and not. Many factors impact on the decision to purchase and for this study, the level of knowledge, awareness, and more importantly, the perception of genetic engineering held by the individuals seem to be critical factors. Our results suggest that the Jamaican consumer is fairly knowledgeable of genetic engineering and, similar to previous studies in other regions, there is differential acceptance and approval of the application of the technology to the genetic modification of plants and animals. Overall, the technology is viewed negatively but GM medicine and plant-based genetic modification are less negatively viewed than animal-based modification. More specifically, those who support the use of genetic engineering for the enhancement of plants’ resistance to diseases and pests are more likely to choose to buy GM foods. Our study also points to the fact that age, gender and religious affiliation have no significant impact on the decision to purchase GM foods. Furthermore, respondents have a higher level of confidence in local university scientists than either the local farmers or the government sector on issues relating to GM crops and food products. It would therefore appear that any policy based on the application of the technology to the development and improvement of medicinal products and plant

varieties may be viable and acceptable to the Jamaican society. Also, given the trust in local scientists, their assistance and involvement in the education of the consumer on the technology would be beneficial.

Our findings should, however, be interpreted within the general limitations of the telephone survey method that we have employed. Our sample was also chosen from Kingston Metropolitan Area of Jamaica and may not be representative of the total population of consumers on the island. These notwithstanding, with the ongoing debate on GM foods across the globe, this paper has the potential of generating interesting discussions, not only because it adds to the literature that shows that concerns for safety of GM foods remain a major issue in developing countries, but largely because it provides an empirical basis for why consumers, in a developing country context, may choose to buy or not buy GM products. It also provides an empirical basis for the drafting of a national policy on biotechnology in Jamaica by emphasizing the importance of knowledge and public awareness about this technology on public perception and hence the support, or lack of it, for the adoption of any national policy.

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