RURAL ECONOMY

Genetically Modified Foods: Consumers' Attitudes and Labeling Issues

Michele Veeman and Wiktor Adamowicz

Project Report 04-01
AARI Project #2000D037

Project Report

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Abstract

Consumers' attitudes to genetically modified (GM) food ingredients and their reactions to and preferences for labeling of GM food are topical issues for Canadian food policy and are the subjects of this study. This project included several components. The first of these was an assessment of public attitudes to biotechnology and to GM food based on evidence from polls and other studies. These show increasing awareness and some increase in wariness of GM food, in Canada and elsewhere. In the second component of the project, analysis of survey data on Alberta consumers' preferences for different policy approaches to GM food was undertaken. This analysis indicates a preference by Alberta residents for GM food policy to emphasize the provision of more information to consumers, through labeling, over a policy that would provide for more rigorous inspection; even so, more inspection was favored by many respondents. More regulation that would restrict biotechnology was the least favoured of the three options that were presented to Alberta respondents. In a third component of the project, a case study on individual's attitudes to and preferences for GM ingredients in two selected food items (one of which was a nacho chip and the other of which was bread) was pursued through focus groups that were conducted in Edmonton, Alberta in 2002. This indicated highly varied attitudes and responses to GM food in general and to the selected products in particular. Attitudes to and preferences for environmental and health benefits that might be introduced through biotechnology were explored in these groups. Some 50 percent of focus group respondents indicated a willingness to buy the identified GM products, at a price discount.

The fourth and final component of the project involved two sections of a Canada-wide survey, conducted in early 2003. These components queried respondents' assessments of the importance of various food safety risks and various environmental issues associated with food and agriculture, as well as attitudes to labelling policy. Overall, Canadians tended to see agricultural biotechnology as more of an environmental risk than a food risk and numbers of other food and environmental issues were seen to be more risky by many respondents. However the use of genetic modification/engineering in food production was seen as a very high risk issue by about one-fifth of respondents. Respondents also indicated a strong desire for public involvement in biotechnology policy, voted strongly for mandatory labeling and disagreed that labeling is not needed if the product's quality remains unchanged.

An appreciable majority of respondents expressed a degree of skepticism concerning the use of voluntary labeling. The findings of this project have served as a basis for subsequent more extensive and detailed assessment of Canadian consumers' risk preferences and trade-offs in the context of specific product GM labelling policies.

I. Background

Genetic modification of agricultural plants and animals for human food uses has the potential to be a major source of technical change in agriculture, for example, from reduced farm costs, from introduction of plant/animal disease resistance, less need for purchased chemical inputs, increased hardiness and other sources of improved yields, amongst other effects. The regulatory process for genetically modified foods in North America has focused on whether or not there is a significant detectable difference in the characteristics of foods resulting from the use of the new techniques, rather than focusing on the process by which biotechnological changes have been introduced, as in European regulatory processes for genetically modified agricultural products. Consequently the use of genetically modified canola, soybean and corn has become widespread in foods processed in North America. Concurrently some consumers, together with some food retailers and processors, have become more aware of--and apparently more wary of--foods that include genetically engineered ingredients. This issue is believed to be of more concern in some European populations than in North American populations, but surveys of public attitudes in Canada indicate that genetically engineered foods are emergent public policy issues in Canada as well. As awareness of genetic engineering grows, it is increasingly important to the agriculture and food industries to know consumers' views of the potential risks of genetic engineering. The perceived risks of biotechnology need to be put into an appropriate context by comparing genetic engineering to other food safety concerns (for example, pesticides, bacteria in food, food additives, fat and cholesterol). The project provides information on such risk attitudes, on public attitudes to genetically modified foods, and on preferences relating to policy approaches to biotechnology and food.

II. Objectives

1. To assess apparent levels of public concern associated with genetically engineered foods, as compared to other food safety concerns, based on the assessment of the variety of recent polls on this issue. Issues that need clarification will be identified.

2. To assess major issues that may impinge on consumers' motivation and behaviour, related to alternative labelling policies, based on published literature in business economics and economics that can be related to labelling and consumers' decision making.

3. Based on 1 and 2, to develop a theoretical model of major influences of information, as through labelling, on Canadian/Alberta consumers' attitudes to genetically modified foods.

4. To rigorously analyse, for a selected Alberta food item, specific effects of alternative labelling procedures on consumer's purchase intentions.

5. To relate the information and evidence from 1, 2 and 3 above to potential product labelling and product information strategies that may be available to Alberta's and Canada's agricultural and food industries.

6. To assess current policy and practices for labelling of genetically engineered foods in the light of the preceding analysis.

No deviations from the original design were necessary.

III. Summary of Literature and Previous Studies

An overview paper supported by this project summarises the social landscape of biotechnology from several perspectives including the information from polls and studies by social scientists of public attitudes and consumers' preferences. This stage of the project is summarised in Veeman (2001).

Numerous Canadian polls indicate a high level of interest in issues of food safety and quality. A survey by Environics (1999) found that 35 percent of respondents identified food safety as the food issue of most concern to them. The nutritional value of food was identified by 26 percent of respondents as their food issue of most concern, while eighteen percent identified quality, taste, and appearance as being of greatest concern. Almost half (47 percent) the respondents were "very concerned" about food safety (Environics, 1999). Queried about specific food safety issues, 63 percent of respondents indicated they were "very concerned" about chemical pesticides, 45 percent were "very concerned" about antibiotic use in livestock and 37 percent of respondents indicated they were "very concerned" about genetically engineered foods or biotechnology (Environics, 1999).

Despite expected benefits of agricultural biotechnology, such as reduced pesticide and herbicide use, together with prospects for improved crop quality and increased productivity, numbers of people are doubtful about the new technology. Those opposed to agricultural biotechnology maintain that neither the long-term human health effects from

consuming genetically modified products nor the long-term environmental effects of growing such crops can be known with certainty. Ethical and social questions that have been raised include the right of large trans-national companies to own and alter the genetics of plants or animals and the rights of consumers to be informed and be able to make choices about foods they consume (Griffiths and Barrett, 1997; Veeman, 2001; Einsiedel and Timmermans, 2004). A number of studies have been undertaken to assess consumers' attitudes towards agricultural biotechnology. For example, Hoban and Katic (1998) surveyed American consumers and found men to be more aware of biotechnology, excluding cloning, than women. Men were also found to be more likely to perceive benefits from biotechnology and to express support for the food labelling policy of the United States' regulatory agency, the Food and Drug Administration (FDA). Hoban and Katic concluded that more highly educated respondents were more aware of the general process of agricultural biotechnology and cloning, as well as the benefits of biotechnology, while men and younger respondents appeared to be more willing to buy foods developed through biotechnology (Hoban and Katic 1998).

Numbers of polls have also focused on Canadian consumers' attitudes toward biotechnology. Surveys were undertaken by Einsiedel in 1997 and 2000 to determine if Canadian consumers' attitudes and knowledge of biotechnology had changed during that time period. Einsiedel (2000) found people under 34 years of age, university graduates, and males to be most likely to agree with the statement that "applications of biotechnology should be encouraged". These studies, patterned on European assessments of consumer attitudes undertaken through Eurobarometer surveys, also shed light on how some attitudes vary internationally. An example is the level of trust in government and related organisations, which seems to be much lower in some European countries than in Canada.

Another example of an assessment of Canadians' attitudes to agricultural biotechnology is the National Institute of Nutrition's qualitative study, completed in 1999, that used focus groups to assess consumers' understanding and interpretation of label messages for the voluntary labelling of biotechnologically-derived foods. From these consultations it was concluded that the wording of labelling messages considerably affects the level of consumer understanding; these consumers preferred to be informed through

simple labelling messages; they also wanted labelling messages to be linked to government regulatory approval (National Institute of Nutrition, 1999).

There have been many polls of public attitudes but relatively fewer studies have attempted to analyze the direct effect on consumption decisions of information on the presence of genetically engineered food products. Some earlier studies focused specifically on consumers' preferences relative to the identified use of recombinant Bovine Somatotrophin (rBST) in milk production. For example, in a Canadian study, Kuperis et al (1999) found a reduced probability of milk purchase if this was to be identified to be from cows treated with rBST. Wang et al (1997) found that individuals with lower education levels tended to be willing to pay less for rBST-free milk. Similarly, consumers in an urban county of the United States were concluded to be willing to pay more for rBST-free milk than people in more rural counties, while consumers with higher income tended to be more willing to pay for rBST-free milk.

Increasing public interest in information on food quality, such as encompassed in labelling of foods derived from agricultural biotechnology, has also stimulated some recent studies of specific labelling policies. These include an assessment by Lusk and Fox of consumer demand for mandatory labelling of beef from cattle administered growth hormones or fed genetically modified corn. This study used data derived from a contingent valuation mail survey to assess willingness to pay for these policies (Lusk and Fox, 2002).

Studies of risk perceptions related to food safety constitute another body of literature that is relevant to this project. A study of consumers' attitudes towards food safety in the United States by Lin (1995) found that individual's age and gender may have a significant effect on attitudes to food safety. Older consumers tended to be more concerned about food safety than younger consumers. Women were observed to be more concerned about food safety than men. Lin (1995) also found households with young children to be more concerned about food safety. The results of the study by Kuperis et al (1999) on consumers' perceptions of rBST-treated milk also indicated that age, gender, the number of years of education completed by the respondent and the number of children in the household under the age of six had significant effects on consumers' risk perceptions and stated choices.

IV. Analysis of Consumer Preferences for GM Labelling

Overview

This particular component of the project formed the MSc thesis research project of Diane McCann. Extensions of the thesis research are included in a paper authored by Diane McCann, Michele Veeman, Wiktor Adamowicz and Wuyang Hu (currently under review by a peer-reviewed journal). This study used data on choices of selected policy options that were collected through a randomly-solicited sample telephone survey of Alberta residents conducted in the time period between January 5 and February 8, 2000. The policy options considered were to: a) follow a more restrictive regulatory policy that would limit the production, processing or marketing of food that contains products of biotechnology; b) increase food inspection: or c) provide information on food labels that give more information about agricultural biotechnology. These types of policy options currently apply for food and more emphasis on them as means to achieve higher levels of food safety and quality has been discussed, both in popular literature on food biotechnology, and in expert assessments, such as the Royal Society of Canada's Panel Report on food biotechnology (Royal Society, 2001).

Conditional and mixed logit models were developed and applied to assess the influence of socio-economic characteristics of respondents on their stated choices of particular policy options. Estimates of consumers' median willingness to pay for the selected policy options were calculated based on the results of these models. These give a general indication of respondents' preferences for the three identified biotechnology policies.

The approach used in this component of the project differed from previous studies of the potential consumer response to agricultural biotechnology which tended to focus on the trade-off between product price and the identification of the use of biotechnology for a particular food product. In contrast, in this study, consumers were asked to make trade-offs between specified types of regulatory policies relative to agricultural biotechnology and the higher levels of food costs that could be associated with the provision of higher levels of assurance of food quality from the application of these policies. Selection of the particular policies for assessment is based on the fact that each has been widely discussed in the context of regulatory policies for agricultural biotechnology. For example, the report of the Royal Society of Canada expert panel on agricultural biotechnology recommended more rigorous

assessment of risks in the regulatory procedures for genetically engineered food products. Amongst numbers of related specific recommendations of the panel there is a recommendation on monitoring and considerable discussion of labelling (Royal Society, 2001).

The Data on Policy Preferences

The Population Research Laboratory of the University of Alberta was commissioned to collect the data that are the basis of this part of the project as part of an annual survey of the population of Alberta; this survey is structured to be representative of Alberta's population. The survey was conducted by means of telephone interviews between January 5, 2000 and February 8, 2000. Initial contact was made with 2,235 Albertans. Following call backs, the final sample included information from 1,203 interviews, for a response rate of 53.8 percent.

Socio-economic data includes, for each respondent, age, gender, years of education, marital status, household income, location of residence and the number of children in the household. Descriptive statistics, based on the final sample of 1,203 respondents, indicate 603 male and 600 female respondents. The average age of respondents was 42. The average household income of respondents was between $50,000 and $54,999. Respondents had completed an average of 14.5 years of schooling. The sample can be considered to be representative of Alberta's population; the indexes of dissimilarity for the total sample demonstrate that this adequately reflects the population from which it is drawn (Dennis, 2000).

The Policy Preference Choices

Each respondent was provided with the following definition of agricultural biotechnology:

"Agricultural biotechnology refers to biological methods that use living organisms, like cells, or parts of them (genes), to make changes in plants or animals so that crop and livestock production can be increased."

Each respondent was also presented with two hypothetical situations (scenarios) relative to policy options for agricultural biotechnology. The focus of scenario one was to assess respondents' preference for a policy that would place regulatory restrictions on the

production, processing or marketing of food, versus a policy that would increase food inspection. In scenario two, the focus was on assessment of preferences for a policy that would regulatory place restrictions on the production, processing or marketing of food, versus a policy for developing a "labelling system for food that gives information on the effects of agricultural biotechnology". In each case there were cost consequences of the policy choice, with the result of higher food prices. In each case respondents could choose not to apply the policy and for food prices to remain unchanged. The purpose of the questions was to determine whether respondents would choose a particular policy option as a means to achieve higher levels of food quality assurance, despite the increased food costs that would be expected from the policy, and to assess which policy option they would prefer.

Scenario One

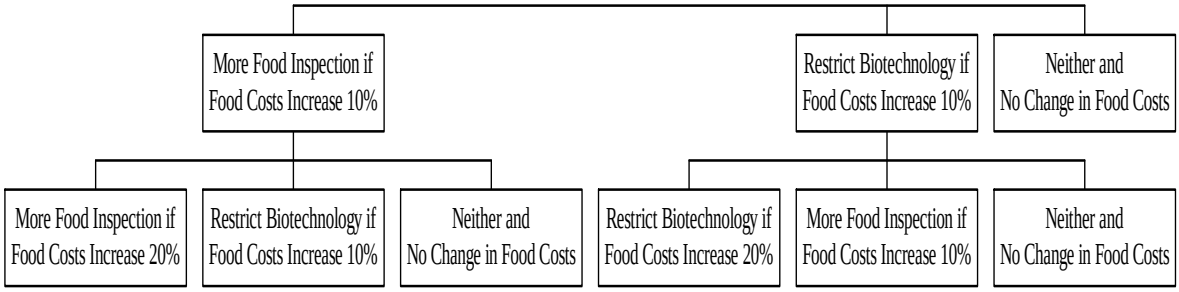
In the first hypothetical situation, respondents were told that food costs would increase if food inspection was increased or if the use of agricultural biotechnology was limited through regulation. Specific questions related to this scenario were as follows:

1. "Now suppose each of these (increasing food inspection and limiting the use of agricultural biotechnology) will lead to a 10 % increase in food prices. If you HAD to choose, would you choose more food inspection, limiting the use of agricultural biotechnology or not restricting either and keeping food prices at current levels?
2. Suppose that increasing food inspection leads to a 20% increase in food costs and restricting agricultural biotechnology leads to a 10% increase in food costs. Which would you choose, more food inspection, limiting agricultural biotechnology or no change and keeping food prices at current levels?
3. Suppose that restricting agricultural biotechnology leads to a 20% increase in food costs and more food inspection leads to a 10% increase in food costs. Which would you choose, increased food inspection, limiting agricultural biotechnology or no change and keeping food prices at current levels?"

All respondents were asked question one. Respondents choosing more food inspection over limiting agricultural biotechnology were then asked question two.

Respondents choosing to limit agricultural biotechnology through regulation in response to question one were then asked question three. Respondents who chose "neither" in response to question one were not asked the second or third questions. A summary of possible responses to the questions is presented in Figure 1. The responses to these three questions composed one set of the discrete choice data used to test econometric models of respondents' choices.

Figure 1: Possible Responses to the Policy Preference Questions in Scenario One



Scenario Two

In the second scenario, a set of questions was applied which relate to the situation in which food costs would increase if a labelling system for food to give more information on the effects of agricultural biotechnology was developed. Again the comparison policy would limit the use of agricultural biotechnology through regulation. The wording of these questions follows:

4. "Now suppose each of these (developing labelling systems and limiting agricultural biotechnology) will lead to a 10 percent increase in food prices. If you HAD to choose, would you choose more food labelling, limiting the use of agricultural biotechnology or not restricting either and keeping food prices at current levels?

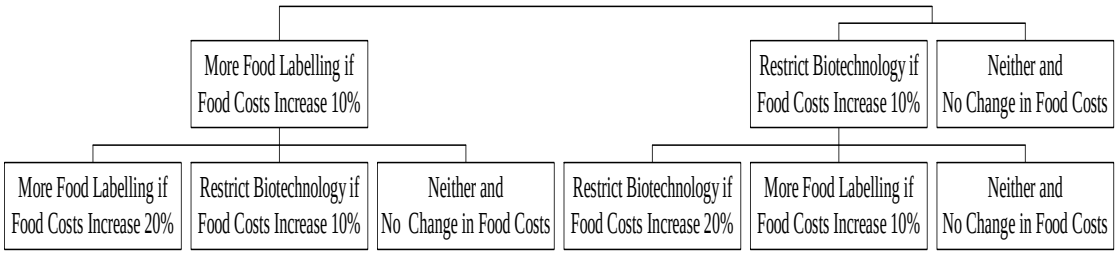
5. Suppose that the labelling requirements lead to a 20 percent in food costs and restricting agricultural biotechnology leads to a 10 percent increase in food costs. Which would you choose, labelling requirements, limiting agricultural biotechnology or no change and keeping food prices at current levels?

6. Suppose that restricting agricultural biotechnology leads to a 20 percent increase in food costs while labelling requirements leads to a 10 percent increase in food costs. Which would you choose, increased food inspection, limiting agricultural biotechnology or no change and keeping food prices at current levels?"

Again, all respondents were asked the first of these questions. Respondents choosing the policy of more food labelling were also asked question five. Respondents choosing to limit agricultural biotechnology through regulation were asked question six. Respondents who chose "neither" in response to the first of this set of questions were not asked the last two of these questions. A summary of the possible responses to this set of policy preference questions is presented in Figure 2. The responses to these questions compose the second set of the data used to test the specified econometric models of respondents' choices.

In each of the two scenarios, the responses indicate respondents' willingness to make a trade-off between paying increased food costs for a higher level of food quality assurance through the specified policy options. The respondents' preferences for the particular policy options and their willingness to pay for the particular policies in terms of higher food costs are reflected in their choices.

Figure 2: Possible Responses to the Policy Preference Questions in Scenario Two



The policy preference questions outlined above approach, but are not a full double-bounded dichotomous choice framework. In a typical double-bounded framework, respondents are involved in two rounds of bidding. Individuals respond to the first dollar amount presented in the first question and then face a second question involving another dollar amount, higher or lower, depending on their response to the first question (Hanemann

et al, 1991). However, in the set of policy preference questions for this study, in the second round of bidding respondents were only given an opportunity to pay a higher amount for the policy option. For example, respondents willing to pay an additional 10 percent for food if biotechnology was to be restricted were then asked if they were willing to make a bigger trade-off, in terms of even higher food costs, to retain the same policy. Unlike the full double-bounded framework, respondents were not provided with an opportunity to pay a lower amount for that policy option. The questions within each of the two scenarios are structured; in view of the complexity of that structuring and the resources available for the survey, the order of presentation of the two scenarios was not randomised across respondents.

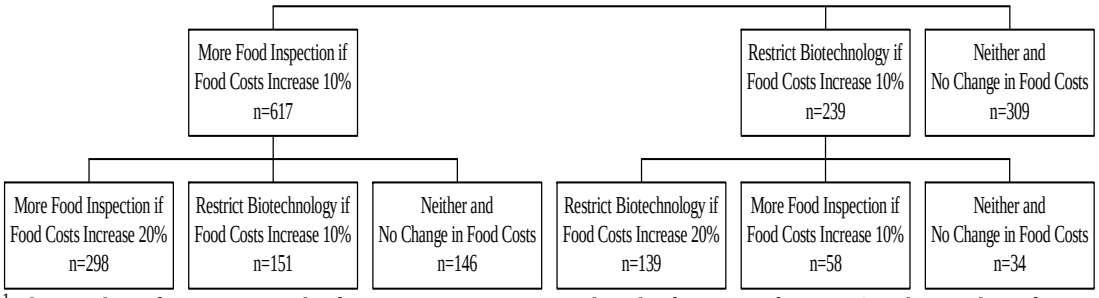
The Responses to the Policy Preference Questions

The numbers of responses to each of the policy preference choice questions in scenarios one and two are presented in Figures 3 and 4. Respondents who answered either "don't know" or gave no response to these questions are excluded from the tables, from the data set and from the econometric estimation that is reported in the paper.

Figure 3 illustrates that in the first scenario a higher percentage of respondents chose food inspection rather than restricting biotechnology or neither of these options. When food inspection increased food costs by 20 percent, almost 50 percent of the respondents that initially chose more food inspection continued to choose inspection over the other two options. When limiting agricultural biotechnology increased food costs by 20 percent, the majority of respondents that initially chose to limit agricultural biotechnology continued to choose this policy option over the other two policy options.

Figure 4 illustrates the numbers of responses in the second scenario and indicates that a larger percentage of respondents chose more food labelling rather than restricting biotechnology or neither option. Of the 600 respondents who chose "more food labelling" in

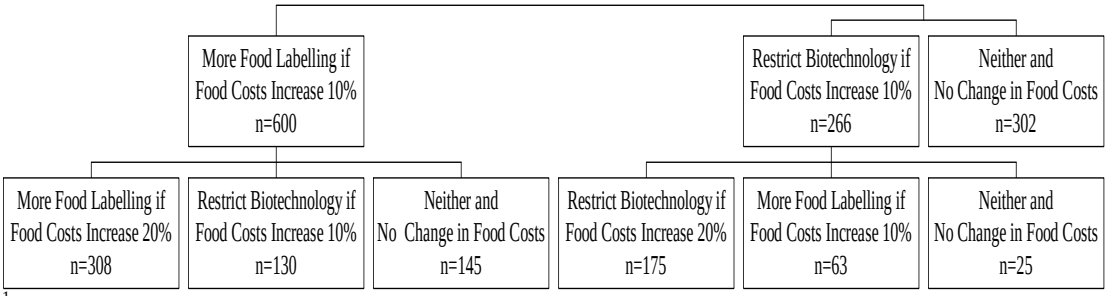
Figure 3: Respondents' Choices of Policy Options to Increase Food Inspection, Limit Use of Agricultural Biotechnology or Neither[1]



[1] The number of responses to the first question are presented in the first row of Figure 3. The number of responses to the second question are presented in the first three boxes in the second row of Figure 3 and the number of responses to the third question are presented in the last three boxes in the second row.

response to question four, 308 respondents continued to choose this option, even when food costs were expected to increase by 20 percent. However in the situation where more information provided by food labelling would increase food costs by 20 percent, compared to only 10 percent for more restrictive regulations (i.e., relative to question six), 130 respondents chose the less costly option of restricting agricultural biotechnology, while 145 respondents would prefer neither of these two policy changes, but chose to keep food prices at the current level. Of the respondents who chose "limit agricultural biotechnology" in response to question four, 175 respondents would continue to choose to limit agricultural biotechnology even when food costs increased by 20 percent.

Figure 4: Respondents' Choice to Develop a Labelling System, Limit Use of Agricultural of Biotechnology or No Change in Either[1]



[1] The number of responses to the first question are presented in the first row of Figure 4. The number of responses to the second question are presented in the first three boxes in the second row of Figure 4 and the number of responses to the third question are presented in the last three boxes in the second row.

Theoretical Approach

It is a basic tenet of the theory of consumer behaviour that consumers purchase goods and services to maximize their utility, subject to their budget constraints. It can be expected that individuals will also prefer and vote for, where appropriate, policy initiatives that will maximize their utility. Discrete choice theory recognizes that consumers often choose among discrete alternatives, as in many purchase decisions or in choosing alternative policies. The number of alternatives presented in the discrete choice set must be finite and the set of alternatives must include all possible alternatives (Train 1986). These requirements permit the consumption/choice of one or more of the goods/alternatives to be zero. Random utility theory suggests a utility function for consumer n choosing alternative i as:

$$U_{ni} = V_{ni} + e_{ni} \qquad (1)$$

where V_{ni} represents the systematic portion of the utility and the stochastic term e_{ni} reflects the errors of observation and measurement from the analyst's point of view. It is often assumed that the stochastic term is identically and independently distributed (Ben-Akiva and Lerman, 1985).

The choice of a policy alternative is assumed to be based on constrained utility maximization, as reflected in the indirect utility functions represented by V_{ni}:

$$V_{ni} = \alpha' A + \beta COST + \gamma' W_n \qquad (2)$$

where $A[A_1, A_2]$ is a set of alternative specific constants (ASCs) capturing the difference in utility between policy alternative i and the base case, which is no policy. In scenario one, A_1 would be one when the policy alternative is "restrict biotechnology" and A_2 would be one if the policy alternative is "more inspection". Similarly, in scenario two, A_1 and A_2 would be one when the policy alternative is "restrict biotechnology" and "more labelling" respectively. Parameters β and γ are coefficients to be estimated. Variable COST is an alternative-specific variable which changes across the different policy options, while W_n is a vector of individual-specific characteristics, such as age, gender, income, and other factors. If the stochastic e_{ni} in (1) is Gumbel distributed, the probability of individual n choosing alternative i can be expressed in a conditional logit format:

$$P_{ni} = e^{\alpha' A + \beta COST + \gamma W_n^i} \Big/ \sum_j^J e^{\alpha' A + \beta COST + \gamma W_n^j} \qquad (3)$$

where J is the total number of alternatives. Since variables in W_n only vary across individuals but not alternatives, for the model to be identifiable, these variables have to be interacted with ASCs and we rewrite this vector as W_n^i.

In this study, when choosing between policy alternatives that involve increasing food costs, consumers' varying ages, incomes, education and other factors reflect their heterogeneities in tastes. However, taste heterogeneities may also exist in consumers' evaluation of alternative specific attributes, that is, in their evaluation of the cost of a policy alternative and their perceptions overall of the policy represented by an ASC. A conditional logit (CL) model, such as specified in (3) cannot reveal these heterogeneities. Conditional logit models also suffer from independence of irrelevant alternatives. Following Train (1998), we therefore adopt, as a second estimation approach, a mixed logit (ML) specification to relax these restrictions. In this approach, α_i is specified as a random variable that is normally distributed across the sampled respondents following a normal density function $f(\alpha)$ with mean α_{i0} and standard deviation $\sigma_{\alpha_i}{}^i$. The choice probability becomes:

$$P'_{ni} = \int P_{ni} f(\alpha) d\alpha \qquad (4)$$

Simulation can be used to evaluate this probability function and the corresponding log-likelihood function. For properties of the simulated maximum likelihood estimator, readers are referred to Lee (1992).

Economic theory, together with information from previous studies and literature on consumers' perceptions of food safety, biotechnology, labelling, and *a priori* reasoning, indicated the importance of socio-economic factors that may influence respondents' preferences for policies relative to food biotechnology for which data were collected. Hoban and Katic (1998), Kuperis et al (1999), Einsiedel (2000), Wang et al (1997) and the study of attitudes to food safety by Lin (1995) suggest the possible importance of age, household income, gender, marital status, years of schooling, number of children in the household, and location of residence as potential factors of importance in explaining individual's choices. The variables used in the final model are defined in Table 1.

Table 1: Socio-economic Variable Descriptions

Variable Name	Variable Description
RESTRICT BIOTECH	Alternative-specific constant representing the utility associated with the respondent's choice to restrict agricultural biotechnology.
INSPECT	Alternative-specific constant representing the utility associated with the respondent's choice of more food inspection.
LABEL	Alternative-specific constant representing the utility associated with the respondent's choice to have more information from food labelling.
COST	Represents the postulated increase in food costs associated with a particular policy option.
AGE	A continuous variable representing the reported age of the respondent.
CHILD	A dummy variable indicating children under the age of 18 in the household, where 1 is indicates at least one child, 0 indicates no children in the household.
EDUC	A continuous variable representing the number of years of education completed by the respondent.
INCOME	A continuous variable representing the total household income before taxes.
MALE	A dummy variable reflecting the respondent's gender, where 1 is indicates male, 0 female.
MARR	A dummy variable reflecting the respondent's marital status, where 1 indicates married or common-law, 0 represents single, divorced, separated or widowed.
URBAN	A dummy variable classifying the respondent's place of residence, where 1 is indicates city or town, 0 indicates village or rural area.

Labelling Preference: Results and Discussion

For the model estimations, non-responses to questions of income (295 instances), age (15 instances), years of schooling (2 instances), and numbers of children in the household (3 instances) were replaced with the respective medians of the reported values. The median of the reported value for income is $57,500. The median of reported age is 40 years, the median years of schooling is 14 years, and the median number of children in the household is zero children. Non-responses to questions about marital status (8 incidences) and location of residence (2 incidences), were omitted from the data set as were "don't know" and non-responses to the policy preference questions presented in scenario one and scenario two.

The CL and ML estimation results for Models I (choices under scenario one) and II (scenario two choices) are presented in Table 2. The variables listed below each ASC, (ie following RESTRICT BIOTECH, INSPECT, and LABEL) refer in each instance to the interaction terms between the ASC and the listed socioeconomic and demographic variables. For example, the estimated coefficient for the variable AGE in Model I under the CL specification is 0.006. This is the estimated coefficient for the interaction between the

Table 2: Results of Model Estimations for Scenario One (Model I) and Scenario Two (Model II)

Model I				Model II		
	Conditional Logit	Mixed Logit			Conditional Logit	Mixed Logit
Variable	**Coefficient (t statistic)**	**Coefficient (t statistic)**		**Variable**	**Coefficient (t statistic)**	**Coefficient (t statistic)**
RESTRICT BIOTECH	0.489 (1.522)	0.283 (0.688)		**RESTRICT BIOTECH**	-0.203 (-0.638)	-0.872 (-1.656)
Standard Deviation	-	1.364** (3.392)		Standard Deviation	-	1.931** (3.903)
AGE	0.006 (1.789)	0.007 (1.717)		AGE	0.004 (1.116)	0.005 (1.013)
INCOME	0.001 (0.741)	0.001 (0.629)		INCOME	0.006** (3.212)	0.008** (2.962)
MALE	-0.620** (-6.342)	-0.731** (-5.527)		MALE	-0.511** (-5.334)	-0.664** (-4.398)
MARR	0.036 (0.325)	0.021 (0.155)		MARR	0.054 (0.497)	0.118 (0.755)
EDUC	0.021 (1.369)	0.026 (1.351)		EDUC	0.023 (1.502)	0.026 (1.217)
CHILD	-0.018 (-0.167)	-0.022 (-0.160)		CHILD	0.363** (3.384)	0.478** (2.997)
URBAN	0.010 (0.074)	-0.060 (-0.339)		URBAN	0.259 (1.815)	0.353 (1.703)
INSPECT	0.816** (2.962)	0.984** (3.405)		**LABEL**	0.720** (2.613)	0.986** (3.274)
Standard Deviation	-	0.016 (0.028)		Standard Deviation	-	0.215 (0.265)
AGE	0.005 (1.701)	0.005 (1.728)		AGE	0.004 (1.387)	0.004 (1.468)
INCOME	0.003 (1.825)	0.003 (1.855)		INCOME	0.003 (1.599)	0.003 (1.556)
MALE	-0.453** (-5.511)	-0.462** (-5.552)		MALE	-0.382** (-4.624)	-0.394** (-4.540)
MARR	0.191* (2.068)	0.199* (2.124)		MARR	-0.129 (-1.392)	-0.130 (-1.362)
EDUC	0.009 (0.704)	0.009 (0.696)		EDUC	0.032* (2.390)	0.033* (2.421)
CHILD	-0.003 (-0.030)	-0.001 (-0.011)		CHILD	0.252** (2.706)	0.264** (2.746)
URBAN	0.490** (3.974)	0.497** (3.984)		URBAN	0.172 (1.430)	0.184 (1.492)
COST	-9.732** (-16.612)	-11.122** (-12.469)		**COST**	-8.375** (-15.006)	-10.693** (-8.531)
Log-Likelihood	-3439.47	-3437.18		Log-Likelihood	-3517.67	-3512.85
Restricted (slopes=0) Log-L	-3638.97	-3638.97		Restricted (slopes=0) Log-L	-3682.24	-3682.24
Chi-Squared (c^2)	398.99	403.58		Chi-Squared (c^2)	329.14	338.78
Adjusted r^2 Stat.	0.089	0.090		Adjusted r^2 Stat.	0.072	0.073

Standard errors are in parentheses. *denotes significance at the a = 0.05 level ** denotes significance at the a = 0.01 level.

variable AGE and the alternative specific constant, RESTRICT BIOTECH. The χ^2 statistic shows that Model I and Model II are highly significant under both the CL and the ML specifications. For each model, the CL and ML specifications yield almost identical results, with the ML specification producing a slightly better fit for both Model I and II as suggested by the ρ^2 statistic. The ML specification also generates four standard deviation (σ_{α_i}) estimates for the four ASCs in the two models which are not available from the CL specification.

The estimated standard deviations for the ASC RESTRICT BIOTECH in the ML specification are strongly significant in both Model I and II, which supports a unified interpretation: holding other factors included in the models fixed, there is significant heterogeneity (compared to the mean) around consumers' perceptions of the relative attractiveness of the policy of applying more strict regulation of biotechnology. (Note that the mean estimate of this ASC is not significant in either model.) A significant standard deviation indicates that consumers are roughly split into equal numbers in terms of their overall perceptions of this policy option, holding other factors constant. Half the respondents preferred more strict control on biotechnology than no policy, while the other half would prefer to have no policy regulating biotechnology. This is particularly evident in Model I, given the relatively large standard deviation.

Compared to no policy, "more information from labelling" is attractive to consumers according to both models, based on the significant and positive ASC for LABEL. Further, the standard deviation is not significant, which indicates that no heterogeneity can be found for this policy option. It seems that consumers are reasonably "unanimous" in terms of their positive view, overall, of more information from labelling relative to no policy.

Turning to assessment of Model I and II separately: in Model I, the estimated coefficient on COST is negative and significant, indicating that the increased food costs that are associated with choosing to "increase food inspection" or "restrict biotechnology" decrease the probability of consumers choosing more food inspection or restricting food biotechnology. The effect of the variable MALE is significant and negative. Male consumers are less likely to choose either "more food inspection" or "restricting biotechnology" than are female consumers. The coefficient on MARR is significant and positive in the choice to increase food inspection in Model I. It appears that married consumers are more likely to

choose “more food inspection” than are single consumers. The coefficient on URBAN is significant and positive in the choice of “more food inspection”. Respondents living in urban areas are more likely to choose “more food inspection” than are consumers living in rural areas.

Some estimated coefficients did not display the signs that were expected. The estimated coefficient on CHILD was expected to be significant and positive in all models. However, CHILD when interacted with RESTRICT BIOTECH and with INSPECT in Model I was insignificant and negative. Thus our results suggest that the probability of consumers choosing to restrict agricultural biotechnology or increase food inspection is not affected by the presence of children in the household. However, it should be noted that correlation between the demographic variables may be influencing these results.

In Model II, the coefficient on COST is negative and highly significant, indicating that the prospect of increased food costs decreases the probability of consumers choosing more information from food labelling or restricting food biotechnology. The effect of the variable MALE is negative and highly significant. Male consumers are less likely to choose either of the policy options of more labelling or restricting biotechnology than are female consumers. The coefficient on INCOME is positive and highly significant in the choice to restrict biotechnology, indicating that the probability of consumers choosing to restrict biotechnology increases as the income of the respondent increases. However, INCOME does not appear to be a significant explanatory variable in the choice of more information from food labelling. The EDUC coefficient is positive and significant in the choice of food labelling. Consumers with more years of education are more likely to choose LABEL than are consumers with less education. The coefficient on CHILD is highly significant and positive, indicating that children in the household increase the probability of the policy choices to restrict agricultural biotechnology or more information from food labelling.

Consumers’ Willingness to Pay for Particular Policy Options

Following the procedure of Hanemann (1984), estimates of the willingness to pay (WTP) for the particular policy options are calculated. These calculations were made for each of a representative female and male consumer. The female consumer (F) is assumed to be a married woman with children. She has 14 years of education, a household income of

$57,500 and lives in an urban area. The second consumer (M) is a single male without children. He has 14 years of education, an annual income of $40,000 and lives in an urban area. These characteristics are representative of the median female and male respondents in the study sample.

If respondent n chose to "restrict biotechnology" or chose "no change in either" the respondent's indirect utility functions, respectively, would be:

$$V_{RESTRICT} = \alpha_{RESTRICT} + \beta(M_n - CV_n) + \gamma' W_n^i$$

$$V_{NEITHER} = 0 + \beta(M_n)$$

where M_n is income and CV_n is the compensating variation of the policy change or the implied willingness to pay for the policy option. Thus, equation (5), expresses the difference in utility between having and not having the particular policy:

$$\Delta V = \alpha_{RESTRICT} - \beta(CV_n) + \gamma' W_n^i \qquad (5)$$

The statistically significant estimated coefficients from Model I and Model II, are used in these calculations. The estimated coefficient on COST is assumed to be the marginal utility of food costs. Thus, the marginal utility of food costs is the same for both consumers in this model. Following Hanemann (1984), an estimate of the willingness to pay for policy alternative i is the value of *CV* that sets the utility difference to zero:

$$WTP = (\alpha_i + \gamma' W_n^i) / -\beta_{COST} \qquad (6)$$

The WTP estimates, in percentage terms, and associated standard deviations of these estimates for both consumers under both the CL and ML specifications, are presented in Table 3. Standard deviations are obtained through the method outlined by Krinsky and Robb (1986). Comparing the mean and the standard deviation, it can be seen that all measures are statistically significant (except zero estimates). The differences between corresponding estimates under the CL and ML specifications are no more than 1%. It appears that each of the representative consumers is willing to pay most for a labelling policy that will provide information about agricultural biotechnology. Specifically, consumer F is willing to pay 16.90 or 16.14 percent more, depending on which specification is used, for information on such food (i.e. if it is labelled to give information), while consumer M is willing to pay just over nine percent more for the information provided through labelled food. Consumer M is not willing to pay more for food in either scenario if agricultural biotechnology is restricted.

Consumer F is not willing to pay, in the form of higher food costs, if biotechnology is restricted in scenario one.

Table 3: Derivation of Consumer's WTP (as a Percentage of Food Costs) for Selected Policies

	Conditional Logit		Mixed Logit	
	F	M	F	M
Scenario One				
Restrict Biotech	0 (0)	-6.41 (0.011)	0 (0)	-6.62 (0.012)
More Food Inspection	15.29 (0.028)	8.64 (0.026)	15.22 (0.025)	9.19 (0.023)
Scenario Two				
Restrict Biotech	8.61 (0.019)	-3.23 (0.013)	9.02 (0.021)	-3.18 (0.016)
More Food Labelling	16.90 (0.023)	9.29 (0.023)	16.14 (0.020)	9.85 (0.020)

Standard deviations are in parentheses.

Policy Preferences: Some Comparisons and Caveats

The measures of consumers' willingness to pay for information provided in the form of labelling of foods derived from agricultural biotechnology in this study are consistent with other estimates of the value of information relating to identification and choices in the context of genetically modified foods. Some of these studies apply different techniques, and apply to respondents in other regions. For example, Huffman et al (2001) report laboratory auction experimental procedures for three food items to determine sampled American consumers' willingness pay for foods with and without genetically modified labels. These authors reported that participants were willing to pay a premium of 14 percent for foods identified as not derived from agricultural biotechnology. This can be interpreted as a premium of 14 % for the information contained in labels providing information on genetic modification of these foods, an estimate that is remarkably similar to ours. Moon and Balasubramanian (2001) used a stated preference approach to assess American consumers' willingness to pay a premium for breakfast cereals identified to consist of non-biotechnology ingredients and found mean estimates of the willingness to pay a premium for this cereal

between ten and twelve percent. Lusk and Fox (2002) reported willingness to pay estimates of 17 percent in the form of higher prices for beef labelling relative to hormone use and lower valued estimates (10.6 percent higher beef prices) for labelling of beef relative to beef animals having been fed genetically modified corn. Each of these three studies is, in essence, providing estimates of the average value to consumers of information, where the information is contained in labels or similar identification, on the genetically-modified content of the food in question.

There are a number of caveats to this component of the project. Whenever respondents are asked to respond to a hypothetical situation, strategic and hypothetical biases are a potential concern. Hypothetical bias may occur in situations where respondents perceive the situation to be hypothetical and do not give an accurate response because of this. Strategic bias occurs if respondents' responses are biased toward the policy they would like to see implemented, rather than accurately reflecting their potential or actual preferences / behaviour. This behaviour could occur if conditions imposed by the hypothetical scenario are sufficient to motivate respondents to state choices that understate or overstate their willingness to pay. The more confident respondents are that the policy will be provided regardless of the amount they choose, and the more that respondents believe that they will actually have to pay the amount they have chosen, the greater is the tendency to underbid in a CV survey (Mitchell and Carson, 1989). Conversely, the more respondents believe that the amount they reveal will influence the provision of the policy and the less they believe their payment obligation will determine the amounts they will actually have to pay, the greater is their tendency to overbid (Mitchell and Carson, 1989). Potential problems of bias must be borne in mind in any of these types of studies, but it is commonly believed that the results of well-structured studies based on products or situations with which respondents are reasonably familiar are useful in giving insights to consumers' preferences and trade-offs; we believe that this applies for this study and are reassured by the consistency of our estimates with those from other studies of the value of information encompassed in GM labelling. Nonetheless, it is noted that the data set for the analysis is drawn from Alberta consumers. Further research to assess the applicability of the results in other regions would be of interest.

Labelling Preferences: Summary and Conclusions

In this survey consumers were asked to choose between, or not to choose, alternative regulatory policies that are applicable to genetically modified food, in circumstances in which food prices increase with increased levels of assurance of food quality. The results suggest that many consumers are prepared to make trade-offs for higher levels of information or assurance of food quality that may be achieved from the specified policies. Estimates of the willingness to pay for the policy options reflect these trade-offs. These estimates, calculated for representative consumers, suggest that Alberta consumers were more willing to pay, in terms of higher food costs, for a policy that would provide more information about agricultural biotechnology on food labels. The representative consumers were also prepared to pay higher food costs for more emphasis on food inspection. The representative consumers were willing to pay the least amount, in terms of higher food costs, for a policy that would restrict agricultural biotechnology. Overall, the most preferred policy of those that were assessed is one that would provide more information through food labels.

V. Focus Group-Based Case Study of Consumers' Risk Perceptions for Two GM Foods

In order to gain more information on attitudes to GM food than is possible in simple attitudinal polling, several focus groups, each consisting of 7 to 9 people, were conducted in Edmonton in 2002. Four groups were mainly composed of University of Alberta students. Two further groups consisted of Edmonton primary household grocery shoppers, formally recruited from the general population by University of Alberta's Population Research Laboratory. An important objective for the group discussions was to gain an understanding of contentious issues relative to GM food in general and for GM ingredients in two selected food products in particular. Other insights gained from these focus group processes were subsequently applied in later research. Two food items were selected for assessment in the focus groups. One was a nacho chip; the other was pre-sliced packaged bread. The nacho product was chosen as a typical snack and the bread represents as staple food product.

In each of the groups, samples of the different samples of the selected products were displayed, and formed a focus of discussion in terms of identifying the characteristics of

individual's preferred choices of the particular product considered in that focus group session. Possible benefits and risks of applications of genetic modification, both in general and with regard to food, were also discussed in the focus groups. Many of our findings from this process mirrored other assessments, in Canada and elsewhere. There was a wide range of knowledge and attitudes towards issues associated with genetic modification through biotechnology. Participants identified health and environmental issues as areas of major concern for genetically modified food, mainly due to the large degree of uncertainty associated with long-term effects of these foods. Even so, some participants explicitly pointed at possible positive effects, citing increased food supply for developing countries, drought resistance of crops, the creation of food with health improvements, or a view of genetic modification as a process involving general advancement of technology that is likely to pave the way for beneficial applications. Overall, as has generally been found elsewhere, respondents expressed less hesitation towards medical biotechnological applications than to biotechnological food applications.

In general, focus group participants showed little specific knowledge of genetically modified food technologies and, with the exception of some individuals with fairly strong opinions, many participants were reluctant to voice a clear opinion in favor of or against these new products. A potential survey instrument was also applied in the focus groups. This specifically explored respondents' purchase intentions for the product containing genetically modified ingredients and their specific attitudes and concerns regarding this technology. In this context, we asked respondents whether, relative to their normal purchase of these products, they would buy the focus product (nacho chips in student groups; bread in the public groups) with genetically modified ingredients that contained specific health and environmental benefits at a price discount. Approximately 50 percent of the focus group participants chose to switch to a GM product that provided health and/ or environmental benefits.

VI. Assessments of the Importance of Food and Environmental Risks

The fourth component of this project involved two sections of a Canada-wide survey of consumers' attitudes, perceptions and preferences relative to agricultural biotechnology

and GM food. An international marketing firm was contracted to apply this survey to a sample of 882 respondents drawn from their internet panel of approximately 40,000 Canadian households; that panel is considered to be representative of the Canadian population. The sample of 882 respondents is reasonably representative of the Canadian population. These data were collected in January 2003.

Canadians' Views of Food and Agricultural Risks

In the attitudinal component of the survey, the 882 respondents were queried on their assessments of the degree of risk associated with each of a number of identified food health risks. These were presented in random order. Respondents were asked to rate each of the identified issues in importance from 1 ("very high") to 4 ("almost no risk") or "don't know." Although genetically modified foods were believed to be very risky by an appreciable number of respondents, overall this issue was seen as less risky for food safety than most of the other listed food risks. The most risky issues for food were thought to be: bacterial contamination (cited as being very risky by 41% of the respondents); pesticide residuals (41%); use of antibiotics in food production (36%); BSE (mad cow disease) (32%); use of hormones in food production (32%); fat and cholesterol in food (25%); use of genetic modification/engineering in food production (21%); and use of food additives (15%).

Respondents were also queried on their assessments of the levels of risk for the environment that are associated with a number of listed agricultural-related issues. A similar four-level scale and the option of "don't know" applied in each case. The most risky issues for the environment were viewed to be: water pollution by chemical runoffs from agriculture (viewed as very risky by 61% of respondents); herbicide/pesticide resistance (50%); agricultural waste disposal (41%); soil erosion (28%); genetic modification/engineering (27%); and adverse effects of agriculture on biodiversity (26%). Overall, the respondents in this survey tended to see agricultural biotechnology as somewhat more of an environmental risk issue than as an issue of food safety. There were relatively few "don't know" responses to these two sets of questions.

Activism, Attitudes and Actions Regarding Labelling

Responses to questions by the 882 Canada-wide respondents concerning GM labelling and policy are summarized in Table 4. Responses were based on a four-point scale

(strongly agree to strongly disagree). In this table, the responses overall are aggregated, so that "tends to agree" includes "strongly agree" and "agree," while "strongly disagree" and "disagree" are combined into "tend to agree". It must be recognized that the nature of the responses to this group of questions is likely to be influenced by their wording.

Table 4: Activism, Actions and attitudes Regarding Labelling with Respect to Genetically Modified Foods

	Yes	No	Don't Know
Stated Actions			
"The possibility of GM/GE content affects my food choices"	40%	53%	7%
"I purposefully buy food at organic stores to avoid GM/GE food"	11%	87%	2%
Stated Activism			
"I donate money to organizations which oppose GM/GE foods"	4%	92%	4%
"I donate money to environmental protection organizations"	25%	73%	2%
"I have lobbied against GM/GE foods"	3%	96%	1%
Views on GM/GE Labeling and Regulation			
	Tend to Agree	Tend to Disagree	Don't Know
"The public is sufficiently involved"	13%	80%	7%
"The right to know warrants mandatory labeling"	88%	10%	2%
"The labeling decision should be left to experts"	57%	39%	4%
"No labeling is needed if the final quality is the same"	14%	83%	3%
"Voluntary labeling might be used as a marketing tool"	71%	25%	4%
"Stricter regulation is better than mandatory labeling"	61%	34%	5%
"Mandatory labeling is preferable over voluntary labeling"	90%	8%	2%

Again there are relatively few "don't know" responses. Respondents indicate a strong desire for public involvement, vote even more strongly for mandatory labeling and disagree that labeling is not needed if the product's quality remains unchanged. An appreciable

majority of respondents expressed a degree of skepticism concerning the use of voluntary labeling. A majority expressed a preference for stricter regulation over mandatory labeling, but about one third of respondents disagreed with this.

VII. Summary of Conclusions

Public opinion about the labelling of genetically modified (GM) food ingredients continues to be a topical and contentious issue for Canadian food policy. This project included several study components directed at assessment of attitudes to food biotechnology and preferences for provision of information of information through GM labelling. The first component of the project was an assessment of public attitudes to biotechnology and to GM food based on evidence from polls and other studies; these show increasing awareness and some increase in wariness of GM food, in Canada and elsewhere. In the second component of the project, analysis of survey data on Alberta consumers' preferences for different policy approaches to GM food was undertaken; this analysis indicates a preference for GM food policy to emphasize the provision of more information to consumers, through labelling, over a policy that would provide for more rigorous inspection, while more regulation that would restrict biotechnology was the least favoured of the three options that were presented to respondents. In a third component of the project, a case study on individual's attitudes to and preferences for GM ingredients in two selected food items (one of which was nacho chips while the other was bread) was pursued through several focus groups that were conducted in Edmonton, Alberta in 2002. The focus group discussions indicated a variety of attitudes and responses to GM food in general and to the inclusion of GM ingredients in the selected products in particular. Attitudes to and preferences for environmental and health benefits that might be introduced through biotechnology were explored in these groups. Some 50 percent of focus group respondents indicated a willingness to buy these GM products, at a price discount.

The fourth and final component of the project involved two sections of a Canada-wide survey, conducted in early 2003. These queried respondents' assessments of the importance of various food safety risks and various environmental issues associated with food and agriculture, as well as their attitudes to labelling policy. Although genetically modified foods were believed to be very risky by one-fifth of the respondents, this issue was

seen as less risky for food safety than most of the other listed food risks by numbers of other Canadian respondents. The most risky issues for food were thought to be: bacterial contamination (cited as being very risky by 41% of the respondents); pesticide residuals (41%); use of antibiotics in food production (36%); BSE (mad cow disease) (32%); use of hormones in food production (32%); fat and cholesterol in food (25%); use of genetic modification/engineering in food production (21%); and use of food additives (15%). Overall, agricultural biotechnology tended to be seen as more of an environmental risk than a food risk and numbers of other food and environmental issues were seen to be more risky by many respondents.

From the survey results of this component of the project, Canadians also expressed a strong desire for public involvement in biotechnology policy, voted strongly for mandatory labeling and disagreed that labeling is not needed if the product's quality remains unchanged. An appreciable majority of respondents expressed a degree of skepticism concerning the use of voluntary labeling. A majority expressed a preference for stricter regulation over mandatory labeling, but about one third of respondents disagreed with this.

VIII. Implications for Alberta's Agricultural and Food Industry and the Advancement of Agricultural Knowledge

The findings of the project provide useful information on public attitudes to agricultural biotechnology and preferences for labelling policies. A dichotomy in attitudes and preferences for GM food is seen. An appreciable group of consumers see GM food as very risky and would avoid this if the information provided by labelling enabled this. However numbers of consumers appear to be less averse to GM food, and more likely to purchase this, at a discount, especially if it incorporates health or environmental benefits. An expectation of public involvement in the development of GM policy and regulations is evident. The project findings do raise questions about the basis and magnitudes of these tendencies, the characteristics of consumers that may underlie preferences for product innovations, and whether/how these preferences may change with information. The findings of the project are serving as a basis for subsequent more extensive and more detailed assessment of Canadian consumers' risk preferences relative to GM food, the impact of information on these preferences, and related issues associated with information on GM food.

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