RURAL ECONOMY

Risk Perceptions, Social Interactions and the Influence of Information on Social Attitudes to Agricultural Biotechnology

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Project Report #05-02
AARI Project Repot # 2001J025

Project Report

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Abstract

We assess Canadian's risk perceptions for genetically modified (GM) food and probe influences of socio-economic, demographic and other factors impinging on these perceptions. An internet-administered questionnaire with two stated choice split-sample experiments that approximate market choices of individual grocery shoppers is applied to elicit purchase behavior from 882 respondents across Canada. Data are collected to assess the influence on respondents' choices for a specific food product (bread) of 1) product information which varies in content and by source and 2) information provided through labeling. These data also enable: a) analysis of trade-offs made by consumers between possible risks associated with GM ingredients and potential health or environment benefits in food and b) assessment of influences on respondents' search for/access of product information.

We rigorously document the extent and type of variation in Canadian consumers' attitudes and risk perceptions for a selected GM food. This is pursued in analysis of experiment 1) data using a latent class model to analyze 445 consumers' choices for bread products. We identify four distinct groups of Canadian consumers: 51% (value seekers) valued additional health or environmental benefits and were indifferent to GM content; traditional consumers (14 %) preferred their normally-purchased food; fringe consumers

(4%) valued the health attribute and could defer consumption. Another 32 % (anti-GM) strongly opposed GM ingredients in food irrespective of introduced attributes. Thus there is a dichotomy in Canadian attitudes to GM content in food: a small majority of the sample (55 per cent) perceive little or no risk from GM food, but this is strongly opposed by 46% of respondents. Differences in gender, number of children in the household, education, and age are associated with the likelihood of segment membership.

We also report on the search for information on characteristics of the GM food by a sample of 445 respondents with opportunity for voluntary access to related information through hyperlinks in the survey. Slightly less than half actually sought such information. Gender, employment status, rural or urban residency and the number of children in the household all affected the probability that respondents would access information.

A further research component examines product choices made in the context of two common GM labelling policies: mandatory and voluntary labelling. We find these two types of strategies to have distinctive impacts on consumers and on measures of social welfare. Knowledge of these may help policy makers to make more informed analyses of the alternative labelling policies.

Specific findings also provide base-line measures of Canadians' attitudes to risks of GM technology in the context of food and environmental risks, as well as documenting the importance of context influences and reference points on consumers' preferences for GM food. We also develop methodological improvements for accurately estimating the value of information on a negative attribute. The project built upon initial findings from a previous AARI project (#AARI Project #2000D037) and is complemented by research supported through a Genome Prairie GE3LS (Genetics, Ethics, Environment, Economics, Law and Society) project: "Commercialization and society: its policy and strategic implications."

I. Background

Agricultural biotechnology is a potential major source of technical change for agriculture, leading to reduced farm costs and yield improvements associated, for example, with introduction of plant/animal disease resistance, less need for chemical inputs, increased hardiness and other sources of improved yields, amongst possible effects (Falcon, 2000). The prospect of "second generation" crop biotechnology holds potential promise to add value by development of functionally enhanced crops oriented to prospective new markets for functional foods and nutraceuticals, while the prospect of plant molecular farming (PMF) holds promises of expanded market uses for agricultural crops and contributions to sustainable supplies of renewable resources of importance to society.

Regulatory processes for GM foods in Canada and the United States have focused on whether or not there are significant detectable differences in the characteristics of foods resulting from the use of the new techniques, specifically in food allergenic properties or composition, together with consideration of possible environmental effects of genetic modification. This has contrasted with process-based emphases on agricultural biotechnology in European regulation for genetically modified agricultural products. Consequently there are relatively few commercial applications of agricultural biotechnology in Europe, imports tend to be shunned, and mandatory labeling applies for GM food. Nevertheless, applications of modern agricultural biotechnology to agricultural research and production have increased dramatically in the past several years and the use of genetically modified canola, soybean and corn has become widespread in foods processed in North America. Licensing of GM wheat has been considered.

Concurrently some consumers, food retailers and processors, have become more aware and wary of foods that include GM ingredients. The issue is believed to be of more concern in some European populations than in North American populations (Gaskell et al, 1999). However, surveys of public attitudes in Canada indicate that GM food issues have emerged as public policy questions in Canada also (Einsiedel, 2000; Bredahl, 2001; Veeman, 2001). As consumers' awareness of food biotechnology continues to grow, it is increasingly important to the agriculture and food industries to know how consumers'

perceptions of food biotechnology are formed relative to other food safety concerns (i.e. pesticides, bacteria in food, food additives, fat and cholesterol) and how individuals update these preferences when new information is received. Better information on these issues should aid development of public policy as well as aiding development of more effective communication and marketing strategies for biotechnology-based foods.

II. Objectives

The objectives of this project are:

To assess levels of public concern with major forms of GM foods and public attitudes to policy for GM foods.

To assess baseline attitudes to major forms of food biotechnology and determine factors that may cause individuals to change their attitudes when more information is provided.

To assess whether different forms and sources of information have different influences on the nature and updating of preferences for food biotechnology.

To test, empirically and rigorously, the process of information updating on GM perceptions, for an Alberta-based GM food, applying a conceptual model of this process which was developed in a complementary project, a component of the Genome Prairie GE3LS Project.

To relate evidence from these analyses to potential risk communication and product information strategies.

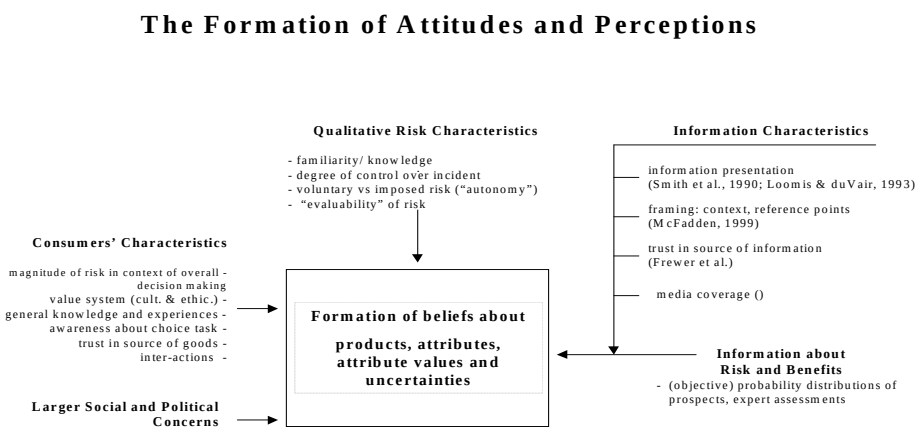
III. Conceptual Basis of the Analysis

The project was initiated with an overview of literature including applications of concepts and methodologies of several disciplines in attempts to explain and predict consumer market behaviour towards GM foods. The communications literature focuses on consumers' underlying attitudes about and perceptions of GM foods (for example, Grunert *et al*., 2000; Frewer *et al*., 1998; Marks *et al*., 2002;), while eliciting the influences of product information (Finlay *et al*., 1999; Noussair *et al*., 2002), and examining the role of trust in information sources (Hunt and Frewer, 2001). Economic studies using stated preference data or data from experimental auctions assess how

attitudes may translate into market behaviour and estimate consumers' willingness to pay for GM foods (Burton *et al.*, 2001; Lusk *et al*., 2003; Chern and Rickertsen, 2002; Alfnes, 2004). Additionally, some other studies specifically analyse how varying information content—positive or negative—about GM foods affects consumers' preferences (examples are Huffmann *et al*., 2003; Tegene *et al*., 2003; Rousu *et al*., 2004; Lusk *et al*., 2004).

We develop a descriptive analytic model of choice behaviour under risk and uncertainty that accommodates two apparently conflicting observations about the formation of attitudes and perceptions. Bayesian learning is a classical economic approach that observes people to systematically process available information. However, there is also evidence and associated theory based on situations where people behave inconsistently with conventional theory. Bounded rationality and prospect theory appear to explain such inconsistencies. We explain consumers' behavior of apprehension towards GM foods based on the hypothesis that consumers maximize their utility in the light of: the costs to them in terms of the time and effort to obtain, process and reconcile complex information about genetically modified organisms (GMOs); rather intangible consumer benefits from the existing array of GM foods; existing uncertainties about features of these products; and the current availability of substitutes for them. A diagrammatic representation of this conceptual basis is given in Figure 1, titled The Formation of Attitudes and Perceptions. Related hypotheses are that some individuals may be relatively uninterested in learning about GMOs and that the content/focus of information may affect risk perceptions. Our findings tend to support these various hypotheses.

Figure 1: The Formation of Attitudes and Perceptions



IV. Research Approach and Data Collection

The major source of data for the study involved a Canada-wide survey of a total 882 participants, conducted in January 2003. This encompassed two statistically-designed experiments, applied on a split-sample basis, with in excess of 400 respondents to each experiment. Each focused on the effects of different types of information – in a manner that simulated hypothetical purchase situations – for a selected food product. In each of the two experiments, purchasing situations were simulated through a fractional factorial design. Each purchase choice situation had three possible choice options: two options described different bread products, while the third option was to choose neither of the first two options. Each respondent was asked to make purchase decisions in each of eight simulated purchasing situations. Pre-packaged sliced bread was chosen as the product for this purpose for several reasons. As a basic food product for many Canadians, bread is consumed in almost all Canadian households; wheat is one of the major agricultural commodities of the country; and, at the time of the survey, genetically modified wheat had been proposed, but not approved for production or sale, in Canada and the United States.

Following an introductory section of the survey which determined the characteristics of bread that each respondent normally purchased, each individual was

randomly assigned to one of the two experiments. Subsequently, each person also completed questions that probed his or her knowledge of agricultural biotechnology and elicited assessments of the importance of different food safety and environmental issues related to agriculture and to genetically modified food. Survey participants were also asked to indicate the extent to which they trusted various sources of information on genetically modified food, as well as the extent of their agreement or disagreement on a variety of attitudinal statements relating to agricultural biotechnology and genetically modified foods. In order to facilitate comparisons across time and across populations several questions that had been asked by other researchers in other contexts were incorporated into our questionnaires. A final section of the survey provides information on socio-demographic and economic characteristics of respondents.

One of the two experiments undertaken in the survey focused on the influence that different types of information, from different sources, had on respondents' choices between particular bread products. These products were described in terms of major characteristics, including health and environmental attributes, which could be associated with genetic modification. The second experiment focused specifically on the effects on choices of genetically modified food in the context of different types of labeling policy for this product. The use of choice-behavior experiments in this study enables study of consumers' perceptions of product quality or risk in the context of the trade-offs that are made relative to product prices, rather than solely interpreting risk perceptions in terms of people's stated opinions, since these may not always reflect behavior. The study is also informed by the literature and methods of sociology and psychology, reflecting the major influence of these disciplines on the study of peoples' behavior relative to risk. The survey was designed and applied in a computer-based interactive form. An international marketing firm was contracted to apply this to a sample drawn from their internet panel of approximately 40,000 Canadian households; that panel is considered to be representative of the Canadian population.

The computer technology enabled respondents to 'build' their own choice of bread, reflecting their preferred choice of characteristics at the very beginning of the survey. This was used as the basis of a modified 'switching model' in the first experiment, based on whether the respondent continued to prefer this initial choice, or

chose another bread type (or chose neither), as attributes of an alternate offering (and information characteristics) were changed. For the second experiment, determination of the characteristics of the normally preferred bread type provided price and GM content reference points for these characteristics, for each person, allowing an assessment of the impact of these factors on product choices in different labeling scenarios. Econometric analyses were performed using the computer program LIMDEP Version 8.0 (Greene, 2002). Discussion of the approach and methodology are in Veeman et al (2005) and Hu et al (2004).

V. Results

A: Baseline Attitudes

The survey incorporated several mechanisms to provide base-line data on Canadian's perceptions of major forms of GM foods. From direct polling, overall, the 882 respondents viewed agricultural biotechnology for animals to be a more important food safety issue than agricultural biotechnology for plants and crops. Even so, neither was the most pressing food safety issue for most respondents: animal biotechnology was selected from a list of food safety issues to be the most important food safety concern of only nine percent of respondents, while agricultural biotechnology for plants and crops was cited as the most significant food safety concern of some three percent of respondents.

Data were collected on major sources of information that respondents sought and relied on about health risks and food benefits. The most frequently cited sources were magazines/newspapers (cited as the source of much information about health risks and food benefits by 65% of respondents); television/radio (cited by 54 % of respondents); books (12%); friends/neighbors/relatives (10%); and food labels (9%).

Baseline data were also collected on knowledge of the topic of genetic modification in terms of six true/false questions. As noted in Table 1, a relatively large number of respondents believed, incorrectly, that Canadian policy required labeling of food containing GM/GE ingredients. Respondents were also asked to assess their own knowledge of genetic modification in terms of how well informed they felt about the subject. Overall, 3% of the subjects indicated that they were "very well" informed on the

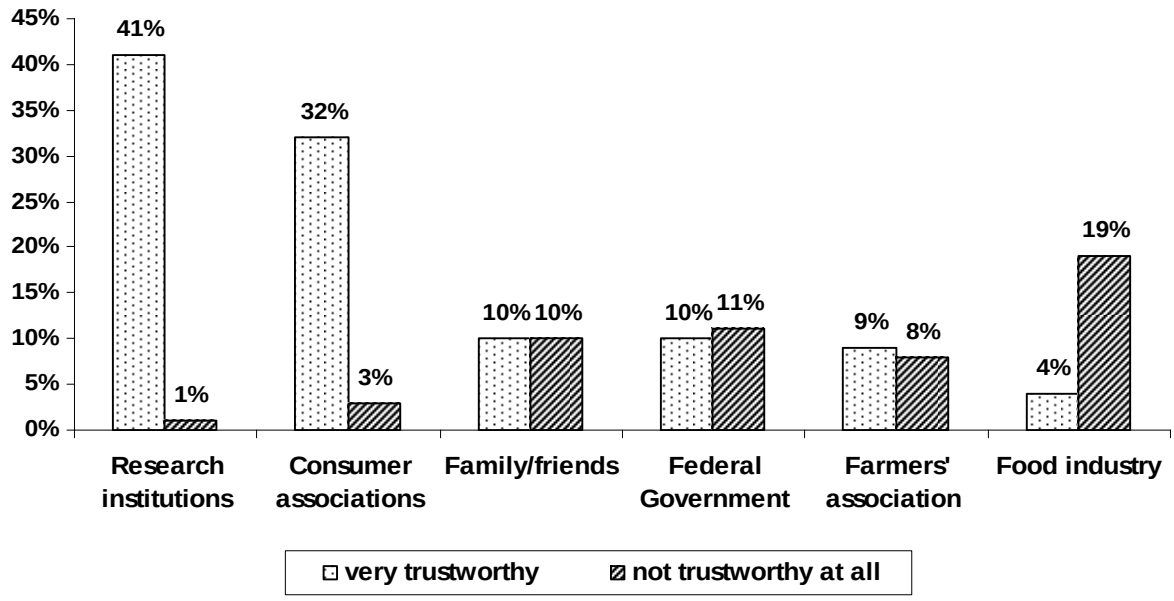
topic, 42% specified “somewhat informed,” 44% chose “not very informed” and 11% reported “not at all informed.”

Table 1: Knowledge of Agricultural Biotechnology

TRUE/FALSE STATEMENTS	CORRECT ANSWER	PERCENTAGE OF RESPONDENTS THAT ANSWERED CORRECTLY
Genetic modification/engineering can only be applied to plants, but not to animals.	No	83%
By eating a genetically modified/engineered food, a person's genes will also become modified.	No	73%
Canola, corn, soybean and potato are amongst the genetically modified/engineered crops currently produced in Canada.	Yes	67%
Genetically modified/engineered food items are currently available in Canadian supermarkets	Yes	89%
All of the food items in Canadian supermarkets contain genetically modified/engineered ingredients	No	81%
Canadian food regulations require the labeling of food items which contain genetically modified/engineered ingredients	No	51%

Using a four-level scale, we asked respondents to assess the trustworthiness of different groups as sources of information about genetically modified/engineered food products. The percentages of respondents indicating ratings of “very trustworthy” and “not trustworthy at all” are indicated in Figure 2. These responses show relatively low trust in “the food industry,” “farmers’ associations” and “the Canadian Government,” on the one hand, and high levels of trust in information from “research institutions (e.g., universities)” and “consumer associations”, on the other. The lowest level of trust in information from the queried institutions was for the food industry, which was rated as “not trustworthy at all” by nearly one-fifth of respondents.

Figure 2: Trustworthiness of Sources of Information on Genetically Modified/Engineered Food Products



In a block of questions on attitudes to agricultural biotechnology, the full sample was presented with thirteen attitudinal statements and asked to indicate their agreement or disagreement with each of these. A four-point rating was used ("strongly agree," "somewhat agree," "disagree" or "strongly disagree"); a "don't know" option was also available. The statements are listed in Table 2. In this table, the "agree" and "strongly agree" responses are summed together as "tend to agree"; while the "disagree" and "strongly disagree" responses are aggregated as "tend to disagree."

An initial non-parametric analysis was applied to the responses to the attitudinal questions listed in Table 2 in order to assess any common groupings of questions and respondents. Responses were reduced into factor scores using a factor analysis with the method of principal components extraction. Two factors were identified (based on Eigen values greater than one) and account for 51% of the variation among the data for the thirteen perception questions. These can be described as:

1. Forecast of a bright future (this groups together questions 1, 2, 3, 5, 10, 11, 12, and 13). Individuals with higher scores for this factor generally perceive a bright

Table 2: Attitudes & Perceptions on Possible Risks and Benefits of Genetically Modified Foods

	Tend to agree	Tend to disagree	"Don't know"
Concerns about GM/GE foods related to human health			
1. "The human health benefits of GM/GE crops outweigh the human health risks."	32%	43%	25%
2. "Foods derived from GM/GE crops are less risky for humans than foods derived from GM/GE animals."	23%	43%	34%
Concerns about GM/GE foods related to the environment			
3. "The overall benefits for the environment of GM/GE crops outweigh the overall environmental risks."	32%	44%	24%
Concerns about GM/GE in animal production			
4. "Overall, I am more skeptical of GM/GE applications in livestock than in crops."	55%	31%	14%
5. "Feeding animals with GM/GE feed is not a concern."	33%	56%	11%
6. "GM/GE applied to livestock will worsen animal welfare."	38%	35%	27%
Concerns about GM/GE foods related to market structure			
7. "Increased GM/GE crops in Canada will lead to a harmful concentration of corporate power."	42%	34%	24%
Overall assessment of GM/GE foods			
8. "GM/GE in agriculture is unnatural."	54%	37%	9%
9. "Foods derived from GM/GE animals are simply not necessary in Canada."	47%	36%	17%
10. "I would sample foods from GM/GE crops to find out whether I like them."	55%	35%	10%
11. "I would prefer cheaper foods derived from GM/GE crops over more expensive GM-free products."	33%	57%	10%
12. "Canada should advance the general field of GM/GE technologies to prevent or cure diseases."	67%	21%	12%
13. "All things considered, benefits of GM/GE in food production outweigh risks."	37%	43%	20%

future for the technology of genetic modification, based either on potential individual benefits or the benefit of society as a whole.

2. Concern about the application of genetic modification (this groups together questions 4, 6, 7, 8, and 9). Individuals with higher scores for this factor generally see genetic modification as unnatural and have concerns about various aspects of its application.

Stratification of the higher and lower ends of these two factor scores indicates four types of strong views or attitudes of individuals in the entire sample, as in the first four rows of Table 3.

Table 3: Representative Consumer Groups Based on Factor Analysis

Attitudes	Number of Individuals	Percentage of the Sample
Concerned, but Bright Future	59	7%
NOT Concerned and Bright Future	91	10%
Concerned and NO Bright Future	128	15%
NOT Concerned, but NO Bright Future	105	12%
No Strong Views Regarding Biotechnology	499	57%

As seen in Table 3, 7% of the 882 respondents believe that agricultural biotechnology is useful (i.e., that it has a bright future), but are also concerned about its potential adverse impacts. Approximately 10% support the development of this technology without any obvious concern. The highest percentage of respondents that expressed consistently strong views across the attitudinal questions fell into the third category, which includes the 15% of respondents that did not consider the technology of agricultural biotechnology to be beneficial and were concerned about its application. The fourth category of respondents, 12% of the total, did not view agricultural biotechnology to be useful, but were not particularly concerned about this issue either. Of those respondents that had strong views on whether or not agricultural biotechnology constituted a concern, the number of “concerned” and “not concerned” respondents were relatively equal (about one-fifth each). However, as is shown in Table 3, overall, 57% of respondents (i.e., those with factor scores that fell within the upper and lower groups of

the two factor scores) did not express strong views either for or against genetic modification, in terms of their attitudinal responses to the questions outlined above in Table 2.

B: Documenting Differences in Risk Perceptions and Determining Factors

Building on the conceptual approach of McFadden (1999), in this component of the project we integrate individual's preferences and respondent's characteristics with utility maximizing behavior through an interactive stated choice experiment. A latent class choice model is applied to analyze respondents' bread product choices on data from Experiment 1. Details of this component of the analysis, including an overview of the theory and methodology employed in the analysis, are in Hu et al. (2004). The analysis led us to identify four distinct classes among respondents. Parameter estimates for the model are in Table 4. Respondents in the segments we label as *Value-Seeking Consumers* and *Fringe Consumers* are indifferent to GM ingredients in their bread, in contrast to the belief that all Canadian consumers are highly averse to GM food ingredients. The members of these two classes of respondents choose to buy GM bread as long health and/or environmental benefits are associated with the GM attribute and they are informed of this. Nevertheless, members of two other segments, *Traditional Consumers* and *Anti-GM Consumers*, avoid bread containing GM ingredients, despite associated health or environmental attributes. Marginal attribute values, including the probability of segment membership, are in Table 5.

Members of the different segments reveal different perceptions about the risks associated with GM foods and different views of the benefits of health and environmental attributes. An unwillingness to make trade-offs between risks associated with the GM attribute and possible attribute benefits characterises the *Anti-GM Consumers*. In terms of the probability of belonging to particular segments, the majority of the sample (55 per cent) see little or no risk from GM food. Nevertheless, the remainder of the sample is distinctly averse to GM food ingredients or perceives significant risks associated with GM food. An *ex post* analysis of individual segment probabilities revealed that differences in respondents' gender, number of children in the household, education, and age are associated with the likelihood of segment membership.

Table 4: Parameter Values for Latent Class Model

Variable	1 Segment model		Segment 1 *Value seeking consumers*		Segment 2 *Traditional consumers*		Segment 3 *Fringe consumers*		Segment 4 *Anti-GM consumers*	
	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio
Option 3 – none option "do not buy any bread"	-6.11*	-23.07	-23.14*	-14.05	-5.23*	-7.96	-2.01*	-4.32	-6.16*	-13.11
GM	-0.33*	-8.79	-0.05*	-0.78	-1.00*	-9.65	0.12	0.72	-1.08*	-13.66
Health benefit	0.50*	12.66	0.79*	11.75	-0.18*	-2.38	0.52*	2.96	0.61*	10.19
Environmental benefit	0.27*	6.41	0.50*	7.12	-0.86*	-8.10	0.05	0.23	0.81*	9.73
GM with health benefit	-0.47*	-3.82	-0.67*	-3.30	1.09*	3.60	-0.83	-1.54	-0.30	-1.55
GM with environmental benefit	-0.10	-0.75	0.09	0.45	1.52*	4.57	0.60	1.15	-1.01*	-4.38
Price paid	-1.34*	-12.56	-5.83*	-14.60	-1.24*	-5.13	-1.33*	-5.14	-0.89*	-4.72

* Estimated coefficients (probabilities) are significantly different from zero at the 1% significance level.

Table 5: Marginal attribute values amongst consumer segments

Variable	Segment 1 *Value-seeking consumers*		Segment 2 *Traditional consumers*		Segment 3 *Fringe consumers*		Segment 4 *Anti-GM consumers*	
	Marginal value	Std. dev.	Marginal value	Std. dev.	Marginal value	Std. dev.	Marginal value	Std. dev.
Option 3 – none option "do not buy any bread"	-7.94*	0.25	-8.42*	0.89	-3.02*	0.39	-13.87*	1.97
GM	-0.02	0.02	-1.66*	0.34	0.21	0.35	-2.46*	0.52
Health benefit	0.27*	0.02	-0.25*	0.16	0.69	0.36	1.39*	0.34
Environmental benefit	0.17*	0.03	-1.49*	0.27	0.10	0.33	1.88*	0.46
GM with health benefit	0.14*	0.02	-0.98*	0.17	0.71*	0.28	-1.14*	0.32
GM with environmental benefit	0.17*	0.02	-1.82*	0.38	0.35	0.42	-1.78*	0.41
Class probability	0.51		0.14		0.04		0.32	

* Significant at the 5% significance level based on the standard deviation.

Note: Values are denoted in Canadian (CAD) dollars.

There are several public policy implications of these findings. First, preferences concerning GM food, and the associated perceived risks of this product, are diverse so that analysis of "the average consumer" is quite misleading. The majority of consumers in this sample are unconcerned by GM ingredients in food. Nevertheless, a significant proportion of the sample is very concerned about risks of GM food (46 per cent). Policy makers need to be aware of the extent and nature of this heterogeneity, and associated views of marginal costs and potential benefits, in terms of the policies and procedures that apply to licensing field trials of GM crops, licensing GM crops for commercial production, labelling domestic and imported processed food, labelling imported commodities, and relative to identity preservation and traceability systems in the grain handling and transportation sub-sectors.

The group labelled *Value-Seeking Consumers,* for example, is not adversely affected by the presence of GM and is interested in inexpensive sources of healthy foods. The preferences of this group of younger individuals, from households with more children, suggest that they would be adversely affected by policies that raise prices of breads through labelling schemes or policies that restrict cost-reducing technologies such as GM technology. Since this group comprises 51 per cent of respondents, the national welfare implication for Canada is significant. Nevertheless, these welfare concerns must be balanced against the strong aversion to GM ingredients and unwillingness to trade off risk and environmental/health benefits held by *Traditional Consumers* and *Anti-GM Consumers* who make up 46 per cent of our sample.

The significant degree of heterogeneity in attitudes to GM food ingredients also suggests that methods of analysis of perceived GM food risks should be capable of accurately capturing heterogeneous preferences, particularly for unobserved heterogeneity. This finding suggests that sample sizes must be large enough to facilitate the examination of heterogeneity and that analytical methods chosen must be sensitive to the possibility of observed and unobserved heterogeneity.

C: Access to Information and Determining Factors

Information search has been postulated as a critical component of consumer purchase behaviour. A theoretical perspective on consumers' information-seeking behaviour was proposed by Stigler (1961) in the context of search for price information. Stigler hypothesised that consumers search for information as long as the marginal benefits outweigh the marginal costs of the search. The approach has been criticised as an insufficient description of much consumer information search, particularly in its omission of non-economic factors identified in other disciplines to have a major impact on search (Urbany, 1986; Goldman and Johansson, 1978; Maute and Forrester Jr., 1991; Avery, 1996). For example, measures of perceived risk and trust in information sources may affect information search, since source credibility is an important determinant of people's reactions to information (Frewer et al., 1998), and trust in information source has been identified as a key determinant in the effectiveness of any attempt to communicate risks (Slovic, 1993). Overall, however, as Urbany concludes, search behaviour is a complex process that would not be predictable or interpretable without considering interactions between broadly defined measures of the costs and benefits of search.

We report on the search for information on the genetically modified (GM) bread products by a sample of Canadian consumers using data from Experiment 1. In the course of that computer-based survey on consumer choices, some 445 respondents had the opportunity for voluntary access to information related to a genetically modified (GM) food through hyperlinks. Slightly less than half actually sought the information. In total, 31% of the sample population accessed health attribute information for the product, while 36% of respondents searched for environmental attribute information and 24.7% accessed the GM attribute information. Binary logit models (Liao, 1994) are postulated and tested in order to assess the impact of specific socioeconomic and demographic factors (postulated to reflect benefits and costs of information search) on respondents' access to the different types of information through hyperlink "clicks". The estimated coefficients for four of these models are reported in Table 6. The full details of this component of the study are in Gao (2005).

The four sub-models of Table 6 relate, respectively, to respondents' access to any of the information provided (Model 1.1); any health information (Model 1. 2); any environmental information (Model 1.3) and any GM information (Model 1.4). According to the significance of the postulated explanatory variables, Model 1 (which relates to whether or not any information was accessed) includes a constant (CONSTANT), respondents' gender (MALE), age (AGE), the squared form of age which accounts for a possible nonlinear response to this variable, the number of children in the household (CHILD) and the place of residence (a dummy variable URBAN, equated to 1, denoting urban residence relative to rural residency, which is specified as 0**).** In Models 2 and 3 shown in Table 6, which explain consumer information search on the health and environmental attributes of the product respectively, the variable denoting employment status, "EMPLOY. STATUS" is included in the basic model, along with a constant, respondents' gender and the presence of children in the household. The last model of the group (Model 4), which is postulated to explain access to GM information, includes a constant, respondents' gender, whether there are children in the household, age and the squared form of age as the explanatory variables.

Gender, employment status, rural or urban residency, and the number of children in the household are found to affect the probability that respondents would access information. Respondents working in full or part time employment were less likely to access information than students, homemakers and the retired, who may have had more time available. This is compatible with the hypothesis of a negative relationship between search and employment status, found or suggested in some other studies (Punj and Staelin, 1983; Srinivasan, 1986; Urbany, 1986). The conclusion from this study that information access was influenced by employment status and the number of children in the household is consistent with the proposition that information search is influenced by the opportunity of cost of time available for search. Individuals with full- or part-time employment obligations and those who had young children in their household apparently experience higher opportunity costs of time and thus search less for information. Higher opportunity costs of time available for information search may also explain the tendency for less information search by rural residents who may face more requirements to spend time on travel related to their rural residency.

Table 6: Parameter Estimates for Binary Logit Models Explaining the Probability of Searching for Information

	Model 1.1: Any info.	Model 1.2: Any health info.	Model 1.3: Any envi. info.	Model 1.4: Any GM info.
VARIABLE NAME	Coefficient (T-ratio)	Coefficient (T-ratio)	Coefficient (T-ratio)	Coefficient (T-ratio)
CONSTANT	1.044019 (0.943)	-0.1887105 (-1.025)	7.40E-02 (0.409)	0.621472 (0.517)
MALE	-0.49438** (-2.379)	-0.2735744 (-1.223)	-0.379076* (-1.754)	-0.518714** (-2.158)
CHILD	-0.23371** (-2.241)	-0.3402256*** (-3.094)	-0.322567** (-3.13)	-0.219056* (-1.735)
URBAN	0.388141* (1.816)	N. A.	N. A.	N. A.
AGE	-6.10E-02 (-1.202)	N. A.	N. A.	-7.78E-02 (-1.436)
AGE SQUARED	7.83E-04 (1.426)	N. A.	N. A.	9.68E-04* (1.676)
EMPLOY. STATUS	N. A.	-0.388403 (-1.745)	-0.376174* (-1.741)	N. A.
Log likelihood function	-274.355	-255.1307	-268.5873	-231.4249
Restricted Log-Likelihood function	-287.767	-264.511	-278.9249	-240.3079
Chi-Square (χ^2)	26.82365	18.76047	20.67537	17.76605
Adjusted ρ^2	0.046606	0.0354628	0.037062	0.036965

Note: * denotes significance at the α = 0.10 level ** denotes significance at the α = 0.05 level
*** denotes significance at the α = 0.01 level

From this analysis, in considering how information might be made available to consumers, there may be advantages in providing information targeted in a manner that specifically recognizes the characteristics of gender, employment status, rural or urban residency, and the number of children in the household as influences on the likelihood of access. Age, education, income, and residence of province were not significant explanators of information search. In terms of a general conclusion, we suggest that only if the benefits of search outweigh the costs of search will consumers search for

information. Overall, reduction in the costs of finding and accessing information should encourage information access.

Further analysis shows an association between information access and respondents' attitudes to GM food. The group of respondents that did not make an effort to acquire further specific information tended to be less strongly opposed to the presence of genetically modified ingredients than those who did access information. The impact of particular types of information on respondents' choices is being analyzed further in the complementary GE3LS project.

D: Labelling Contexts and Reference Effects

Since GM presence or absence is a credence characteristic and since there is dispute about GM food, in many nations GM labelling has been pursued for GM foods as a policy that may help to reduce market deficiencies caused by product uncertainties (Schwartz and Wilde 1985; Teisl and Roe 2001) and that may cause relatively little market disturbance (Antle 1996). Even so, there are considerable differences in international approaches to GM labelling approaches. Although there is much variation in the details of different labelling policies (Veeman 2003) the two main types of labelling policy are: mandatory labelling of GM content (seen in Europe, Australasia, and many Asian countries) and voluntary labelling of GM content or absence (the approach chosen in the United States and Canada). This component of the report summarises research examining impacts on consumers of two common GM labelling policies: mandatory labeling and voluntary labelling. Fuller details are in Hu (2004).

With mandatory labelling, products with GM ingredients must be identified if the level of GM ingredients is above a pre-determined threshold. However, in the United States and Canada, producers and the food industry have concerns that this could send a potentially inaccurate message of adverse quality and that the costs associated with mandatory labelling, at both private and the social levels, would be overly high for GM producers and processors. These costs would include segregation and identity preservation through production, handling, processing, and distribution, as well as the costs of testing, and verification (Huygen et al. 2004). Thus voluntary labelling is argued by these groups as being more cost efficient. With voluntary labelling, subject to the

provision of accurate information, producers can choose to label their product as GM or as non-GM food. Given that GM food products to date have focused more on modifications that express benefits to producers, rather than to consumers, it is generally expected that with voluntary labelling, only non-GM products will be labeled (Hu et al. 2004).

Data for this component of the study were collected from the 437 respondents to Experiment 2 of the internet-administered survey. Participants in this experiment were randomly assigned to product choice situations that simulated mandatory or voluntary labeling regimes but were not informed as to whether they were in these situations. In Experiment 2, bread products were described in terms of the price and type of bread and whether or not it was labelled as containing or not containing GM ingredients. The results indicate that these two types of strategies have distinctive impacts on consumers and on measures of social welfare.

One purpose of this component of the study is to examine the impacts of labeling policies on consumers' choices. This objective can be approached through a variety of ways. First, as with any other product-specific characteristics, such as the price or brand name, labeling may directly affect the utility consumers obtain from purchasing a product. Since the context of labelling in this study is for the GM attribute, interaction terms between the two labeling policies and the GM attributes are created. The interaction terms are used in the statistical analysis, just as for the other types of bread characteristics. A basic logit model is estimated based on this specification (Model 2.1). Second, impacts of labelling may affect consumer's utility indirectly, in that this may contribute to the degree of certainty of consumers in making product choices. In this context, the effect of different labelling policies may be used to explain the variance of consumers' choices and therefore to indirectly affect the utility obtained from their choices. The basic logit model is modified by specifically parameterizing the variance term to capture these impacts (Model 2.2). Lastly, when consumers make choices, their behavior may not be independent from their beliefs or their previous actions and situations. Related psychologically-based factors, such as prospect theory and related concepts of reference-dependence have attracted increasing attention in recent economic studies of consumer behavior. Thus we also report results based on modification of the

basic discrete choice model to capture reference point effects in respondent's purchasing decisions, as suggested from prospect theory (Kahneman 1992). This is pursued in Model 2.3.

In principle, reference point effects describe the impact of differences in utility, relative to the current level of utility, of making a product choice. In this study, the characteristics of bread that consumers indicate, at the start of the survey, as their normal bread purchase, serve as the reference point for their stated choice purchases. Specifically, relative to the price of a product, if respondents view the price they normally pay for a loaf of bread to be higher than a loaf chosen in the survey, they experience a "gain" since they need to pay less than normally to obtain the bread. On the other hand, if the price respondents normally pay for a loaf of bread is lower than what they have to pay in the survey, they suffer a "loss" in price, since now they have to pay higher than normally to buy bread. According to reference point theory, when gains or losses are involved in making a choice, for the same magnitude of gain and loss, the disutility associated with the loss will be larger than the utility associated with the gain. This asymmetric effect has been documented in studies reported in both psychology and economics literature (Kahneman and Tversky 1979; Tversky and Kahneman 1991).

Many of the previous studies involve a highly controlled laboratory environment and a small number of subjects. This component of the project applies and tests the theory in a more general environment. Another innovation of is the measurement of reference point effects surrounding the GM attribute. Since the GM attribute tends to focus on producer-level benefits and may be associated with some uncertainties (for example, to human health or to the environment), we assume that in general consumers do not wish to have the GM attribute in their bread products. According to this assumption, when a consumer who thought the bread s/he normally purchased did not contain a GM attribute, but bought a loaf with the GM attribute, a "loss" is viewed to be generated. If a consumer thought the bread they normally purchased did contain a GM attribute, but chose a loaf with no GM ingredients, then a "gain" is viewed to be generated. These gains and losses (both in price and in the GM attribute) may be used to explain the choice probabilities.

To study the social benefit of the two different labeling policies, a consumer welfare measure, called the value of information, is also developed. This measure describes how consumers value the information revealed by the different labeling policies. A distinction needs to be made to distinguish the difference between the value of information and the value of attributes. In a mandatory labeling situation, a product containing GM ingredients must be labeled; in this case, those consumers that do not prefer the GM attribute will benefit from knowing that the product contains GM ingredients. Knowing the presence of GM ingredients will help these consumers to increase utility by avoiding GM bread in their next purchase. In other words, the presence of GM ingredients may in itself be associated with negative utility, but being informed of this negative attribute helps consumers to make choices that better reflect their true preferences. The conventional welfare measure known as the compensating variation is modified to derive the correct measure of value of information (Hu, Veeman, and Adamowicz 2005). More detail on the analytic models and results are given in Hu, Veeman, and Adamowicz (2005) and Hu, Adamowicz and Veeman (2005).

Table 7 presents direct estimation results of a simple logit model that uses bread characteristics and labeling policy interacted terms as explanatory variables for choice probabilities. It is evident from this table that consumers' utility was appreciably reduced by the last option in a choice situation, the no-choice option, as represented by the negative coefficient of variable "Buyno." Utility is also lower for bread with a store brand (variable Storeb), compared with a national brand. Breads are less desirable, as indicated by their negative coefficient in the estimation results, that are either white (variable White), partially whole wheat (variable Partial) or whole wheat (variable Whole), compared with multigrain bread. The variable Price is associated with a negative coefficient, suggesting that the higher is the price for a loaf of bread, the lower is the purchasing probability for that bread.

Table 7. Estimation Results for Model 2.1

Attribute	Coeff.	Std. Error
Buyno	-2.865***	0.115
Storeb	-0.221***	0.052
White	-0.781***	0.083
Partial	-0.617***	0.078
Whole	-0.222***	0.077
GMO	-0.706***	0.109
NOGMO	0.358***	0.101
Price	-0.708***	0.033
MGMO	-0.256**	0.130
VNOGMO	-0.169	0.129
pseudo-R^2	0.109	
LL	-3267.702	

*, **, *** indicates significant at the 10%, 5%, and 1% significance level respectively.

As predicted, GM ingredients (variable GMO), have a negative impact on choice probabilities, indicating that when a loaf of bread contains GM ingredients, consumers are less likely to choose that bread as their preferred alternative. In contrast, when it is clearly indicated that product contains no GM ingredients (variable NOGMO), consumers' utility is increased, as indicated by the positive sign on this coefficient. It is seen in Table 7 that the interaction term MGMO is significant and negative, indicating that compared with the situation where no labelling context applies, for choices in the mandatory labeling context, the negative effect of the presence of GM ingredients in bread is exacerbated. That is, not only is there a negative coefficient on the original variable GMO in the utility function, but due to the negative sign of the interaction term MGMO, the effects of GM ingredients become even more negative. These findings suggest that where a mandatory labelling policy is in force, products that must be labelled as containing GM ingredients will be adversely viewed by consumers. The other interaction term, VNOGMO is not significant. This suggests that that there is no particular benefit to consumers when a product is labelled as containing no GM ingredients and when a voluntary labelling policy is in place, relative to the situation when there is no particular labeling policy.

Table 8 reports the results of the model that assumes that labelling policy differences may explain the variance of consumers' choices. The model underlying these results is a basic logit model with a reparameterized variance term. The interaction terms in the first model are now redirected as variables in the second section of Table 8 (variance specification). Comparison of the likelihood function suggests this model has a slightly better fit than the first model. In general, these results describe a similar situation to the first model: coefficients for variables Buyno, Storeb, White, Partial, Whole, GMO and Price are all significant and negative and the coefficient associated with variable NOGMO is significant and positive, suggesting that consumers like national branded multigrain bread with no GM ingredients. The variables in the second section of Table 8 provide information that could not be observed from the initial model. It needs to be noted that for convenience in modeling, the reported coefficients are opposite in direction to the actual variance of choices: a positive coefficient for a variable means a smaller choice variance is identified around that variable.

Variables Mand and Volun are two dummy variables representing the two different labelling policies. Variable Mand is not significant, indicating that compared with the case with no specific labelling requirement, there is relatively little difference among different consumers' choices under mandatory labelling. However, the coefficient on variable Volun is significant and positive. This suggests that in a voluntary labelling situation, choices made by different individuals (or by one individual at different times) may differ less compared with situations with no labelling requirements. In other words, in a voluntary labelling situation, researchers will be more likely to predict and analyze consumers' choice behavior due to less variation in choices. The variable Task measures the progression of choice tasks made by individual consumers—choices made toward the end of the survey are assumed to be further in the choice progress than those made at the earlier stages of the survey. Choices tend to become more variable in the process of the survey, which may reflect a fatigue effect. Similarly, compared with female consumers, male consumers tend to make more variable choices and compared with individuals with less education, college graduates are more consistent in terms of their choices.

Table 8. Model 2.2: Labeling Effects and Choice Variance

Attribute	Coeff.	Std. Error
Buyno	-3.093***	0.276
Storeb	-0.221***	0.062
White	-0.871***	0.086
Partial	-0.711***	0.092
Whole	-0.256***	0.076
GMO	-1.436***	0.131
NOGMO	0.304***	0.101
Price	-0.558***	0.082
Factors Affecting Choice Variance		
Mand	0.088	0.061
Volun	0.118**	0.050
Task	-0.022*	0.013
Male	-0.080***	0.022
College	0.051**	0.026
pseudo-R^2	0.139	
LL	-3195.968	

*, **, *** indicates significant at the 10%, 5%, and 1% significance level respectively.

Table 9 displays the estimation results of Model 2.3, which is similar to Model 2.2 (for which results were given in Table 8), but with four added variables (these are added directly to the specification of the underlying utility function) to capture reference point effects. This modification further improves the fit of the model as revealed by the likelihood function. The results have similar implications to those in the first two tables. The reference point effects, however, are new. Variable PriceG represents a price gain, as defined previously, which does not appear to be significant in the model. Variable PriceL represents the effect of a loss in terms of the price of the bread. This coefficient is significantly negative, which indicates that when the price of a loaf in the survey is higher than that normally paid by consumers, a loss effect will occur. This loss effect will further intensify the negative effect of price in making a purchasing decision. Comparison of the effect of loss and gain (the latter is not significant) surrounding the price coefficient indicates that the effects of consumers' loss are greater than their gains. This finding of asymmetry in losses and gains confirms the existence of price reference point effects, as predicted by prospect theory.

Table 9. Model 2.3: Labeling Effects on Choice Variance with Reference Point Effects

Attribute	Coeff.	Std. Error
Buyno	-3.093***	0.276
Storeb	-0.221***	0.062
White	-0.871***	0.086
Partial	-0.711***	0.092
Whole	-0.256***	0.076
GMO	-1.436***	0.131
NOGMO	0.304***	0.101
Price	-0.558***	0.082
PriceG	0.016	0.031
PriceL	-0.269***	0.028
GMG	0.104	0.142
GML	0.483***	0.139
Factors Affecting Choice Variance		
Mand	0.065	0.060
Volun	0.094**	0.048
Task	-0.027**	0.013
Male	-0.077***	0.022
College	0.042*	0.025
pseudo-R^2	0.143	
LL	-3136.317	

*, **, *** indicates significant at the 10%, 5%, and 1% significance level respectively.

For the reference point effect associated with the GM attribute, the interpretation is quite different. In Table 9, the coefficient on the variable representing the gain surrounding the GM attribute (GMG) that may be experienced by consumers is not significant. The coefficient on the variable representing GM loss (GML) is significant but positive. This varies from initial expectations, since if consumers indeed view the GM attribute to be undesirable, a loss in terms of the GM attribute is expected to be negative, as for the loss surrounding the price variable. However, a closer examination of respondents' attitudes towards the GM attribute reveals that an appreciable number of consumers do not necessarily treat the GM attribute as undesirable. Their attitudes may range from negative to neutral and even to positive relative to this attribute. Previous studies have verified this observation, particularly in North America (Hu et al. 2004 and

Rousu et al. 2004). Differences among consumers may help to explain the finding on loss associated with the GM attribute: although on average, consumers' attitudes toward the GM attribute are negative, many consumers do not care about this issue. Some may simply treat the presence of GM ingredients as a new feature in the product, and therefore be more likely to purchase the product, in terms of seeking a new variety of product.

E. Valuing Information

The value of information revealed through the two different labelling policies is calculated based on the estimation results presented in the previous tables. Since the data are collected through a stated preference survey, no actual "market" for the bread described in the survey exists. Consumer welfare measures, including the value of the information measure, must be calculated based on a hypothetical market. It is therefore necessary to construct a hypothetical market that includes various bread products. Several trips to a major grocery store chain in Canada provided information for this simulation. A total of 16 bread products are assumed to be available to consumers at the grocery store. The characteristics of these products, based on the store observations, are given in Table 10.1.

Table 10.1. Characteristics of the Hypothetical Market for Sliced Bread

Categories	White	Partially Whole-Wheat	Whole-Wheat	Multigrain	Sum
National Brand	1	1	2	1	5
Store Brand	3	1	4	3	11
Sum	4	2	6	4	16

Table 10.2. The Eight Breads Affected by Labelling Policies in Scenarios Three and Four

Categories	White	Partially Whole-Wheat	Whole-Wheat	Multigrain	Sum
National Brand	1	1	1	1	1
Store Brand	1	1	1	1	1
Sum	2	2	2	2	8

Based on this hypothetical market for sliced bread, different labelling policies are assumed and their impacts are evaluated. Four scenarios describing different situations under the two labeling policies are created. In the first scenario, mandatory labelling is assumed and only one of the 16 products is affected. This bread is a nationally branded white bread, specifically labelled as containing GM ingredients. In the second scenario a voluntary labelling policy is assumed. We suppose in this case that the bread in scenario one is qualified to be labelled as containing NO GM ingredients. Scenarios three and four are also assumed to represent mandatory and voluntary labelling policies respectively, except that in these scenarios eight products are affected by the labelling policy. The characteristics of the eight products are given in Table 10.2

Table 11 reports the estimated value of information under these different scenarios. The first two columns of the table give the value of information in the case that labelling differences are assumed to directly affect the utility functions through the interaction terms but without considering reference point effects. Sample standard deviations are calculated based on the value of information obtained for each individual consumer. Two interesting features can be observed in these two columns. First, when only one product is affected by the two labelling policies, the value of the information revealed under a mandatory labelling policy is higher than that revealed under a voluntary labelling situation. When eight products are affected (scenarios three and four), a similar pattern is observed. This supports a general conclusion that the information revealed under mandatory labelling is valued more than the information provided under voluntary labelling. Second, comparing the various scenarios indicates that the value of information increases along with the number of products that are affected by the labelling policy, whether in a mandatory or a voluntary labelling situation.

Table 11. Value of Information Estimates

Scenarios	Without Considering Reference Point Effects		Considering Reference Point Effects	
	sample mean	sample std. dev.	sample mean	sample std. dev.
Mandatory Labeling: One Labelled as GM	$0.08	0.05966	$0.08	0.05404
Voluntary Labeling: One Labelled as NO-GM	$0.01	0.05594	$0.01	0.05219
Mandatory Labeling: Eight Labelled as GM	$0.46	0.05439	$0.69	0.20900
Voluntary Labeling: Eight Labelled as NO-GM	$0.01	0.05531	$0.04	0.05612

The last two columns of Table 11 give results of value of information measures based on a very similar model but also with the consideration of reference point effects. The features noted above are also found here. It is also noted that the sample standard deviations of these estimates are generally higher than for the first two columns. This arises because, depending on individual consumers' reference point and their actual choices in the survey, reference point effects may have very different roles in the estimate of the value of information: some consumers may consistently have gains or losses involved with price and/or the GM attributes or a mixture of gains or losses depending on each choice situation. Therefore the variation among estimates of consumers' value of information when considering reference point effects measures is expected to be higher.

F: Two Case Studies on GM Implications for Agricultural Costs

Two further thesis research studies were supported in part by AARI Project # 2001J025 and partly by the complementary Genome Prairie GE3LS (Genetics, Ethics, Environment, Economics, Law and Society) project. These are embodied in the M.Sc. thesis research projects completed by Elspeth White and Israel Huygen.

The study by White (2004) focuses on economic analysis of the use of conventional and genetically modified potatoes in Prince Edward Island in the context of costs, including costs of associated health risks of air-borne pesticide residues and consequent potential impacts on the health of farmers and their families. Estimates of

health impacts and other related costs are developed for conventional potato growing practices and in growing genetically engineered potatoes (NewLeaf, NewLeaf Plus and NewLeaf Pro potatoes, each genetically modified for particular traits). From interviews with potato specialists and potato farmers, it was discerned that pesticide applications were reduced when using the genetically modified potatoes. The extent of reduction in pesticide applications is documented and translated into financial benefits and potential health benefits received by the pesticide applicator. It is concluded that the financial benefits gained from the use of fewer inputs are much more substantial than are the health costs associated with reduction of exposure to pesticides in the case studied.

The study by Huygen (Huygen 2004) focuses on the creation of supply chains involving identity preservation of genetically modified (GM) and non-GM crops. Cost differences are estimated for three selected supply chain systems for Canadian non-GM wheat at different levels of tolerance for GM materials. The selected systems extend from the farm to export port and include use of both mixed and dedicated country and export elevators, as well as farm-level containerization of wheat. There is an appreciable increase in the costs of identity preserved marketing of non-GM wheat within each system as threshold levels tighten from 5.0 percent to 0.1 percent.

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

The various components of this project indicate significant diversity amongst Canadians in their views on genetically modified food. The statistically rigorous analysis of stated choice data indicates four distinct segments of Canadians relative to GM food. For nearly half of the sample, choice behavior indicates a high level of aversion to genetically modified food. However, the choice responses of a slight majority of respondents do not demonstrate a particularly high level of aversion; when health or environment attributes are introduced the product is preferred by some consumers. Differences in respondents' gender, the presence of children in the household, education, and age are associated with the likelihood of segment membership. We outlined implications of these findings, and note that policy must recognize the strong dichotomy in public attitudes in Canada.

When information on GM-related issues is available and accessed, choices tended to be affected. However, only about half of the respondents who could have accessed further information actually chose to do so. In general, those who chose not to access information tended to be less opposed to genetically modified food. Our work shows gender, employment status, rural or urban residency, and the presence of children in the household to influence the probability that respondents access information on particular GM-related topics. Female respondents, not working outside the home, without children in the household, and living in urban areas were the major socio-demographic characteristics of people who accessed information on the product. We noted implications for information provision. Overall, we expect that reduction in the costs of finding and accessing information should encourage information access. Information provision programs should also recognize that not all information sources are equally trusted sources of GM information—information from industry groups and government are not highly trusted, whereas information from research institutions and consumer groups are perceived to be more trustworthy.

A further section of this project builds on work undertaken in a previous AARI project, with the assistance also of a complementary Genome Prairie project. This focused on labelling approaches to regulate foods with genetically modified ingredients through examination of consumer behavior and welfare implications of two common policies: mandatory and voluntary labelling. Consumers' evaluation and welfare analysis of products with or without GM ingredients are appreciably different under these labelling policies.

Under a mandatory labelling policy, without product improvements, consumers are more averse toward GM ingredients than under voluntary labelling or no labelling requirements. Estimates of the value of information revealed under the two labelling policies are also distinctively different. Consumers in general place more value on information provided in the mandatory labelling situation than under voluntary labelling and the value of information increases with the number of product alternatives that are affected by the labelling policy. Knowledge of these different effects and implications of the two labelling policies can be useful to policy makers in assessing labelling and other policies for GM foods. We also found that GM ingredients and prices can affect

consumers' utility and purchasing intentions through reference point effects. Whether a product contains GM ingredients and how it is labelled can affect consumers' GM reference point effects, product choices and valuations.

Several methodological and empirical contributions have been made by the project, including the consideration of product innovations on individual's attitudes and choices, the identification of latent classes representing different purchase motivations, and the application of an appropriate method of valuation of information from labelling. Further, the two case studies provide information on different aspects of the costs of GM/non GM crops that can impinge directly on farmers (White, 2004) or on specialized supply-chains for non-GM product that accompany the development of GM crops. Almost all previous studies on the impact of information on consumers' choices of GM food have required respondents' to read information and then assessed impacts, rather than assessing voluntary information access which is undertaken in this project.

Despite contributions of this project, there are numbers of interesting and important issues relating to the potential impact of information on social attitudes to agricultural biotechnology that remain for further analysis. These include extended consideration of the simultaneous assessment of determinants of consumers' information search behaviour and their attitudes and/or purchasing intentions for GM foods. A related issue is whether and how consumers' attitudes on GM products evolve over time given exposure to increasing amounts of information.

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