RURAL ECONOMY

Consumer's Perceptions of Environmental Risks and the Demand for Food Safety

Michele Veeman and Wiktor Adamowicz

Project Report 00-01

Alberta Agricultural Research Institute Project No. 960730

Project Report

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Abstract

Public concern regarding food safety has emerged as a major policy issue. Chemicals and biotechnological processes are perceived as risks of food safety despite their contribution to an efficient, low cost agriculture and food industry. Increases in uses of biotechnological processes for foods are expected to be a major potential source of productivity improvements for Alberta and Canadian agriculture in future years. However, the demand for food safety involves increasing awareness and concern by consumers of chemical inputs and biotechnological processes in the agriculture and food industries. Nonetheless, there is a lack of basic economic and agricultural economic theory and methodology to analyze these issues and a need for policy, socioeconomics and marketing research on biotechnology and other environmental risk situations in the agricultural and food industry. This project was directed at developing and applying economic theory and methodology to help fill this gap. A major contribution of the project is the identification and verification of methodologies of stated choice to analyse tradeoffs arising from food safety perceptions of concerns by consumers.

One component of the research project involved assessment of Alberta consumers' stated preferences and purchase behaviour for foods exhibiting a range of environmental risks, including perceptions of pesticide residues and hormonal treatments derived from biotechnological processes. The results of this survey indicated that Albertans were more concerned about pesticide use in food production than about the use of hormones. In contingent valuation questions developed for the study, more Albertans wish to restrict pesticide use (relative to a base case of not restricting either hormones or pesticides). They tended to persist in these choices in the face of potential increases in food costs, reflecting a higher level of concern with pesticides than hormones. Increasing education increased this concern. Increasing food cost decreased the probability of choosing to restrict pesticide or hormone use. Women appeared to perceive pesticide use in food production as a greater food safety risk than was perceived by men. The inferred average willingness to pay to restrict pesticide and

growth hormone use in food production amounted to about 25% and 13% respectively of the average Albertan's food expenditures respectively.

In the second survey of consumers' food/environmental risk perceptions undertaken relative to this project, the responses of a random sample of consumers to the use of recombinant bovine somatotrophin (rBST) in milk production were elicited using a stated preference methodology. A conditional logit model of consumer choice was developed and tested to analyse consumers' choices of milk with varying characteristics of fat content, price, freshness and rBST treatment. Awareness of rBST presence or otherwise is implied by labelling. The approach attempts to simulate market conditions with and without rBST labelled milk and to predict consumers' responses to variations in these conditions. Welfare calculations for a representative consumer indicate welfare losses with the introduction of rBST. These were slightly less for a male than a female household food purchaser and were less for food purchasers with higher levels of income and education. There was a small welfare gain when the representative food purchaser was offered a full range of "rBST" and "non-rBST" milks. The results suggest that making appropriately labelled "rBST-free" milk available to consumers could decrease consumer welfare losses associated with any introduction of rBST.

The outcomes from application of these methodologies were related to the evidence of consumers' purchasing behaviour after licensing of the technology of rBST for use in the United States; this introduction did not require labelling. The assessment suggests a critical impact of product labelling policies and strategies on potential market impacts. An assessment is also made of Canada's food safety regulatory framework. The need for increased transparency and greater public participation in regulatory processes as means to increase public confidence in such food safety regulatory processes, specifically relating to biotechnology, is also identified.

I. Introduction

Public concern regarding food safety has emerged as a major policy issue. Chemicals and biotechnological processes are perceived as risks of food safety despite their contribution to an efficient and low cost agriculture and food industry. Increases in potential uses of biotechnological processes and treatments for foods are expected in the future. Such processes and treatments are, indeed, expected to be a major potential source of productivity improvements for Alberta and Canadian agriculture in future years. However, the demand for food safety involves increasing awareness and concern by consumers of chemical inputs and biotechnological processes in the agriculture and food industries. Nonetheless, there is a lack of basic economic and agricultural economic theory and methodology to analyze these issues and a need for policy, socioeconomics and marketing research on biotechnology and other environmental risk situations in the agricultural and food industry. This project was directed at developing and applying economic theory and methodology that will help fill this gap. It is one of the first Canadian agricultural economic research studies on food safety.

A national survey of risk issues in the early 1990s revealed that approximately 30% of Canadians felt that “pesticides in food” and “food additives” are high health risks. These two categories of risk were rated as about as high a risk as “PCBs and Dioxins” and “Drinking Alcohol” and as higher risks than “Asbestos” and “Bacteria in Food” (Government of Canada, 1993). The level of anxiety that is often associated with concerns about food risks is illustrated by the long debate over the licensing of the recombinant form of the naturally occurring protein, rBST (the biotechnologically derived form of bovine somatotropin, a growth hormone that stimulates milk), which was finally resolved in Canada in early 1999 when the decision was reached not to license this drug, essentially on animal welfare grounds. This issue is the basis of a case study that was undertaken as part of this project. It is, therefore, discussed in more detail later in this report. Similar public concern and debate about appropriate policy surrounds biotechnology-derived food products, food additives and

perceptions regarding pesticide residues in food products. These concerns increased through the 1990s as biotechnological processes and treatments for foods increased. Some of these risks can be viewed as "environmental risks" or broadly defined "food risks" since they stem from the use of chemicals or biotechnological processes in an agricultural setting. There is some evidence of an increase in public concern about these types of risks, as opposed to the traditional type of food safety risks, such as from pathogen contamination of food. Informed policy analysis of these issues requires information on the tradeoffs consumers are willing to make between various types of risk, prices and other attributes of food products and the effects of their perceptions and tradeoffs on the demand for food. Furthermore, effective risk communication and risk management requires information on risk perceptions and tradeoffs. This project is directed at these issues.

The use of pesticides, biotechnology derived food products, and other related processes is regulated, necessitating information on the benefits and costs associated with licensing and related regulatory decisions for policy analysis and development of appropriate policy. Information on consumer preferences, including tradeoffs between perceived risks and various attributes or components of foods, is expected to be useful to primary producers and food manufacturers as they make production and management decisions in response to changing economic circumstances and consumer perceptions and preferences. Such information may lead to the development of new marketing approaches or new products or new marketing approaches (eg. Hammitt, 1990), as well as aiding risk communication regulation and policy.

II. Project Objectives

The key objectives for this research involved assessment of the impact of the effects of various environmental risk factors and perceptions, including pesticide residues and hormonal growth treatments, on consumers' preferences for food. The detailed objectives of the study were specified as:

(a) assessment of the nature of risk perceptions of Alberta consumers regarding selected biotechnological processes and chemical residues or additives. This was specified to involve i) a broad assessment and ii) a specific case study pertaining to milk from rBST treated cows.

(b) assessment of the likely impact of such perceptions on market demand. Arising from the request by AARI that we expand the scope of the study for this purpose, the objectives were expanded to relate consumers' stated preferences on milk from rBST-treated cows to evidence on actual market choices following the licensing of this particular biotechnological process (rBST treatment) in the United States.

(c) assessment of the regulatory processes that apply to the licensing of biotechnological processes and chemical residues or additives based on the information from (a) and (b).

III. Changes in Project Relative to Original Objectives

An extension of the project was necessitated by the AARI request that we expand its scope to include actual results of US consumers' perceptions about rBST use. This is reflected in II. b. above.

IV. Summary of Research Design, Data Collection and Analytic Approaches

Theoretical Approach

Consumer theory assumes that consumers are rational in that they allocate their limited resources, in the form of a limited budget, among a variety of goods and services in a way that maximizes utility. A refinement of this framework is given by Lancaster (1966) in which he points out that consumers typically purchase attributes which are embodied in goods, rather than purchasing goods for their own sake. An example would be the desire to obtain a healthy diet, which is reflected in the purchase of foods that contain relatively low fat levels. Discrete choice theory follows the major concepts of consumer theory but allows for the consumption of discrete quantities of goods and services in a manner that permits the consumption of one or more goods to be zero.

This body of theory is useful in examining food safety issues. Consumers cannot directly buy units of food safety. They can choose to avoid foods that they may perceive as risky, such as milk

from cows that have been treated with rBST. They can also choose to pay a higher price for foods that may be perceived to be less risky, such as "organically" grown fruit and vegetables. These types of choices lend themselves to analysis in a discrete choice framework.

Discrete choice models are formulated with both a deterministic and a random utility component. In such "random utility" models, the probability of an individual choosing a particular alternative is viewed to be a function of both the attributes of the alternative and the characteristics of that individual. It is assumed that the researcher knows some or all of the attributes of an alternative and can measure the individual's characteristics. The researcher cannot, however, know all of the preferences and characteristics of the individual. In addition, there may be unknown or unobserved attributes of an alternative that enter into the individual's utility function. Thus, there is both a deterministic component (attributes and characteristics known by the researcher) and a random component (unknown attributes and characteristics) of a random utility model. For consumer i faced with J choices the utility of choice j can be depicted as:

$$U_{ij} = ß'Z_{ij} + e_{ij} \quad \textbf{(1)}$$

where: Z_{ij} is a vector of the attributes of the characteristics of individual i and the attributes of alternative j.

The probability that consumer i will choose j is equal to the probability that U_{ij} is greater than the utility received from any other alternative in the set of alternatives. Random utility models are obtained by specifying a distribution for the error terms (e_{ij} in equation 1). It is commonly assumed that the e terms are IID Gumbel (or Extreme Value Type 1) randomly distributed (Ben-Akiva and Lerman, 1985).

In some choice situations utility depends on characteristics which vary across individuals, and attributes which vary across alternatives. Consumers of varying ages, incomes and education choosing between milks of varying price, freshness and fat content provide an example of such a situation. The conditional logit model has been formulated for these situations (Greene, 1991). In the conditional logit model, utility depends on Z_{ij}, which includes characteristics that are specific to the

individual as well as attributes that are specific to the choices. Thus, let $Z_{ij} = [X_{ij}, W_i]$, where X_{ij} is a vector of the attributes of altenative j as experienced by consumer i and W_i is a vector of the characteristics of consumer i. Then, X_{ij} varies across the choices while W_i does not. Thus the probability of individual i choosing alternative j is:

$$\text{Prob}[Y_i = j] = \frac{e^{\beta' X_{ij} + \theta_j' W_i}}{\sum_j e^{\beta' X_{ij} + \theta_j' W_i}} \qquad \textbf{(2)}$$

where **$** and **(** are parameters to be estimated. For more explanation of the conditional logit model the reader is referred to Greene (1991).

Extension of Choice Theory to Stated Preference Applications

This project examines the effects of risk and risk characteristics on consumer choice through disaggregate econometric models of consumer choice. Such models have been used to assess values associated with environmental attributes. They have also been used in studies of marketing, transportation, and geography to assess choices (Louviere, 1991). In economics these models are typically applied to assess actual choices as functions of attributes of the goods, or analysis of revealed preference data (McFadden, 1974). Recently, the use of stated preference models of choice, in which the individuals describe choices from descriptions of situations (rather than actual choices) have become popular in the environmental literature (Adamowicz et al, 1994a; 1994b). Stated choice models have the advantage of being able to cover a larger range of attributes than is the case in many actual market choices, thus allowing for the assessment of choices of goods that are not currently in the market (eg. pork produced using porcine growth hormone or milk from cows treated with recombinant bovine somatotrophin). Furthermore, stated preference models are designed such that the effect of each attribute is separated in the model, whereas in actual market data, information on attributes is often correlated. In this study we applied stated choice methodologies that pose hypothetical questions to elicit information on preferences and monetary measures of risk tradeoffs (eg. Smith and Desvousges, 1987; Horowitz, 1994).

Data Collection

To analyze the effects of risk perceptions on consumers' preferences and risk tradeoffs for foods, stated preference data were collected. The approach required individual responses to choices from a structured hypothetical market. Initial research using focus groups was used to develop the attributes associated with the selected foods and the descriptions of the attributes that consumers related to. Included in these attributes are perceptions of food risks and characterizations of these risks. The focus groups were used to design the stated preference component of the research and the survey instrument.

Summary of Analytic Approach

Based on the results from the focus groups, two sets of stated preference experiments were constructed. These examine the choice of product based on characteristics that include price, selected risk characteristics, and other product characteristics. Two approaches were applied for disaggregate data collection. One approach involved a telephone survey of Alberta consumers. The second approach used a mail survey of a random sample of individuals in the City of Edmonton from whom both revealed and stated preference data were requested. Multinomial logit models that are based on the economic theory of random utility, arising from errors in perceptions and observations, were developed for both sets of data. Fuller outlines of the theory, methodology and analysis are presented in the working papers, MSc thesis, conference paper and refereed journal paper that have emanated from this project to date (Kuperis, et al, 1966; Kuperis, 1997; Kuperis et al, 1999; Veeman, 1999).

Following the suggestion of the AARI screening committee, an assessment is made of the impact that a selected risk perception issue, the use of rBST in milk production appears to have had on US milk demand. We consider whether this effect might apply in Canada. Finally, an assessment of the process of regulation of food safety that applies for various food risks was undertaken in the light of the preceding economic analyses.

V. Results and Discussion

Survey of Attitudes and Trade-Offs in Food Purchases

Two surveys were undertaken through this project. For both surveys, informal focus group processes were pursued to identify appropriate product attributes and survey design; the survey instrument was then designed, pretested and applied to obtain specified data. One of these, the survey of Alberta consumers' attitudes to food risks and trade-offs concerning various specific environmental risks associated with agriculture and food, was undertaken with assistance also from the Eco-Research Chair in Environmental Risk Management. This survey on food safety attitudes and trade-offs was conducted through the mechanism of the University of Alberta's Population Research Laboratory. This included a telephone survey of a representative sample of 1,240 Alberta consumers. In this survey we elicited information on Alberta consumers' willingness to pay for the reduced use of both pesticides and growth hormones in food production. Attitudes towards a variety of food-borne health risks (which are considered by food scientists to constitute a more appreciable food safety risk) were also surveyed. The questions were framed in a manner to enable the testing of a multinomial logit model that allowed analysis of the effect that increasing food costs and respondent's demographic characteristics have on consumer's stated preferences to purchase pesticide-free or hormone-free foods. Fuller details of this survey and analysis of these data are available as a working paper (Kuperis, *et al*, 1996).

Comparison of the results from this survey with previous studies suggest that Albertans are similar to other consumers in their rating of food safety concerns. Pesticides and dietary fat and cholesterol were rated as moderate or high health risks by over 75% of the respondents. Growth hormones, bacteria in food and food additives were rated as moderate or high risks by two thirds of the respondents. These ratings are described in more detail in Table 1.

Table 1. Albertans' Rating of Food Safety Issues

	Percentage of Respondents Specifying:			
	Almost No Health risk	Slight Health Risk	Moderate Health Risk	High Health Risk
Pesticides	4.4	18.3	40.0	37.4
Bacteria In Food	9.2	28.1	39.1	23.6
Food Additives	7.9	29.6	39.3	23.1

Growth Hormones	10.0	23.3	37.1	29.5
Fat and Cholesterol	3.6	9.5	37.3	49.5

A second group of food safety questions that were applied in this survey were designed to elicit discrete choice responses as to whether respondents would chose to regulate pesticide use or hormone use at a 10% food cost or whether they would choose to regulate neither of these agricultural inputs. Those who chose to restrict were queried whether they would continue to do this if the consequences were for a 20% increase in food costs. The aggregate responses to this portion of the survey are presented in Table 2.

Table 2. Numbers and Percentages of Albertans' Choosing to Restrict Pesticides, Hormones or Neither at Given Increases in Food Costs

Choice	***Pesticides at 10% Cost Hormones at 10% Cost***	***Pesticides at 20% Cost Hormones at 10%***[1] *Cost*	***Pesticides at 10% Cost Hormones at 20%***[2] ***Cost***
Pesticides	548 (48.8%)	413 (78.2%)	62 (20.0%)
Hormones	325 (28.9%)	50 (9.5%)	220 (71.0%)
Neither	251 (22.3%)	65 (12.3%)	28 (9.0%)

[1,2] These choices are conditional on the choice of pesticides or hormones at a 10% cost increase. That is, the responses to a 20% cost of the 548 individuals choosing to restrict pesticides at a 10% cost are given in column 3. The responses of the 325 individuals who chose hormones at a 10% cost are given in column 4.

The final section of the questions on food safety that were applied in this survey examined the ranking of food safety concerns by Albertans. Fat and cholesterol were most frequently ranked as the most important concern, followed by pesticides. Hormones, food additives and bacteria ranked as less significant concerns for most respondents. These rankings are consistent with Table 1.

Table 3. Albertans' Ranking of Health Concerns

Concern	**Numbers Citing Concerns as the Most Significant Health Risk**	
	Number	**Percent (%)**
Pesticides	362	30.3
Bacteria in Food	127	10.6

Food Additives	104	8.7
Growth Hormones	111	9.3
Fat and Cholesterol	491	41.1

It is evident that Albertans considered pesticides to be a greater health risk than growth hormones. This is reflected in the ranking of the two risks, shown in Table 3, and in the choices to restrict at a 10% cost given in Table 2.

Based on the data described in the preceding sections, an econometric model was estimated using the entire data sample for which individual-specific responses were available. Thus, those individuals who did not answer one or more of the relevant demographic questions (age, gender, number of children, income, years of education, urban resident) were not included in this section of the analysis. The dependent variable in this analysis is the choice to restrict pesticide use, hormone use, or to restrict neither pesticide or hormone use in food production. Based on the econometric estimates, measures of Alberta respondents' willingness-to-pay for reducing pesticide and hormone use were calculated using average weekly food expenditure data for Alberta (Statistics Canada, 1992). A representative consumer in the sample is willing to pay an increase in weekly food costs of $33.01 for restrictions on pesticide use. He or she is willing to pay an increase in weekly food costs of $17.90 for restrictions on hormone use.

Conclusions from Survey of Attitudes and Trade-Offs in Food Purchases

Overall, the conclusions from the survey which used contingent valuation methods to ascertain Albertans' attitudes to two specific food safety concerns, pesticide and growth hormone use in food production, can be summarized as follows. Albertans' stated choices to restrict either pesticide or hormone use, as opposed to restricting neither, were examined. Some of the general results were similar to those elicited by earlier surveys (Consumer's Association of Canada 1990; Finn and Louviere, 1992). This survey indicated that Albertans were more concerned about pesticide use in food production than about the use of hormones. When asked to choose, more Albertans chose to restrict pesticide use than hormone use, as opposed to the base case of not restricting either. They

tended to persist in these choices in the face of rising food costs. The choice to restrict pesticides was more persistent than the choice to restrict hormones. This reflected a higher level of concern with pesticides. Increasing education increased the probability of an Albertan choosing to restrict pesticides or hormones. Increasing food cost decreased the probability of choosing to restrict pesticide or hormone use. Women appeared to perceive pesticide use in food production as a greater food safety risk than was perceived by men. A significantly larger number of women than men chose to restrict pesticide use and were willing to pay a larger amount for a program to do so. The inferred average willingness to pay to restrict pesticide and growth hormone use in food production amounted to about 25% and 13% respectively of the average Albertan's food expenditures respectively. While the estimates of the implicit willingness-to-pay for food safety values may seem large, they did not differ greatly from amounts that consumers have been estimated to pay for various agricultural support programs in some high income countries.

Case Study of Attitudes to rBST and Trade-Offs in rBST Use and Other Milk Attributes

Bovine Somatotrophin (BST) is a naturally occurring hormone that stimulates increased milk production in dairy cows. This effect of BST has been known to researchers since the 1930's. Until the development of recombinant DNA techniques, the large scale production and use of BST was not commercially feasible. Subsequently commercial recombinant Bovine Somatotrophin (rBST) products have been developed which make it possible to treat cows with rBST in order to increase milk production. The proposal to license these rBST products for use in Canada met with significant opposition from dairy processors, consumer groups, some dairy producers and some scientists. Those in favor of licensing rBST argued that there may be significant gains to producers and consumers from reduced costs of milk production through the use of rBST. They also emphasize that treating cows with rBST does not cause any discernible change in the composition of milk, so that consuming milk from cows treated with rBST should pose no human health risks.

Those opposed to the use of rBST maintained that the long term human health effects of milk from cows treated with rBST are not known, that the use of rBST would lower the demand for dairy products and that the injection of cows with rBST is inhumane. It is also claimed that rBST use will reduce the number of family dairy farms. The initial result of this debate was the decision, announced in August 1994, to place a moratorium on the use of rBST in Canada until July 1, 1995 to allow further review and study (Powell and Leiss, 1997). This moratorium was extended and in January 1999 Health Canada announced that rBST would not be licensed for use in Canada, as its use could adversely affect animal health. As further developments in biotechnology occur, the number and frequency of these types of debates can be expected to increase.

Previous Research Relative to Case Study

While much research into the potential production effects and farm-level economic effects of rBST has been undertaken, few studies have assessed consumer response to, and perceptions of, the use of rBST. Most of the research on consumers' response to rBST has been performed in the United States. Recombinant Bovine Somatotrophin has been licensed for use in the United States and was introduced for use in February 1994.

Studies by Preston, McGuirk and Jones (1991) and by Kaiser, Scherer and Barbano (1992) surveyed US consumers to determine their potential response to rBST. These studies predicted possible consumption declines of 14 percent and 15.6 percent, respectively, if rBST was approved for use and milk prices did not change. Fox, Hayes and Kliebenstein (1994) used experimental auction techniques to assess consumers' responses to rBST. Approximately 60 percent of the subjects would purchase "rBST milk" at the same price or a slightly lower price than "rBST-free" milk. While the studies noted above concluded that milk consumption might decline if rBST was licensed in the United States, this does not appear to have occurred.

Brinkman (1995), in a report to the Task Force appointed by the Government of Canada to review the impact of rBST in Canada, stated that fluid milk consumption in the United States actually

increased by 0.6 percent in the first full year of rBST use. Both Preston et al. (1991) and Kaiser et al. (1992) indicated that there was a potential market for milk labeled as “rBST free”. Brinkman (1995) however, states: “There are no precise figures for sales of milk identified as rBST free, but it appears from discussions of knowledgeable persons in a number of states and in the USDA that these sales likely represent less than two percent of total U.S. fluid milk sales” (Report of the rBST Task Force, 1995). This discrepancy may be due to the fact that the studies assumed that milk from cows treated with rBST would be identified in some manner. In most states, however, labeling of milk from cows treated with rBST has not been required.

If “rBST milk” and “rBST-free milk” were available to consumers at the dairy case, a different consumer response may have been observed. It is also possible that the response found by these researchers may have been due to the fact that their surveys drew specific attention to the use of rBST. Supporting this possibility, a survey by Finn and Louviere (1992) of Alberta residents showed that food safety concerns rank relatively low compared to other social issues such as crime, quality medical care and poverty. When instances of unsafe foods occur, and receive media coverage, food safety becomes of more immediate concern to consumers.

The approach used in this study differs from those used in previous studies of consumer response to rBST use. These focused on a single trade-off, that of milk price and the use of rBST in examining consumers' anticipated reaction to this use. In contrast, in this study, consumers were asked to choose from a hypothetical set of milks (including a non-purchase option) rather than being asked “Would you buy more, less or the same amount of milk if rBST was licensed for use?” The study creates a hypothetical market that is analogous to the current situation confronting consumers at the dairy case by introducing to this a new element, the use of rBST. This approach relates more directly to consumer behaviour in allowing consumers to make trade-offs between rBST and the selected milk attributes of fat content, milk price and milk freshness through stating their preferences for products described as having different levels of these characteristics.

The value of estimates obtained through stated preference methods is a matter of some debate. Stated preference methods deal with goods that do not exist or goods that are not currently traded in a market (such as “rBST-free” milk). Estimates based on consumers' stated reactions to a hypothetical situation may not be as accurate as those obtained through revealed preference methods that observe actual consumer behaviour. However, a recent meta-analysis of 83 studies that compared stated preference to revealed preference estimates over a range of goods and issues found no significant difference between the two methods (Carson, et al, 1996).

Methodology for Case Study

The Conditional Logit Model of Milk Purchases

This component of the study was concerned with the consumer’s decision to purchase milk and the effect that rBST might have on this decision. This choice can be modeled as a process involving two decisions. First, the consumer decides whether s/he will purchase milk on a particular shopping trip. Second, the consumer decides which type of milk to purchase. Thus, a consumer can be imagined as approaching the dairy case having already decided to purchase milk. At the dairy case s/he evaluates the attributes of the milk types present and chooses to purchase one or more types of milk. This study introduces a new attribute, the use of rBST, which enters into the consumer’s decision process. This new attribute may cause the consumer to change the usual milk purchasing behaviour, for example, to buy “rBST-free” 2% milk as opposed to the usual purchase of skim milk --or the consumer may decide not to purchase any milk at all.

The milk purchase decision is assumed to be based on constrained utility maximization, as reflected in the indirect utility functions described below. These functions are linear in parameters and their arguments include Z_{ij}, a vector of attributes of milk; W_i, a vector of socioeconomic characteristics of individual i; and β and γ, vectors of unknown parameters. The postulated indirect utility functions for the four types of milk are:

$$V_{1i} = ASCS + \beta' Z_{1i} + \gamma_1' W_i \quad \textbf{(3)}$$

$$V_{2i} = ASC1 + \beta' Z_{2i} + \gamma_2' W_i \quad \textbf{(4)}$$

$$V_{3i} = ASC2 + \beta' Z_{3i} + \gamma_3' W_i \quad \textbf{(5)}$$
$$V_{4i} = ASCH + \beta' Z_{4i} + \gamma_4' W_i \quad \textbf{(6)}$$

where subscript 1 denotes Skim milk, 2 denotes 1% milk (that is, milk with 1% milkfat content), 3 denotes 2% milk and 4 denotes Homogenized (Homo) milk, which has a higher level of milkfat. The alternative specific constants ASCS, ASC1, ASC2 and ASCH are intended to capture the satisfaction associated with choosing Skim, 1%, 2% and Homogenized milk, respectively. That is, ASCS is intended to capture the difference in utility between the alternative of choosing to purchase skim milk and the base case, which is choosing not to purchase any milk at all, all other things held constant. For a fuller discussion of alternative specific constants, the reader is referred to Ben-Akiva and Lerman (1985).

Using the four indirect utility functions given above, a conditional logit model was specified for the milk purchase decision. Based on prior discussions with numbers of consumers, the variables chosen for the vector Z included major attributes of milk that may be directly observable by the consumer at the dairy case. The variables included in this vector are: price, freshness and the "presence" of rBST. The fat content of the milks is expressed through the four milk types.

An examination of previous studies on rBST and literature related to consumers' perceptions of food safety, combined with *a priori* beliefs, led to the inclusion of the following socioeconomic variables in the model: age, gender, number of young children in the household, household income, years of education and prior knowledge of rBST. Studies of food safety, such as Lin (1995), have indicated that age and gender may have a significant effect on attitudes towards food safety. Older consumers are generally expected to be more concerned about food safety. Women generally appear to be more concerned about food safety than are men. Lin (1995) also suggests that households with young children will be more concerned about food safety and that consumers with higher levels of education will be more aware of food safety issues. Households with higher incomes may feel they have greater financial resources to devote to reducing external risks. Depending on the nature of the

previous information they have received, consumers with prior knowledge of rBST may, or may not be, concerned about its use. The inclusion of these variables is supported by the studies of consumers' perceptions of rBST conducted by McQuirk, Preston and Jones (1990); Kaiser, Scherer and Barbano (1992); Grobe and Douthitt (1995); and Fox, Hayes and Kliebenstein (1994). The variables used in estimating the final models are defined in Table 4 below.

Table 4. Case Study: Variable Definitions

ASCS	An alternative specific constant representing the utility associated with Skim milk.
ASC1	An alternative specific constant representing the utility associated with 1% milk.
ASC2	An alternative specific constant representing the utility associated with 2% milk.
ASCH	An alternative specific constant representing the utility associated with Homo milk.
PRICE	The price per litre for the milks presented in the choice scenarios
rBST	A dummy variable indicating whether the milk presented in a choice scenario is from cows that have been treated with rBST. 1=Yes, 0=No
FRESH	The freshness of a milk presented in a choice scenario.
AGE	Age of the respondent.
GENDER	A dummy variable representing the respondent's gender, 1=female, 0=male.
YCHILD	The number of children in the household who are under the age of six.
HINC	Total household income before taxes.
EDUC	Number of years of education completed by respondent.
PRIOR	A dummy variable representing whether the respondent had knowledge of rBST prior to receiving the survey. 1=Yes, 0=No.

In conditional logit models the socioeconomic variables do not vary across the alternatives and therefore must be expressed as alternative specific variables. That is, the variables denoting age, gender, etc. are each expressed as constants that are specific to each alternative. Thus, there are four age coefficients in the model: AGES, AGE1, AGE2 and AGEH. The coefficient AGES expresses the effect of age on the probability of choosing to purchase Skim milk relative to the base case (choosing not to purchase any milk) while AGE1, AGE2 and AGEH express the effect of age on the probability of choosing 1%, 2% and Homo milk, respectively. PRICE, BST and FRESH are already expressed as alternative specific variables. Table 5 gives the name of each variable in each alternative.

Table 5. Case Study: Alternatives and Variables

Variable	**Alternatives and Coefficient Names**			
	Skim	**1%**	**2%**	**Homo**
CONSTANT	ASCS	ASC1	ASC2	ASCH

PRICE	PRICE	PRICE	PRICE	PRICE
BST	BST	BST	BST	BST
FRESH	FRESH	FRESH	FRESH	FRESH
AGE	AGES	AGE1	AGE2	AGEH
GENDER	GENDERS	GENDER1	GENDER2	GENDERH
YCHILD	YCHILDS	YCHILD1	YCHILD2	YCHILDH
HINC	HINCS	HINC1	HINC2	HINCH
EDUC	EDUCS	EDUC1	EDUC2	EDUCH
PRIOR	PRIORS	PRIOR1	PRIOR2	PRIORH

The Data for the rBST Case Study

The data for this section of the study were collected through a mail survey of residents of Edmonton. The survey was designed to elicit information on consumers' attitudes towards milk, consumers' perceptions of attributes of milk, consumers' attitudes towards the use of rBST and socio-economic and demographic characteristics of the survey respondents. The final design for the contingent choice questions yielded 64 choice scenarios. These were split into four groups of 16 scenarios each. This resulted in four versions of the survey. The responses to these contingent choice questions comprise the choice data used in this study. An example of a contingent choice question is given in Figure 1 below. Further details are in Kuperis (1997).

Figure 1: Example of A Choice Scenario
If the 4 milks listed below were available at all stores and were the only milks available

Feature	***Skim***	***1 %***	***2 %***	***Homo***
Price ($/litre)	0.99	0.79	0.99	0.89
BST	No	no	Yes	no
Freshness	4 days before expiry date	8 days before expiry date	10 days before expiry date	8 days before expiry date
I would buy:	__litres of skim milk	__litres of 1% milk	__litres of 2% milk	__litres of Homo milk
		___I would not buy any milk		

As can be seen from Figure 1, the respondent could choose to buy more than one milk. That is, the respondent could choose to buy Skim milk, 1%, 2% and Homogenized milk in the same choice scenario. This is an extension of previous choice surveys where the respondent could only choose one of the alternatives in a choice scenario. The data generated by this technique are converted into proportions. For example, consider a consumers' choice to purchase 4 litres of Skim milk and 4 litres of 2% milk in the scenario given in Figure 1. The proportions of the milk types chosen are: 0.5, 0,

0.5, and 0 for Skim milk, 1% milk, 2% milk and Homo milk respectively. The choice probabilities are calculated based on the proportion of each milk type chosen in a given choice scenario.

The survey was relatively lengthy (16 pages) for a mail survey and was designed using the Total Design Method to maximize the response rate (Dillman, 1978). The distribution of the survey was conducted by Advantage Field Research in the spring of 1996. Based on current Edmonton telephone listings, a random sample of four hundred Edmonton households was recruited for the survey by telephone. Two hundred and ninety four households completed and returned the survey, a return rate of 73.5%.

The survey was completed by 191 women and 88 men. Fifteen individuals did not indicate their gender. The higher number of female respondents was not unexpected. The cover letter included with the survey indicated that the survey should be completed by the person in the household that makes the majority of the food purchases. Household food purchases continue to be made primarily by women.

Comparison of the age distribution of the sample with the age distribution found in the 1991 Census data for Edmonton (Statistics Canada, 1991) suggests that the survey sample is reasonably representative of residents of Edmonton, at least in terms of this feature.[1]

Table 6 compares the percentage of each type of milk purchased by the respondents to the sales of each type of milk in Alberta during 1995.

Table 6. Case Study: Distribution of Milk Types Purchased

	Alberta 1995[1]	**BST Survey 1996**
Milk Type	%	%
Skim	10.24	21.2
One Percent	19.63	29.1
Two Percent	44.94	37.4
Homogenized (Homo)	13.54	12.3

[1] For example, the percentage of the study respondents that were younger than 30 years was 22.8%; in the 1991 Census, 22.8 of Edmonton residents were in this age category. The percentage of study respondents that were of age 30 to 60 years was 58.8; this age category included 54.5% of Edmonton residents according to the 1991 Census. Some 13.5% of the survey respondents were older than 65 years; this was also the case for 18.5% of the Edmonton Census respondents. Some 4.8% of survey respondents did not give their age; however, this does not apply with the Census.

Chocolate	6.47	*these types of milk were*
Buttermilk	0.57	*not included in the*
Eggnog	0.59	*survey*
Total	100.0	100.0

[1]From the Annual Report of The Alberta Dairy Control Board, 1995.

The respondents to this survey appear to purchase the low-fat milks (skim and 1%) in higher proportions than the aggregate sales data for Alberta would indicate. However, the sales data for Alberta are not identified as being for household consumption only. It is understood that the aggregate data for Alberta also include sales of milk to hotels, restaurants and institutions. Anecdotal observation suggests that such sales tend to include a greater proportion of higher fat milks. This may explain the discrepancy between the survey sample and the Alberta sales data. The sample can be considered to be representative in that it reflects the continuing popularity of one and two percent milk with consumers. We conclude that the sample was reasonably representative of Edmonton residents in terms of age and milk purchasing patterns.

Results and Discussion for the rBST Case Study

The coefficients of the model described in Equations 2 through 5 were estimated using LIMDEP, Version 7.0 (Greene, 1995). The results are given in Table 7. The chi-squared statistic shows that the model is highly significant. The value of the adjusted McFadden's pseudo R^2 is 0.183.[2]

Table 7. Case Study: Multinomial Logit Estimates

Log-Likelihood		-5256.830
Restricted (slopes=0) Log- L		-6449.018
Chi-Squared (X) (d.f. = 31)		2358.376
Significance Level		0.000
Adjusted Pseudo R^2		0.183
Variable	**Coefficient**	**Standard Error**
PRICE	-0.91997*****	0.19518
BST	-1.7021*****	0.04550
FRESH	0.07311*****	0.00867
ASCS	-0.54708	0.32422
AGES	0.00561*	0.00315
GENDERS	0.54097*	0.12611

[2] Following Ben-Akiva and Lerman (1985), the calculation for McFadden's adjusted R^2 is: $R^2 = 1 - [(\text{Log-L of the unrestricted model} - \text{the number of coefficients in the unrestricted model})/\text{Log-L of the restricted (slopes=0) model})]$.

YCHILDS	-0.07441	0.09878
HINCS	0.00349	0.00212
EDUCS	0.03547*	0.01591
PRIORS	0.80332*	0.26403
ASC1	1.1907*	0.26689
AGE1	0.00534*	0.00286
GENDER1	0.31910*	0.11108
YCHILD1	-0.02744	0.08882
HINC1	0.00372*	0.00187
EDUC1	-0.02768*	0.01210
PRIOR1	1.2020*	0.22982
ASC2	1.6235*	0.27232
AGE2	0.00234	0.00289
GENDER2	0.04011	0.11072
YCHILD2	0.35783*	0.08501
HINC2	-0.00331*	0.00193
EDUC2	-0.02242*	0.01235
PRIOR2	0.48521*	0.24558
ASCH	0.57049*	0.30089
AGEH	0.00099	0.00385
GENDERH	-0.05888	0.13487
YCHILD	0.74931*	0.09652
HINCH	-0.00358	0.00235
EDUCH	-0.03812*	0.01607
PRIORH	1.1709*	0.27686
***** denotes significance at the $\alpha = 0.05$ level.		

In a conditional logit model the coefficients are indicative of the sign of the marginal impacts, and the marginal probability of a change in attribute k is equal to $(1-P_j)P_j ß_k$ where P_j is the probability of choice j and $ß_k$ is the coefficient of attribute k. If the marginal probabilities are calculated at the mean values of the independent variables, the marginal probability is simply the coefficient times a constant for each alternative. Thus, in the literature that employs conditional logit models, most researchers report only the coefficients. This practice is followed here.

The estimated coefficients display the expected signs. PRICE is negative and significant, indicating that increasing price decreases the probability of a consumer purchasing milk. The coefficient on rBST is also negative and significant. This indicates that the probability of a consumer purchasing milk decreases if the milk is from cows that are treated with rBST. In contrast, the coefficient on FRESH is positive and significant. An increase in the freshness of milk increases the probability of a consumer purchasing milk. The effect of the variable AGE is positive for all types of

milk, that is, each of the coefficients AGES, AGE1, AGE2 and AGEH are positive and AGE is significant for skim and 1% milk. Thus, the probability of a consumer purchasing skim and 1% percent milk increases as the age of the consumer increases.

The coefficients on GENDERS and GENDER1 are also significant. Female household milk purchasers are more likely to purchase skim and 1% milk than are male household milk purchasers. Since women continue to make the majority of household food purchases, they can be expected to be more aware of the fat level of the household diet. Coefficients on YCHILD2 and YCHILDH are positive and significant. Households with young children have a higher probability of purchasing 2% and Homo milk than choosing the base case of not purchasing any milk.

The coefficient on EDUCS is positive and significant. Consumers with higher education levels are more likely to purchase skim milk. EDUC1, EDUC2 and EDUCH are negative indicating that more educated consumers are less likely to purchase 1%, 2% or Homo milk. Because of the possibility of correlation between education and income, the variable HINC was excluded in one test of the model. This exclusion did not affect significantly the coefficients on EDUCS, EDUC1, EDUC2 and EDUCH, suggesting that if a correlation between household income and education does exist in the data, this does not seem to have a significant effect on the estimated coefficients.

The coefficient on HINCH is negative and significant, indicating that households with higher incomes are less likely to purchase Homo milk. HINC1 is positive and significant while HINC2 is negative and significant. Households with higher incomes are more likely to purchase skim and 1% milk and less likely to purchase 2% milk. The coefficient on PRIOR is significant and positive for all milk types. That is, consumers who are more likely to purchase milk, also tend to purchase larger amounts of milk and are more informed on issues relating to milk. ASCS is negative in all three models. This could be taken to indicate that there is some disutility associated with purchasing skim milk, all other things held constant. The alternative specific constants, however, cannot be interpreted separately from the other estimated parameters of the model.

Welfare Implications for Case Study Simulations

Changes in economic welfare of consumers arising from the possible use of rBST were calculated according to Braden and Kolstad (1991), following Hanemann's (1982) method. This method calculates economic welfare as the compensating variation associated with a change in the quality of a good. The introduction of rBST use can be viewed as a change in the perceived quality of milk. This method calculates the amount, C, by which a consumer would have to be compensated, in order to be at least as well off as he or she was before the introduction of rBST. The change in welfare, C, was calculated as:

$$C = 1/\mu[ln\Sigma e^{X1\beta1} - ln\Sigma e^{X2\beta2}] \qquad \textbf{(7)}$$

where: μ = the marginal utility of money (the coefficient on PRICE is used to represent the marginal utility of money)[3]

X_1 = the values of the variables in the current situation (i.e. BST = 0, AGE = 40, etc)

X_2 = the values of the variables when the milks may be from cows treated with BST (i.e. rBST = 1, AGE = 40, etc)

β_1 = the coefficients for the current situation (i.e. where all milk is "rBST-free")

β_2 = the coefficients that apply when all the milks may be from cows treated with rBST.

It was assumed that milk from cows that have not been treated with rBST is clearly identified as such at the retail shelf. Because the coefficient on rBST was negative, its introduction can be expected to decrease consumers' welfare if rBST-treated milk replaces all non-rBST treated milk. The welfare calculations were performed for a representative consumer. This representative consumer is a woman, aged 40, with one young child, a household income of $40, 000.00 and 12 years of education, who has not previously read or heard about rBST. This consumer was chosen as being broadly representative of the consumers in the sample.

[3] Since income enters separately under each alternative, it is not possible to recover a single coefficient on income. According to Hanemann, income and price should enter the indirect utility function as y-p_i and therefore, the estimated coefficient on price can be assumed to be the coefficient on income, with a sign change.

Table 8 shows the estimated changes in welfare for the representative consumer in eleven different situations. The base case (i.e. X1β1) was specified as milk that is known to be "rBST-free", costs $0.79/litre and has 8 days remaining before the expiry date. In Situation 1 there was a change from the current situation (all milk is "rBST-free") to all the milk being "rBST milk". In Situation 2 the same change occurs but the "rBST milk" was fresher (12 days to expiry date). In Situation 3 the "rBST milk" was 16 days from its expiry date. In Situation 4 both "rBST-free milk" and "rBST milk" had the same freshness level but "rBST milk" was less expensive ($0.49/litre). In Situation 5 the "rBST milks" were priced even lower, at $0.29/litre. In Situation 6 all the milks available were "rBST milks" but the "no purchase" option was not available to the consumer. That is, in Situation 6, the consumer had to purchase at least one type of milk.

Table 8. Case Study: Welfare Changes

Situation	Welfare Change ($/shopping trip)
1 (all milks are "BST milk")	-1.53
2 ("BST milks are 2 days fresher)	-1.42
3 ("BST milks" are 4 days fresher)	-1.30
4 ("BST milks" are $0.49/litre)	-1.32
5 ("BST milks" are $0.29/litre)	-1.16
6 (all milks are "BST milks" but the no purchase option is not available)	-1.85
7 (skim milk is "BST-free")	-0.67
8 (1% milk is "BST-free")	-0.26
9 (2% milk is "BST-free)	-0.67
10 (Homo milk is "BST-free")	-0.67
11 (full variety)	0.24

In all six situations, the consumer experienced a loss in welfare. The loss decreased with increasing freshness for the "rBST" milk, but this effect levels off when freshness was 12 days before the expiry date. The consumer did not appear to be willing to trade-off freshness for rBST after a gain in freshness of four days. This was probably due to the fact that milk is usually consumed quickly, rather than being stored for future use. The consumer likely gains little from increased freshness levels that are greater than 12 days before expiry. The results indicate that the representative consumer was willing to make a trade-off between rBST and price. A decreasing price did reduce the welfare loss to the consumer. However, there still was a welfare loss when "rBST milk" was $0.50/litre cheaper than "rBST-free" milk (Situation 5). Thus, a significantly reduced price for "rBST milk" did not appear to offset completely the consumer's concern about the use of rBST. When the consumer was denied the option of not purchasing any milk (Situation 6), the welfare loss was the greatest. It appears that the representative consumer had a negative perception of the use of rBST and wished to avoid "rBST milk".

In Situation 7 skim milk was "rBST-free" while the other milk types were not. In Situations 8, 9 and 10, respectively, 1%, 2% and Homo milk are "rBST-free". In Situation 11, the representative consumer was presented with a full variety of rBST and non-rBST milks. That is, in Situation 11, the dairy case was assumed to contain skim, 1%, 2% and Homo milks that were "rBST-free" as well as

skim, 1%, 2% and Homo milks that are “rBST milks”. When Skim, 2% and Homo milk were “rBST-free”, respectively, the welfare loss was $0.67. When 1% milk was “rBST-free” the welfare loss was $0.26. Skim milk purchasers may be more health conscious than other consumers. Homogenized and 2% milk are often purchased for children. This might explain the higher welfare losses in Situations 7, 9 and 10.

When the consumer was presented with a full variety of milks, (Situation 11), there was a welfare gain of $0.24 per shopping trip. This result contrasts with the welfare changes estimated when all the milks are “rBST milks” or when only one of the milk types is “rBST-free” (Situations 1 through 10). Situation 11 allowed consumers that are concerned about the use of rBST to avoid this without changing their milk purchasing habits, and this may be reflected in the welfare estimate. Consumers that are not concerned about rBST use can be expected to be unaffected by Situation 11. It is also possible that this result is simply the consequence of the consumer having a greater variety of available choices, a situation that normally results in increased welfare.

When the gender of the representative household food purchaser was specified to be male, the welfare losses decreased slightly. Increasing the age, education level and household income of the household food purchaser also decreased the welfare losses, but the behaviour pattern reflected in the welfare estimates did not change. The identified use of rBST, under the assumptions of this study, resulted in welfare losses that were not entirely offset by increases in the freshness of milk or by decreasing the price of milk. When the representative household food purchaser was offered a full selection of rBST and non-rBST milks, a small welfare gain resulted.

Conclusions from the Case Study

The case study examined Edmonton consumers’ choices of milk in a hypothetical market situation. This hypothetical market included milk that was identified as possibly being from cows treated with rBST. The study was designed to examine the trade-offs that consumers appear to be willing to make between the four milk attributes of fat content, price, freshness and rBST. The effects

of selected socioeconomic variables on these trade-offs were also examined. A conditional logit model of consumer choice was developed to examine the choice between milks that varied in price, freshness and the use of rBST. The four fat contents of milk available (Skim, 1%, 2% and Homo) were used as the choice alternatives or "brands" in the study. Welfare calculations for a representative household food purchaser were calculated based on the coefficients estimated by the conditional logit model. A number of different situations were postulated and economic welfare impacts were calculated for a representative consumer.

In all but one of these situations, the representative household food purchaser experienced welfare losses with the introduction of rBST. A reduced price or increased freshness level for "rBST milk" was not sufficient to offset the welfare losses. The welfare losses were slightly less for a male household food purchaser than for a female household food purchaser. Increased levels of education and income also reduced the welfare losses slightly. These welfare losses were greatest when the representative household food purchaser was denied the option of choosing not to purchase any milk at all. When the representative food purchaser was offered a full range of "rBST milks" and "non-rBST milks", a small welfare gain was observed. That is, when Skim, 1%, 2% and Homo milks were offered as both "rBST-free" and as "rBST milk" there was a small welfare gain. This welfare gain may also result from the fact that more choices are available if both "rBST" and "rBST-free" milks are present. Even so, it can be reasonably inferred that making appropriately labeled "rBST-free" milk available to consumers could decrease negative reactions to the introduction of rBST.

Relating the Case Study to Evidence from the US Market

Evidence on milk consumption patterns in the United States following the licensing of rBST suggests that there has been little actual aggregate impact on consumer behaviour. In this context, it is important to recognize that following rBST introduction in the US market, mandatory labelling of rBST use was not required; however, labelling of the absence of rBST is permitted, with a disclaimer concerning the lack of evidence of any adverse effects of rBST. In Minnesota and New York "rBST-

free" milk was reported to be sold at a premium of 10 to 15 cents per gallon (producer level) in 1994. However, this milk accounted for a relatively small portion of milk sales, approximately 4 percent to 5 percent. In Wisconsin and Vermont, however, "rBST-free" milk was reported to account for a significant portion of milk sales. Initial popularity of "rBST-free" milk in Wisconsin and Vermont was suggested to be more related to farmer opposition to rBST and rural lifestyle issues than to consumers' concern over the safety of rBST (Brinkman, 1995). Subsequently, the popularity of "rBST-free" milk was thought to be declining in these states (Brinkman, 1996).

With the passage of time, it has been possible for some statistical testing of whether there has been a change in US demand for milk since 1994 when rBST was licensed. The hypothesis of a reduction in demand for milk in the US is not supported statistically. Even so, there is evidently an appreciable niche market in the US for milk that is labelled as "non-rBST"; as seen by the reported success in marketing milk that is so labelled by the US upper midwest food cooperative company, Land O'Lakes. Sales of fluid milk labelled to be not from cows treated with rBST accounted for 18% of all Land O'Lakes fluid milk sales in 1999, despite the fact that the milk label also carries a disclaimer to the effect that the (US) federal government has determined that treated milk is safe, that treatment does not harm treated animals, and that no significant difference is shown between treated and untreated milk (Runge and Jackson, 1999).

One conclusion that can be drawn from the rBST case study and the evidence from the US market relative to studies that implied a reduction of demand with (implicitly so labelled) rBST use, concerns the importance of labelling. When milk is so labelled, as implied in the case study reported here, many consumers express concern and see this as a negative attribute. Mandatory labelling of "rBST milk" was not required in the US; voluntary "negative" labelling is allowed and the Land O'Lakes experience suggests that this seems to have been conducive to niche marketing. Any policy requiring labelling involving biotechnology-related foods would evidently have to be carefully designed and worded since negative perceptions of consumers could be raised by mandatory

labelling. However, there are international pressures that may favor mandatory labelling. The issue of labelling of such foods creates a need for government and industry not only to provide accurate and clear information about biotechnology impacts to consumers but also to understand the impact of different labelling policies of strategies. An examination of how consumers screen, use, accept or reject label and other information on food safety and modifications in food production and processing would aid in understanding how consumers' perceptions on biotechnological treatments of food are formed and aid producers and processors to better assess labelling policy. Further study of the factors that influence consumers' perceptions of food safety and quality would be helpful in assessing how possible use of biotechnological treatments in agriculture and food may interact with labelling policy to influence the patterns of consumption of particular foods.

VI. Regulatory Overview

The legislative basis for regulation of food risks and the application of this involves the overlapping authority and actions of federal, provincial and municipal authorities. At each such level, this involves more than one agency/government department. Even so, Canada is one of a number of countries that have chosen to move towards a centralized federal-level food inspection agency, the Canadian Food Inspection Agency (CFIA), which focuses on the federal-level inspection activities associated with food safety. Health Canada is mandated to set the regulatory standards which CFIA is charged with enforcing. Health Canada also is mandated to assess CFIA activities; however, CFIA reports through the Ministry of Agriculture. Since 1997 the CFIA has brought together food inspection services previously provided through four federal government departments (Agriculture and Agri-Food Canada, Fisheries and Oceans Canada, Health Canada and Industry Canada) to consolidate delivery of federal food, animal and plant health inspection programs (CFIA, 1999). The auditor-general's recent assessment of CFIA states that CFIA reporting is such that it is difficult to assess how well it is doing its job (CFIA, 1999, annex), suggesting a need for more transparency in operations and/or the reporting of these.

Many aspects of regulation of food risks, including the approval processes for novel foods such as those that are derived from biotechnology, are responsibilities shared by Health Canada and CFIA. Health Canada is responsible for assessing all new foods, including those derived from biotechnology, while the CFIA has responsibility to perform environmental safety assessments on all agricultural products, including biotechnology-based products (CFIA, 1999).

Canada's regulatory system for food safety has been favourably assessed as a science-based system that is providing consumer and environmental safety (see, for eg. AIC, 1998). Even so, it has become evident from a series of public polls in recent years that while public knowledge of the technology involved in new foods is not widespread, there is some evidence that public concern about biotechnology is increasing. There are also indications that while most Canadians have a high level of trust in the safety of the food system, trust in the regulatory system of government may be somewhat less than in earlier years. All of these tendencies are illustrated, for example, in the results of a very recent poll of public attitudes in Canada to food safety and biotechnology reported by Environics International (1999). Increased public concern focuses on issues of labelling and polls have suggested that many members of the public agree that labelling of biotechnically derived food should be mandatory. Another focus of apparent public attitudes suggests that increased attention is seen by many members of the public to be needed to provide for public participation in and transparency of regulatory processes for food risks and food biotechnology.

VII. Implications for Advancement of Agricultural Knowledge

Future increases in potential uses of biotechnological processes and treatments for foods are expected and are thought to be a major potential source of productivity improvements for Alberta and Canadian agriculture in future years. However, public concern regarding food safety has become a major policy issue. Chemicals and biotechnological processes are increasingly perceived as risks of food safety, despite their contribution to an efficient and low cost agriculture and food industry. Major findings from this project arise from

A) Documentation of perceptions of health risks for selected food risks such as perceived for agricultural chemicals and biotechnologically derived growth hormone;

B) Development, adaptation, and verification of economic methodologies to assess the strength of consumers' perceptions of such risks relative to price/cost and other food attributes of specific foods; and

C) Identification of some issues where further research will aid policy action to respond to public concerns relative to food safety issues. These relate specifically to a need for more transparency in regulatory processes and an associated need for public participation in regulatory processes. In addition, from the case study and associated evidence, the issue of labelling has also been identified as requiring further research.

The reality of increasing consumer sensitivity, internationally and nationally, to issues of biotechnology, in particular, necessitates development of methodologies to assess, in an economic framework, the potential market impacts of perceptions of risk and the value of perceived risk reduction. The approach used in this project, which involved the development /adaption of research approaches from environmental valuation analysis and the combination of these with more traditional methodologies of analysis of marketed goods, provides a contribution to the science and methodology of economic analysis of food risk perceptions.

VIII. Dissemination

The results of the study have been presented in the form of working papers and refereed publications. To this point, presentations of the results of the study have been made at conferences of the Canadian Agricultural Economics Society (CAES), the American Agricultural Economics Association, and the Western Agricultural Economics Society. Two working papers have been distributed, one MSc thesis was completed (this received the CAES runner-up thesis award in 1998); and a peer reviewed journal article has been published. Based on the findings of this project, a

program of further economic research on consumers' reactions to alternate labelling codes and strategies is being developed.

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