

## Do Canadian Consumers Have Concerns about Genetically Modified Animal Feeds?

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This article analyzes responses from a 2008 survey of Canadian meat consumers about concerns regarding genetically modified (GM) feed used in livestock meat production. Approximately 50% of the sampled consumers express relatively high levels of concern about GM feeds. Based on the results from an ordered probit model that relates respondents' ratings of concern to their demographic characteristics, residents of Quebec and British Columbia tend to be more concerned than those in other locations. Respondents who express more trust in food industry institutions and show more confidence in buying beef and chicken tend to express less concern about GM animal feed. Other demographic characteristics and the household's levels of expenditures on different types of meat are not found to have an effect on expressed concerns with respect to GM-fed animals.

**Key words:** Canada, consumers' concerns, genetically modified (GM) feed, ordered probit.

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### Introduction

Use of genetically modified (GM) components in animal feed is a controversial topic in Europe but has received less attention in North America (Brookes, 2000; Lusk, Roosen, & Fox, 2003; Paarlberg, 2002). Labeling of GM animal feed was introduced in the European Union for implementation in 2004 by Regulation [EC] No. 1829/2003 (European Parliament and the Council of the European Union, 2003). However, it is not necessary for food obtained from GM-fed animals (i.e., eggs, milk, and meat) to be labeled in Europe, although critics of the use of GM-derived feed have argued for this type of labeling as well (Phillips & McNeill, 2000; Roosen, Lusk, & Fox, 2001). Canada does not require labeling of either GM animal feed or foods produced from GM fed-animals. We are not aware of previous research on Canadian consumers' attitudes towards the use of GM-derived crops to feed agricultural animals.

This study analyzes data from the Neilson Company's Canadian Homescan™ consumer panel and from an additional supplementary survey on food opinions, which, by arrangement with the Nielsen Company, was sent in 2008 to 5,000 Canadian households. The survey explores consumers' concerns regarding the use of GM crops in animal feed in order to assess whether concerns expressed in Europe might also be evident in a North American nation. Sexton, Zilberman, Rajagopal, and Hochman (2009) argue that GM crops are part of the solution to increase productivity in food and feed in order to avoid future food crises. With more food and feed products from GM crops becoming available

worldwide, there may be changes in perceptions and consumers' concerns about GM crops and GM feeds; this study provides a Canadian baseline for a current time period.

### Background

There has been much research—in many countries—on consumers' opinions about GM foods in recent years. For example, Kaneko and Chern (2003) used contingent valuation methods and found that US consumers indicate that they are willing to pay 30-50% above base price to avoid GM products. Hwang, Roe, and Teisl (2005) concluded that the greatest concerns of US consumers in food production were pesticides and hormones, followed by GM foods.

Research in other countries (e.g., in Canada by Hu, Huennemeyer, Veeman, Adamowicz, & Srivastava, 2004; in the Netherlands by Novoselova, van der Lans, Meuwissen, & Huirne, 2005; in the United Kingdom, Germany, and France by Tonsor, Schroeder, Fox, & Biere, 2005; in India by Deodhar, Ganesh, & Chern, 2008; and in South Korea by Govindasamy, Onyango, Hallman, Jang, & Puduri, 2008) suggests varying attitudes towards GM food in these countries. Based on cross-Canada surveys, an assessment by Veeman and Li (2007) of Canadian consumers' ratings of risks perceived for issues associated with food and agriculture found that residents of the province of Quebec were more likely to express greater concern about food and environmental risks from GM usage than respondents from other Canadian provinces, and that perceptions of

GM food risk appeared to be higher in 2005 than in 2003.

Consumers' attitudes towards genetic modifications in crops used to feed agricultural animals have received research attention in some studies; however, this was usually not a focal point of the research. De Frahan and Tritten (2003) used a partial equilibrium trade model to study the implications for trade of then-proposed EU regulations for novel food and feed, including traceability. These authors explored potential changes in consumer prices of meats based on the hypothetical introduction of voluntary labeling that would identify meat from animals fed with GM-derived feed. De Frahan and Tritten concluded that consumer prices of meat from non-GM-fed animals would increase by 6% for pork, 4% for beef, and 3% for poultry, whereas the prices for meat from GM-fed animals would change by less than 1%. Kaneko and Chern (2003) included GM-fed salmon—as well as other products—in their survey that assessed consumers' acceptance of GM-derived food products in the United States. From their results, they conclude that survey respondents were willing to pay about 40% more for non-GM-fed salmon to avoid GM-fed salmon. Li, McCluskey, and Wahl (2004) determined that a sample of United States consumers would require, on average, a price discount of 8% to choose GM-corn-fed beef over regular beef. However, Deodhar et al. (2008) concluded that Indian consumers were willing to pay only negligible price premiums for non-GM-fed chicken versus GM-fed chicken. Bernard, Pesek, and Pan (2007) determined that, among other attributes, 'chicken fed with GM feed' had less of a negative impact on US consumers' likelihood to purchase chicken than two other food technologies ('GM chicken' and 'irradiation'), but was viewed more negatively than the other two issues considered ('antibiotics' and 'free range'). A comprehensive choice experiment applied in the United Kingdom, Germany, France, and the United States determined that European consumers placed a higher value on non-GM-corn-fed beef than did US consumers (Lusk et al., 2003).

There is a wide array of scientific literature on potential impacts of GM feed on animals in relation to animal health and performance, as well as the safety and quality of food from such animals. By far the largest number of studies report no adverse effects of GM feed on animals (e.g., Alexander et al., 2007; Flachowsky, Aulrich, Boehme, & Halle, 2007). Occasional studies report traces of GM-derived DNA in GM-fed animals or in the products derived from GM-fed animals (e.g., Agodi, Barchitta, Grillo, & Sciacca, 2006; Phipps,

Deville, & Maddison, 2003; Sharma et al., 2006). However, detection of these traces depends largely on the chosen detection methodologies, types of animals and feeds, and parameters to be measured, which suggests uncertainty and provides arguments for further research.

While some studies have touched on the issue of consumers' attitudes towards GM-fed animals in other nations, this has not been assessed for Canadian consumers. Information documenting levels of concern should be useful in revealing consumers' preferences and may be helpful in assessing current and potential future policies on feed usage. This study contributes to an improved understanding of consumers' attitudes about GM-fed meat and explores the link between actual expenditures on meat relative to expressed concerns with GM feed by a sample of consumers.

## Model

Ordered probit models are often used to evaluate survey responses to Likert rating scale questions (e.g., Govindasamy et al., 2008; Lusk & Coble, 2005; Veeman & Li, 2007). A question using a five category Likert scale might ask the respondents to indicate if they are 'not at all concerned,' 'have minor concerns,' 'have some concerns,' 'have major concerns,' or are 'very concerned' about the use of GM feed in meat production. The ordered probit model estimates the probabilities that a particular respondent will choose these category ratings. Generally, the dependent variable of the model represents an unobservable latent variable  $y^*$ , where  $y^* = \beta'x + \varepsilon_i$ ,  $\beta'$  is a vector of coefficients to be estimated,  $x$  is a vector of explanatory variables such as demographic variables, and  $\varepsilon_i$  is an error term assumed to be normally distributed across observations. Threshold values  $\mu_0, \mu_1, \dots, \mu_j$  separate one category from the next. Thus, with a five-category scale, the dependent variable is often entered into the data as (Greene, 2002)

- $y_i = 0$  if  $y^* \leq \mu_0$ , where  $\mu_0 = 0$ , (i.e., the respondent chose 'not at all concerned' and  $\mu_0$  represents the threshold between 'not at all concerned' versus 'minor concerns'),
- $y_i = 1$  if  $\mu_0 < y^* \leq \mu_1$ ,
- $y_i = 2$  if  $\mu_1 < y^* \leq \mu_2$ ,
- $y_i = 3$  if  $\mu_2 < y^* \leq \mu_3$ , and
- $y_i = 4$  if  $y^* > \mu_3$ .

The threshold values are estimated as part of the probit model, and for estimation purposes one of the thresholds has to be fixed (i.e.,  $\mu_0$  is set equal to 0 in this example).

Since the signs of the coefficients on the explanatory variables obtained from ordered probit models only show the direction of the impact on the probability of choosing the first and last categories of the scale, interpretation of model results is usually based on marginal effects. These show by how much the probability that the respondent will choose a particular category of the scale changes when the explanatory variable changes by one unit. The survey and model variables are discussed below.

### Survey Data and Variables

The Nielsen Company, an international information and media company that is involved in marketing research in more than 100 countries, maintains their Canadian Homescan™ consumer panel consisting of more than 10,000 Canadian household representatives. These representatives track their weekly purchases, including food purchases, by scanning barcodes with hand-held scanners at home. The Canadian Homescan™ consumer panel is designed to be regionally representative of the Canadian population. By arrangement with the Nielsen Company, a supplementary survey on food opinions, designed by researchers from the University of Alberta, was applied to those members of the Canadian Homescan™ consumer panel that had remained in the panel during the period from 2002 to 2007. The survey was applied between March 3 and March 29, 2008. Some differences between the survey sample and the Canadian population are evident. In general this sample is somewhat older and better educated, compared to the Canadian population, as measured by census data for 2006 (Statistics Canada, 2010a, 2010b).<sup>1</sup>

Of the 5,000 Homescan™ panelists who received the paper survey on food opinions, 4,090 completed it. The survey included questions on attitudes toward food, safety of meat products, animal-production-related concerns, and trust in food industry institutions. The dataset links individual survey respondents to the Homescan™

consumer panel records of households' actual expenditures on annual meat purchases from 2002 to 2007 and to their socio-demographic information.

The dependent variable in our econometric model is based on respondents' ratings of their concerns with the use of GM feed through their answers to the question 'to what extent are you concerned about genetically modified animal feeds?' measured on a five-category scale (1=not at all concerned, 2=minor concerns, 3=some concerns, 4=major concerns, 5=very concerned). This variable is termed *GMFEED*. Summary statistics and the description of variables used in this study are reported in Table 1.

Demographic characteristics—hypothesized to explain a respondent's concern ratings about use of GM animal feed—are defined as dummy variables. These include the household's province of residence, range of household annual income, presence of children in the household, respondent's age, respondent's education level, and whether the respondent resides in an urban or rural area. The number of household residents is defined as a continuous variable (for summary statistics see Table 1).

The confidence of respondents in the safety of beef and chicken/poultry products is hypothesized as a potential influence on risk perceptions about use of GM food. Other potential influences considered include household meat expenditures and trust variables. For model estimation, the data on confidence about the safety of beef and chicken/poultry, measured on a five-category scale (from 1=no confidence at all to 5=complete confidence) are constructed as dummy variables, which take values of 1 ('confident'), if scored as 4 and 5 on the noted scale, and 0 ('no confidence') otherwise.

Household meat expenditures of panel members were also assessed as potential influences on respondent's concern about the use of GM feed. Expenditures on different types of meat purchased by respondents from January to June 2007 were available from the Homescan™ data set and matched to survey respondents. Expenditures for more than 40 categories of meats were regrouped and aggregated into six meat groups: beef, pork, poultry, mixed meats (e.g., sausages containing both pork and beef), other meats (e.g., frog, ostrich, etc.), and processed meat products (meats identified with a UPC code). Expenditures on each of these six groups of meat were initially entered into the model as continuous variables; in an alternate version of the model, expenditures on the six groups of meat were also aggregated and entered the model as a single total expenditure variable for each household.

1. *Some of these differences may stem from different cutoff points for categories in the survey sample compared to the 2006 Census. For example, in the survey sample, 37% of the respondents are 65 years old and above, whereas education levels are reported only for those Canadians in the range of 25-64 years of age from the 2006 Census (Statistics Canada, 2010b).*

Table 1. Definition of variables and descriptive statistics for survey respondents (N=4090).

Variable	Description	Mean	SD	Min	Max
<b>Dependent</b>					
<b>GMFEED<sup>a</sup></b>	Concern about genetically modified animal feeds	3.529	1.164	1	5
<b>Demographics</b>					
<b>Maritimes</b>	1 if resides in Maritimes (including Newfoundland), 0 otherwise	0.132	0.339	0	1
<b>Quebec</b>	1 if resides in Quebec, 0 otherwise	0.241	0.428	0	1
<b>Ontario</b>	1 if resides in Ontario, 0 otherwise	0.263	0.440	0	1
<b>Man Sask</b>	1 if resides in Manitoba / Saskatchewan, 0 otherwise	0.102	0.302	0	1
<b>Alberta</b>	1 if resides Alberta, 0 otherwise	0.129	0.335	0	1
<b>British Columbia</b>	1 if resides in British Columbia, 0 otherwise	0.133	0.340	0	1
<b>Income low</b>	1 if < \$39,000 per year, 0 otherwise	0.366	0.482	0	1
<b>Income medium</b>	1 if \$40,000-\$69,000 per year, 0 otherwise	0.178	0.383	0	1
<b>Income high</b>	1 if > \$69,000 per year, 0 otherwise	0.456	0.498	0	1
<b>Children</b>	1 if the household has children under 17 years old, 0 otherwise	0.144	0.351	0	1
<b>Age young</b>	1 if < 44 years old, 0 otherwise	0.134	0.341	0	1
<b>Age middle</b>	1 if 45-64 years old, 0 otherwise	0.491	0.500	0	1
<b>Age old</b>	1 if > 64 years old, 0 otherwise	0.375	0.484	0	1
<b>HH size</b>	Number of people in the household	2.125	1.107	1	9
<b>Education low</b>	1 if up to high school, 0 otherwise	0.150	0.357	0	1
<b>Education medium</b>	1 if college or some university, 0 otherwise	0.632	0.482	0	1
<b>Education high</b>	1 if completed university, 0 otherwise	0.218	0.413	0	1
<b>Urban<sup>b</sup></b>	1 if resides in urban area, 0 otherwise	0.583	0.493	0	1
<b>Rural</b>	1 if resides in rural area, 0 otherwise	0.417	0.493	0	1
<b>Perceived safety of meat<sup>c</sup></b>					
<b>Confid beef</b>	Confidence about the safety of beef products	0.537	0.499	0	1
<b>Confid chicken</b>	Confidence about the safety of chicken/poultry products	0.510	0.500	0	1
<b>Total household meat expenditures in CAD (Jan-Jun 2007)</b>					
<b>Expend total</b>	Expenditures on all meat	197.167	172.301	0	3482.260
<b>Expend beef</b>	Expenditures on beef	65.218	76.263	0	1150.510
<b>Expend pork</b>	Expenditures on pork	40.786	45.275	0	480.120
<b>Expend poultry</b>	Expenditures on poultry	45.625	59.988	0	1824.870
<b>Expend mixed</b>	Expenditures on mixed meats	0.821	4.133	0	80.450
<b>Expend other</b>	Expenditures on the other meats	8.824	22.130	0	447.510
<b>Expend UPC<sup>d</sup></b>	Expenditures on meat products with UPC code	35.894	47.165	0	439.880
<b>Trust in food industry institutions<sup>e</sup></b>					
<b>Trust manuf</b>	Trust in manufacturers	18.693	4.136	6	30
<b>Trust retail</b>	Trust in retailers	18.265	4.203	6	30
<b>Trust gov</b>	Trust in government	18.627	4.790	6	30
<b>Trust farm</b>	Trust in farmers	19.868	4.039	6	30

<sup>a</sup> measured on a five-category scale ranging from 1 (not at all concerned) to 5 (very concerned).

<sup>b</sup> major urban centers with population of 100,000 and larger.

<sup>c</sup> 1 if scored as 4 and 5 on a five-category scale ranging from 1 (no confidence at all) to 5 (complete confidence), 0 otherwise.

<sup>d</sup> the products entered using UPC did not have information on the type of meat in the database.

<sup>e</sup> measured on a five-category scale ranging from 1 (strongly disagree) to 5 (strongly agree).

**Table 2. Cross-classification of the respondents' concern ratings about use of GM feed relative to trust and confidence attitudinal variables.**

		Respondents' concern ratings about use of GM feed (N=4090)				
		Not at all concerned	Minor concerns	Some concerns	Major concerns	Very concerned
Variables	% (row)	n=247 <sup>a</sup>	n=480	n=1266	n=1056	n=1041
<b>Trust in food industry institutions <sup>b</sup></b>						
<b>Manufacturers</b>	Do not trust	3.9	8.3	27.3	28.2	32.3
	Trust	8.1	15.1	34.6	23.5	18.7
<b>Retailers</b>	Do not trust	4.4	9.6	29.3	26.6	30.0
	Trust	8.0	14.4	33.0	24.8	19.7
<b>Government</b>	Do not trust	3.8	8.9	28.3	27.5	31.4
	Trust	8.3	14.6	33.6	24.1	19.4
<b>Farmers</b>	Do not trust	4.8	9.1	30.0	27.1	29.0
	Trust	6.9	13.6	31.6	24.9	23.0
<b>Confidence about the safety of meat products <sup>c</sup></b>						
<b>Beef</b>	Not confident	2.2	7.2	27.3	29.8	33.5
	Confident	9.3	15.7	34.1	22.4	18.5
<b>Chicken</b>	Not confident	2.7	7.3	27.4	29.7	32.9
	Confident	9.2	16.0	34.4	22.1	18.3

<sup>a</sup> the number in each column (e.g., n=247) represents the total number of respondents from the survey who selected that concern rating.

<sup>b</sup> 'trust' if cumulative score on the battery of six statements is 19 or more; 'do not trust' otherwise. An example on how to interpret the rows is that 3.9% of respondents scored as 'do not trust manufacturers' are 'not at all concerned' about use of GM feed.

<sup>c</sup> 'confident' if scored as 4 or 5 on a five-category scale; 'not confident' otherwise.

Four continuous variables that summarize each respondent's views of trust regarding the safety of food products—expressed in manufacturers, retailers, government, and farmers—were developed based on the aggregation of respondents' responses to six statements about each of these (see Appendix). These responses were measured on a five-category scale (from 1=strongly disagree to 5=strongly agree). In cross-classification examination of selected variables (see Table 3), for simplification, the trust variables are expressed as dummy variables.

## Results

Overall, more than 50% of respondents indicate that they have 'major concerns' and are 'very concerned' about GM feeds (Table 2). Assessing the frequency distributions of respondents' concern ratings about the use of GM feed and trust expressed in food industry institutions suggests that those who express *more trust* are less likely to be concerned about the use of GM feed, while those who express *less trust* are more likely to be concerned. Even so, slightly more trust is expressed in farmers than in other food industry institutions. Similarly, those who express *more confidence* in the safety of

meats are less likely to be concerned about the use of GM feed, while those who express *less confidence* in meat safety are more likely to be concerned about GM animal feed.

The ordered probit model estimation results are given in Tables 3 and 4. A respondent's rating of concern about the use of GM feed is the dependent variable, while demographic characteristics (respondent's food attitudes and trust in the food industry, together with household meat expenditures), are the explanatory variables. The excluded dummy variables *Maritimes*, *Income low*, *Age young*, *Education low*, and *Rural* are used for comparison to the others in the respective categories. The estimated model has a statistically significant chi square statistic, which tests the hypothesis that all the coefficients except a constant are zero, indicating that the model does have explanatory power. Coefficient estimates are presented in Table 3 and marginal effects (for statistically significant coefficients only) are in Table 4.

The significant coefficients on *Quebec*, *British Columbia*, and *Trust farm* are positively associated with consumers' concerns about GM feed usage, whereas coefficients of *Confid beef*, *Confid chicken*, *Trust manuf*, *Trust retail*, and *Trust gov* are negatively associ-

**Table 3. Results of ordered probit model of GM feed usage.**

Variable	Use of GM animal feed	
	Coefficient	SE
Constant	2.853 <sup>***</sup>	0.137
Quebec	0.233 <sup>***</sup>	0.059
Ontario	-0.046	0.058
Man Sask	-0.068	0.071
Alberta	-0.030	0.067
British Columbia	0.123 <sup>*</sup>	0.067
Income medium	0.010	0.049
Income high	-0.069	0.044
Children	-0.038	0.073
Age middle	0.081	0.055
Age old	0.045	0.060
HH size	0.013	0.024
Education medium	0.035	0.050
Education high	-0.068	0.061
Urban	0.010	0.035
Confid beef	-0.248 <sup>***</sup>	0.052
Confid chicken	-0.162 <sup>***</sup>	0.052
Expend beef	-0.00033	0.00029
Expend pork	0.00027	0.00046
Expend poultry	0.00019	0.00034
Expend mixed	-0.00075	0.00092
Expend other	0.00010	0.00083
Expend UPC	-0.00044	0.00038
Trust manuf	-0.032 <sup>***</sup>	0.006
Trust retail	-0.023 <sup>***</sup>	0.006
Trust gov	-0.016 <sup>***</sup>	0.005
Trust farm	0.012 <sup>**</sup>	0.005
Mu(1)	0.671 <sup>***</sup>	0.021
Mu(2)	1.632 <sup>***</sup>	0.020
Mu(3)	2.378 <sup>***</sup>	0.023
Chi squared	528.119 <sup>***</sup>	
McFadden R <sup>2</sup>	0.044	
Obs.	4,090	
df	26	

\*\*\*, \*\*, \* significant at the 0.01, 0.05, and 0.1 levels, respectively.

ated with the dependent variable. The estimated marginal effects are relatively small in magnitude and range from -7.7% to 7.5%.

Respondents from Quebec are more concerned about GM animal feeds than other Canadian consumers. This mirrors the results reported by Veeman and Li (2007), who found that consumers in Quebec attribute higher level of risks to food and agricultural hazards than do

most other Canadians. The marginal effects show that the respondents from Quebec are 7.5% more likely to be ‘very concerned’ and 2.1% less likely to be ‘not at all concerned’ about GM feeds compared to most other respondents. The respondents from Ontario, Manitoba/Saskatchewan, and Alberta do not have significantly different levels of concern from those in the Maritime provinces. In British Columbia, the concerns of respondents regarding GM feeds are slightly higher than in the Maritime provinces: 3.9% are more likely to be ‘very concerned,’ 1.0% are more likely to have ‘major concerns,’ and 1.1% are less likely to be ‘not at all concerned’ (Table 4).

The concerns of medium- and higher-income-level respondents are not significantly different from lower-income-level respondents. The other demographic variables, such as age, education, presence of children under 17 years old in the household, the size of the household, and urban versus rural residence are not significant explainers of concern with GM feed.

Those respondents who are confident about the safety of meat products tend to be less concerned than others about the presence of GM in animal feeds. For example, the respondents who are confident about safety of beef and chicken are 7.7% and 5.0%, respectively, less likely to be ‘very concerned’ about GM feed compared to those who are not confident (Table 4).

The explanatory variables of trust in manufacturers, retailers, and government have negative signs on estimated coefficients (Table 4). In other words, those respondents that place more trust in these food industry institutions tend to express lower levels of concern about GM animal feed. However, in contrast, respondents that express higher levels of trust in farmers also express higher levels of concern about GM animal feed. Farmers may tend to be viewed differently than other food industry institutions; it can be speculated that respondents’ trust in farmers may lead to more concern for farmers themselves and the impact that GM feed may have on farmers rather than concern about the safety of food products that farmers produce.

None of the coefficients on the six meat-expenditure variables were statistically significant in the estimated model (Table 4). This was also the case for the coefficient in an alternate model version in which aggregate household expenditure on meat purchased was included in the estimated model. Further, omission of the expenditure variable from the model entirely did not appreciably change the estimates, suggesting that the level of respondents’ concerns about the use of GM feed in meat production does not depend on the levels of household

**Table 4. Marginal effects of GM feed usage.**

Variable	Not at all concerned	Minor concerns	Some concerns	Major concerns	Very concerned
Quebec	-0.021	-0.032	-0.039	0.017	0.075
British Columbia	-0.011	-0.017	-0.020	0.010	0.039
Confid beef	0.024	0.035	0.039	-0.021	-0.077
Confid chicken	0.016	0.023	0.025	-0.014	-0.050
Trust manuf	0.003	0.005	0.005	-0.003	-0.010
Trust retail	0.002	0.003	0.004	-0.002	-0.007
Trust gov	0.002	0.002	0.003	-0.001	-0.005
Trust farm	-0.001	-0.002	-0.002	0.001	0.004

Note. Marginal effects only for the statistically significant variables in Table 3 are presented.

meat expenditures. (Since the coefficients from these alternate estimations are consistent, only the initial version of the model is reported in Table 4.)

Some people do not eat certain types of meats at all. One question in the survey asked whether respondents ate beef (consumption of other types of meats was not queried). A dummy variable indicating whether the respondents reported eating beef was not included in the ordered probit model due to the very small number of beef non-consumers. However, a simple t-test for equality of means of the respondents' concerns regarding GM animal feeds for consumers of beef (as opposed to non-consumers) was performed. This indicates that those respondents who did consume beef express significantly lower levels of concerns about GM feed for animals (mean=2.51, SD=1.162) compared to beef non-consumers (mean=2.84, SD=1.150). It was not possible to control for potential specific reasons associated with beef non-consumption, such as religious or vegetarian beliefs, due to lack of such data.

## Summary and Conclusions

The issue of GM-derived feed used in agricultural animal production is asserted to be of major concern by about half of the sample of Canadian consumers when this is posed as a question. The levels of concern expressed for GM feed are higher among Quebec residents—and slightly higher in British Columbia—than in other provinces of Canada. Other demographic characteristics, including age, income, education, household size, presence of children in the household, and urban versus rural residence, do not seem to affect the level of respondents' concerns about the use of GM-derived feed for agricultural animals. Similarly, the level of a household's meat expenditures is not associated with a respondent's concerns about usage of GM components in animal feeds. However, the level of trust in food industry institutions expressed by respondents, as well

as the level of their confidence regarding the safety of beef and chicken/poultry meat products, has statistically significant impacts on concern ratings. In general, the higher is the level of confidence in the safety of meat products and the higher is the level of trust expressed in the food industry by respondents, the less are their levels of concern regarding the use of GM feeds in animal feeding. The only exception to this tendency is the variable of trust in farmers. Respondents that trust farmers tend to express higher levels of concern towards GM animal feed.

The results of this study reveal that appreciable levels of concern are expressed by numbers of the Canadian survey respondents about usage of GM feed. It should be emphasized that there may be multiple sources of such concern, including concern about human health and food safety, animal welfare and performance, and farmers' welfare. However, evidently this does not seem to have been associated with considerable public resistance against GM food and feed in Canada, such as has been observed in European nations. Whether the expressed concern about GM feed has potential to be translated into pressure for GM-feed labeling in Canada is a very open question. A number of GM feed crops are approved by Canadian Food Inspection Agency for unconfined release in Canada. The area of cultivation of GM crops worldwide is increasing every year (GMO Compass, 2010). Commercialization of GM crops for food and feed seems to exhibit a growing trend: the number of countries growing GM crops and the number of traits to be improved are projected to double within the 2006-2015 time period (James, 2007).

A limitation of this study is that since the data are cross-sectional in nature, the results do not reflect how consumers' concerns may have changed over time. Further, the study is specific to Canada and may not reflect situations in other countries. In addition, the nature of causality between consumers' concerns about the use of

GM components in animal feeds and meat expenditures variables may be ambiguous. Meat expenditures were assumed to affect the level of respondents' concerns with GM feed. The possibility of respondents' concerns affecting meat expenditure levels is noted.

In terms of further investigation, it would be of interest to assess whether the considerable levels of concern expressed by some Canadians may translate into lower levels of purchases of GM-fed meat or whether premiums might be appreciable for identification of non-GM-fed meat. Related to these issues, it would be of interest to determine whether buyers of regular (i.e., non-organic) meat differ in their concerns from the buyers of organic meat. Further data would be required to conduct analyses in order to answer these questions.

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## Appendix

Below is a list of statements used to assess trust in food industry institutions. This example applies to trust in food manufacturers; these questions were also asked relative to 'retailers,' 'government,' and 'farmers.'

1. Manufacturers have the competence to control the safety of food.
2. Manufacturers have sufficient knowledge to guarantee the safety of food products.
3. Manufacturers are honest about the safety of food.
4. Manufacturers are sufficiently open about the safety of food.
5. Manufacturers take good care of the safety of our food.
6. Manufacturers give special attention to the safety of food.

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