Factors determining the adoption of BMPs for iodine and mastitis: Do producer perceptions play a role?

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INTRODUCTION

The adoption of Best Management Practices (BMPs) on Canadian dairy farms is still a challenge. Some important efforts were done since 1997 with the implementation of Canadian Quality Milk (CMQ) program by dairy farmers of Canada under Agriculture and Agri-Food Canada's food safety and quality program which is based on HACCP principles. As indicated by Jacques Laforge, President of the Canadian Dairy Farmers, the first objective of his organization is to provide to Canadians the best dairy products and beef meat in terms of quality (Agriculture and Agri-food Canada and Dairy farmers of Canada, 2010).

Base-line findings of the research indicate that producers have to continue improving their practices on farms. Here are some reasons to do so.

Adoption of various BMPs for mastitis and iodine control varies significantly. Only 64% of producers agreed that their milkers consistently wear gloves during every milking, while 75.5% admit being quite worried about mastitis. For 77.9% of herds, pre-milking udder treatment consists of using a disinfectant dip or wipe treated with udder wash, while only 7.6% report using a disinfectant spray. Single paper or cloth towels are used for teat cleaning before milking in 83.7% of herds. Likewise, 83.7% of the herds received a disinfectant dip treatment at post milking versus only 14% receiving a post-milking disinfectant spray. For 96.6% of those herds receiving a post-milking disinfectant dip, the dip coverage goal is at least the bottom two thirds (2/3) of each teat.

Producers agree that excess iodine in milk will lead to loss of consumer confidence in milk (70.5%), but between iodine excess and mastitis, their priority is to control mastitis (82.8%). A substantial proportion of them believe that milk with excess iodine is safer to drink than milk with excess microbes (40.6%).

Between 58.6% and 73.1% of producers attribute iodine excess in milk to udder disinfectant use and milking procedures, while between 37.5% and 41.1% agreed that excess iodine is the result of dietary components.

Despite efforts of dairy farmers of Canada, one can clearly state that BMPs according to mastitis and iodine are not 100% adopt. Why does this situation persist? Which factors determining the adoption of BMPs for iodine and mastitis? Do producer's perceptions play a role?

Producers' perceptions and attitudes model their behavior

Attitude is well known as an important factor which creates and changes behavioural intentions and actions (Ajzen and Fishbein, 2005). In this study, the concept of attitude is taken as the cognitive beliefs and affective associations which include knowledge, beliefs, values, goals and intentions.

In a relationship model between attitude, behaviour and mastitis, Jensen (2009) showed that farmers' behaviour and external factors like weather influence mastitis; and farmers' behaviour itself can be influenced by attitudinal factors, such as opinions, values, beliefs, knowledge, but also by external factors, such as weather or a farmer's social environment (Ajzen and Fishbein, 2005). This relationship supports the thesis that the effect of the human factor has to be taken into account in farm performance analysis unlike to the historical perspective.

Using an OLS model in the Dutch dairy farming context, Jensen (2009) obtained that mastitis can be explained to a certain extend by farmers' attitudes and behavior; only farmers' attitudes explain between 17% and 47% of the variance in mastitis indicators.

Basing on a qualitative survey, Gauthier and Gaudreau (2011) noted that Canadian dairy farmers were concerned with regard to the risk of the increase of mastitis if iodine-free disinfectants were used instead of iodine-based ones. In the same research, the authors mentioned that, according to farmers, iodine is seen like « something clean ». Indeed, farmers said that it is preferable to consume milk with exceeded iodine instead of milk with somatic cells (microbes) due to mastitis. So, one can normally think that dairy producers will act according to their perceptions.

METHODS

In order to obtain some responses to the previous questions, a questionnaire was elaborated in English, then translated into French based on Dillman's (2007) suggestions for both question formulation and layout. The interdisciplinary members of the project's research team[1] participated in the questionnaire elaboration. They are experts in different fields, including dairy cow nutrition, animal health and sociology. The questionnaire was nine (9) pages long. Data were collected from August to October, 2012 using the questionnaire on self-reported attitudes and behavior as well as information items. During this period, each potential respondent was invited four times, by e-mail and/or mail, to fill out the questionnaire. Multiple contacts are deemed essential for maximizing response rates to surveys (Dillman, 2007).

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Invitations to complete the questionnaire were distributed to a total of 3,180 dairy producers in four Canadian provinces. Their names and addresses were provided through confidentiality agreements with their provincial dairy producer organizations. Of the 3,180 producers, 1,197 were randomly selected from Québec and 1,200 from Ontario, while all 200 producers in Prince Edward Island (PEI) and all 583 producers in Alberta were contacted. As noted in Table 1, each producer had the choice to respond through either a Web-based questionnaire or by an identical paper copy sent through the mail. The overall response rate was 31% (N=970). The response rate, however, was much greater among the Québec producers (38%), than among those in PEI (25%), Ontario (24%) and Alberta (27%).

Iodine and mastitis BMPs adoption data as dependent variables

Two scales index are constructed as dependent variables. One is related to mastitis BMPs adoption and the other one is related to iodine BMPs adoption. Each scale index is composed of responses to few questions on the questionnaire.

Mastitis BMPs indicator

This indicator is based on nineteen questions. The details are shown in table 2 and the distribution is presented by graphic 1. The reliability alpha for the scale is 0.722. Similarly, each question in the scale alludes to the willingness (unwillingness) of the producer to adopt practices which permit a best management of mastitis on farm. Here again, higher scores on each of the ten questions indicate the unwillingness of the producer to adopt mastitis BMPs.

Iodine BMPs indicator

It is similar to the previous one and based on responses to ten questions. Table 3 reports the exact formulation of the ten questions, their responses categories and their descriptive statistics. The distribution (mean=18.7, std. dev. =4.2) of the indicator is given by graphic 2. The reliability alpha for the scale is 0.7231. Each question in the scale alludes to the willingness (unwillingness) of the producer to make changes to their practices in order to lower the level of iodine residues in bulk-tank milk on their farm and protect the consumer health. Higher scores on each of the ten questions indicate the unwillingness of the producer to adopt BMPs regarding to iodine.

Before performing the OLS model, the dependent variables have to meet the normality distribution requirement. In order to verify that, some analyses were done and permitted us to accept the dependent variables normality. In fact, the results indicated that iodine BMPs adoption indicator is normally with skewness 0.33 and kurtosis 3.04. In addition, the Shapiro-Wilk value equals is close to 1 with 0.99. Well, mastitis adoption indicator is normally with skewness 0.35 and kurtosis 2.89 (which is close to 3). Shapiro-Wilk test gives 0.99.

Attitudinal and information data as independent variables

Independent variables are related to items regarding iodine, mastitis, information and producer and farm characteristics. A principle components analysis (PCA) with Varimax rotations was performed on items which were measured on the same Likert scale. The variables are kept in the same group when the proportion of each variable's variance which can be explained by the principal components is more than 55%. Then, reliability using Cronbach's alpha is tested. Combining items in the same measure is accepted when alpha is more than 0.7. These new multiple-item measures were computed for all producers by taking the average score of the underlying variables.

The multiple-item measures were used in the OLS model performing. Items which could not be grouped based on PCA and reliability were regarded as independent variables and were included individually in the analyses. Descriptive statistics of all the sixty five independent variables used in the model are presented in Table 4.

Mastitis variables

Fifteen variables are related to mastitis. These are divided into three categories. The first one includes eleven variables which give the perception or the attitude of the producer. For example, one asks to the respondent if he agrees or disagrees with the statement that "Bad luck plays an important role in mastitis outbreak". Among these twelve variables, two are the scales index created from responses to underlying questions related to mastitis as an annoying disease and cow caring as an effective way to prevent mastitis. The second category includes three variables which are related to mastitis generally speaking. One gives the bulk milk tank somatic cell count (BMTSCC) record on farm and the two other are the agreement or disagreement of the producer to first "A very serious outbreak of mastitis occurred at least once on my farm" and second "We don't have enough time to work on mastitis prevention". The last category is the response to the following yes or no question. "Do you have a standard procedure to prevent/control mastitis?"

Iodine variables

Seven variables are related to iodine. Four variables are about the producer's perception of iodine residue in milk contamination sources. For example, the respondent gives his agreement or disagreement with the following statement "Drugs used to treat to treat cows is a source of excess iodine in milk on your farm". The other ones are related to the producer's perception of iodine as a good or bad element for human or cow health. For example, one asks the respondent to give his agreement or disagreement with the following statement "Milk with excess iodine is safer to drink than milk with excess somatic cells.

Information variables

Twenty four variables are related to information with six which are obtained after using PCA and Cronbach's alpha analyses. Information variables were classified into three

categories. First, how the producers deal with information? Do they search actively information in order to improve the farm management? Do they exchange information with their colleagues? For example, the respondent is invited to give his agreement or disagreement to the following statement "I care about what other people think about how I manage my dairy". Second, the attention is given to the producer's perception of the usefulness of the information according to its source. For example, does the respondent think that information from the herd veterinarian is very useful, quite useful, limited use or not useful? Finally, the last category of these variables is about the favorite sources of information generally speaking and the principal source of advice according to specific items (teat disinfectant procedures, teat disinfection products, bacteriology test results and lactating herd diet formulation). Among few propositions, the respondent had to choose his two favorite sources of information and his two principle sources of advice for each item.

Producer and farm characteristics

Nineteen variables are related either to producer or farm characteristics with sixteen which necessitate a direct response by the respondent. Among these variables, we have the responses to the questions like "At this moment, what is the total number of cows in your dairy herd? Or what is the total number of paid employees on your farm who are full time, part time? There are also some questions where the respondent has to choose among a few propositions. For example, what kinds of training in agriculture have you receive (hands-on, technical, college or university)? Finally, there is one question for which the respondent had to answer yes or no. It is the follow: Do you participate in "Dairy Herd Improvement" initiatives (i.e. Valacta or CanWest)?

Two step wise linear regression models with significant level fixed to .05 were performed beginning with the full model in order to identify which independent variables are determinants in BMPs adoption according to iodine and mastitis. For each of the two dependent variables, the same independent variables are tested.

RESULTS

Respondents' socio-demographic profile

One average a respondent works since 23.27 years (SD=11.81) as a dairy producer. More than half of respondents (54.5%) had between 11 and 30 years of experience as dairy producer. Quebec contains the highest part of producers with less years of experience and producers from PEI are the most experienced.

More than half of respondents (57%) had a dairy training by hands-on. 33% had a college or university training level and the remaining 20% had technical training.

More than half of the respondents (53%) had on average a farm annual income which falls between 100,000$ and 499,999$. This trend was seen in all the provinces except in

Alberta. In this province, more than half of producers (63.8%) has more than 500,000$ and more of quarter (28.9%) has 1 million $ or more. Quebec is the province where dairy producers earn less. For the low levels of annual income, this province registers the most important part of producers and for the high levels; it also registers the lowest part of producers.

Herds' characteristics

On average, each respondent has 68.49 (SD=70.28) lactating in his herd. About three quarts of producers (73.1%) have 70 lactating cows or less. This trend was observed in all provinces except Alberta where most of dairy producers (32.3%) have between 71 and 200 lactating cows. This province also registers the most important part of producers whom lactating herd size is more than 200. Quebec is the province where one met producers having smallest lactating herd size.

Average milk production per cow and per year was 9404.10 liters (SD=1589.29). 70.6% of producers have their average milk production per cow and per year between 5,000 liters and 10,000 liters. In each province, most of producers' level milk production falls in this interval. However, we note a more important yield in Alberta. In fact, about half of producers (47.3%) had an average milk production per cow and per year varying between 10,000 and 15,000 liters.

BMTSCC average level announced by producers was 209,416.1 Cells/liter (SD=95,860.7). Almost all producers (97.2%) have their last BMTSCC record less than 400,000 cells/ml; the tolerable threshold in dairy industry.

Analyses from BMT indicated an average level of 260.05µg/liter (SD=198.25) of iodine. Almost half of producers had their iodine record in BMT varying between 187µg/liter and 387µg/liter. More than 90% of producers had an acceptable threshold according to the recommendations from Health Canada. But we noted that records are higher in Ontario. Indeed, more than 15% of dairy producers in this province had their iodine record upper to 500µg/ml which is the tolerable threshold. That represents more than twice the part of producers with the same record in the sample.

Predictors of mastitis BMPs on farm

Results from the step wise OLS regression model indicate that more than 62% of the variance in the level of adoption of BMPs regarding to mastitis was explained by the variables in the model (Table 5). Variables measuring practices and perceptions about mastitis and information as well as those related to farm characteristics have statistically significant relationships with the mastitis BMPs adoption indicator.

Producers who feel that mastitis is under control on their farm are more willing to adopt best practices. The coefficient associated to this relation is the most important with 3.43. One the other side, that means that producers who feel that mastitis is not under control are less willing to adopt BMPs. That is not logical. A rational behaviour should indicate that producer for whom mastitis is not under control should improve their practices by adopting BMPS.

Dairy producers' frame of reference has also a statistical significant relationship with their willingness to adopt BMPs. In fact, results indicate that more higher is the value of the BMTSCC for which the producer is satisfied; less is his willingness to adopt BMPs. A similar relationship is obtained with the producer perception of what the BMTSCC penalty level should be. In other words, producers who think that the threshold of BMTSCC taken as the penalty threshold by dairy industry is too low are willing to not adopt BMPs regarding mastitis. It is like that these producers' frame of reference is different from the industry's one and that conduct them to not make some efforts to improve their practices.

Unlike to what would be predicted, producers for whom, bad luck plays an important role in a mastitis outbreak are more willing to adopt best practices while managing mastitis. Logically speaking, pessimist producers should be less willing to adopt the best practices. But, results do not give such information.

Items related to information are also statistically significant. One notes that seven variables are statistically significant with the dependent variable. Among them, three variables are related to the producers' motivation to get information in order to improve their practices according to mastitis management. The significant relationships indicate that motivated producers are more willing to adopt the best practices. That is logical. In fact, more they are motivated, more they obtain interesting information and more they perceive the importance to adopt the best practices.

Among the remain four statistically significant information variables, two are related to the producers' perception of the usefulness of information according to its source and the other two are related to what the producer consider as his principle source of advice according to some specific mastitis items. It appears that producers who think that information from dairy organisation, provincial federation/board and breed association is useful are willing to adopt mastitis best practices on farm. But the relationship is different when one considers the usefulness of information from media as internet and magazines. In other words, the producers who give more credibility to information from their organizations are willing to adopt recommended practices. One can think that these organizations provide more relevant information for mastitis management on farm.

For the two other variables, the significant relationships indicate that the principle sources of advice for choosing teat disinfectant procedures to prevent mastitis is

determinant in mastitis BMPs adoption; as well as is the principle source of advice for treatment procedures after the producer receive the bacteriology test results. In the questionnaire the respondent had the choice between nine sources of information. According to the statistics obtained from the results of this study, respectively 58.5% and 52.5% of respondents choose a milking equipment company or veterinarian as their principle source of advice for teat disinfectant procedure. Well, 84.5% of respondents choose the veterinarian and 45.7% decide themselves what to do when they receive bacteriology test results.

Some characteristics from the producer and the farm are also determinants in mastitis BMPs adoption. For example, an increase of iodine residue in milk is accompanied by a decrease of mastitis BMPs adoption. This can be explained by the fact that producers who do not adopt best practices on farm tend to use disinfectants with a high level of iodine in order to fight mastitis; so that they increase iodine residue in milk. The question could be analysed deeply in the framework of another study.

Well, a positive relationship is established between the producer's highest degree or diploma and his willingness to adopt mastitis BMPs. It is shown that higher is the degree; lower is the mastitis BMPs adoption level unlike to what seems logical. This question could also be investigated deeply.

Results indicated an inverse relationship between BMPs adoption and BMTSCC record on farm. That means that more milk quality worsens more the producer is willing to improve his practices on farm. This behavior is rational since the BMTSCC's threshold is fixed to 400,000 cells/ml. If the BMTSCC record is up to this threshold, the producer registers financial losses. A similar relationship is obtained between the number of total paid milkers on farm and the willingness of adoption of BMPs on farm. In fact, higher is this number; higher is also the level of BMPs adoption regarding mastitis. This situation is certainly due to the fact when the number of milkers increases; more attention is paid for job.

Predictors of iodine BMPs on farm

For this indicator, results indicate that 46% of the variance was explained by the variables in the model (Table 6). Here again, variables related to perceptions/attitudes, information and farm characteristics are statistically linked to the level of iodine BMPs adoption on farm. 13 significant relationships are mentioned.

Among these significant variables, five are related to producers, perceptions/attitude towards mastitis and iodine. For example, producers who do not agree that milk with excess iodine is safer to drink than milk with excess somatic cells are more willing to adopt best practices regarding iodine on farm. The coefficient beta of the relationship equals -2.07. That is logical. In fact, the producer attitude is that: like somatic cells in milk, iodine is not good for consumer health and its residue in milk can lead to the loss of consumer confidence in milk. The same relationship is observed with producer for

whom between iodine excess and mastitis, the priority is mastitis. The value of the coefficient beta is -0.7. That means that more the producer disagrees with that statement, more he is willing to adopt best practices regarding iodine on farm. The previous explanation is also true in this case.

The other three significant variables related to attitudes/perceptions of the producer revealed an inverse relationship with the dependent variable. For example, the producers who do not perceive the disinfectants used for udder treatment as a potential source of iodine residue in milk are less willing to adopt best practices regarding iodine management on farm. This attitude leads to increase iodine residue in milk.

The attitude towards mastitis can have an impact on iodine BMPs adoption as mentioned by the following relationship. In fact, producers who state that they do not follow a standard mastitis treatment plan are more unwilling to adopt BMPs regarding iodine. The reason is that, without a standard plan, the risk of mastitis development is more important and producers are willing to use more iodine to fight mastitis in order to reduce financial losses. The same reason can permit to explain the positive relationship revealed between the level of iodine BMPs adoption and the independent variable related to the BMTSCC threshold for which the producer begin to be quite concerned. The relationship shows that more this threshold is high, lower is the willingness to adopt best practices.

Significant relationships which are related to information deal with the behaviour of the producers towards information from other people and the principal sources of advice according to the choices of teat disinfection procedure for mastitis prevention and cow treatment once bacteriology test results are available. Results indicate that producers who do not care about what other people think about how they manage their farm are more unwilling to adopt best practices regarding iodine. This is logical since information from different sources contribute to increase the producers' skills. Concerning the choices of the procedures, these same variables were significant with the adoption of BMPs regarding to mastitis. So the same explanation is true again here.

Three variables related to producer and farm characteristics revealed a significant relationship with the dependent variable. These are BMTSCC record, the gender of the producer and the fact that the producer participates or not in "Dairy Herd Improvement" initiatives.

For the BMTSCC record, the relationship is inverse like with the indicator related to mastitis BMPs adoption. But, unlike to the mastitis indicator where the coefficient beta was substantially zero, the coefficient beta is -9 at that time. That means that more the milk quality is bad due to somatic cells, more the producer is willing to adopt best management practices regarding to iodine. This seems illogical since the proof is made that the dairy producers use iodine-based disinfectants to fight mastitis in order to

reduce their financial losses (see Hogeveen et al., 2011; Erskine et al., 1997). And this behaviour leads to iodine residue in milk. That can be seen like an inconsistency between BMPs adoption regarding to mastitis and BMPs adoption regarding to iodine. That is true if we only consider iodine-based disinfectants using. But, if we consider a global strategy of BMPs, a consistency is possible. For example, attention to cows' welfare in general and promoting a clean and healthy environment for animals contribute greatly to fight against mastitis. That conducts the producer to use less iodine on farm; which is a best practice of iodine management.

The two other significant variables register negative values for the coefficient beta. Since these variables are related to yes or no question and according to the codification, it means that women are more willing to adopt BMPs adoption regarding to iodine than men. Similarly, producer who participate to DHI initiatives are more unwilling to adopt best practices while managing iodine. That seems illogical since Valacta and CanWest are dairy organizations which support and promote the production of milk with standard quality. But, one can also think that, iodine problematic is not as integrated as mastitis one in these organizations' programs since it is a new one. This problematic is kept on the second plan.

CONCLUSION AND IMPLICATIONS

Canadian dairy farmers' perceptions appeared to plays an important role in mastitis and iodine BMPs adoption on farm. In the framework of this study, les perceptions are about cows caring, the farm management, the sources of information and information management on farm.

Producers who had a high level of BMPs adoption for mastitis were from Québec (Table 7) and those with the high level of iodine BMPs adoption were from Alberta (Table 8). Since iodine BMPs adoption is consistent with the attention the producers give to consumer health, we can support that producers from Alberta expressed more concern to that problematic. Perhaps this is due to the fact that many Alberta producers are actually managing a dairy owned by a Hutterite colony (West & Ouattara, 2013). According to the authors, the people in Hutterite colonies generally believe in mutual responsibility for life, and thus would be more sensitive to any expression of potential harm resulting from the way they manage their dairy farms.

Concerning the high level of mastitis BMPs adoption in Québec; that could be explained by the fact that, this province registers the most important part of dairy producers you participates to the Dairy Herd Improvement initiatives. Our results indicated that the participation rate is the highest in Québec (85%). In the other provinces the participation rates are also high but lower than 80%. Another possible reason is that

dairy farmers from Québec spend more time with their cows because on average the lactating herd size is lower than those from other provinces.

The challenge now is to determine what actions we have to implement in order to improve the level of adoption of best practices regarding to mastitis and iodine. Ours results indicated that the producers' principal sources of advice are determinant in BMPs either for mastitis and iodine. These are the veterinarian and the milk equipment company. We have to intensify information campaign trough these channels. Since changing attitudes and behavior is difficult to achieve, the message to be conveyed must target the producers' sensibility. To do so, Gale & Ouattara (2013) suggest an effective approach. According to them, if an information campaign targeting dairy producers was to clearly indicate that it is socially unacceptable to remain indifferent to consumer concerns, the more reluctant producers might be more likely to make efforts to change their attitudes and behaviors regarding iodine and mastitis control measures.

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Table 1: Sample description

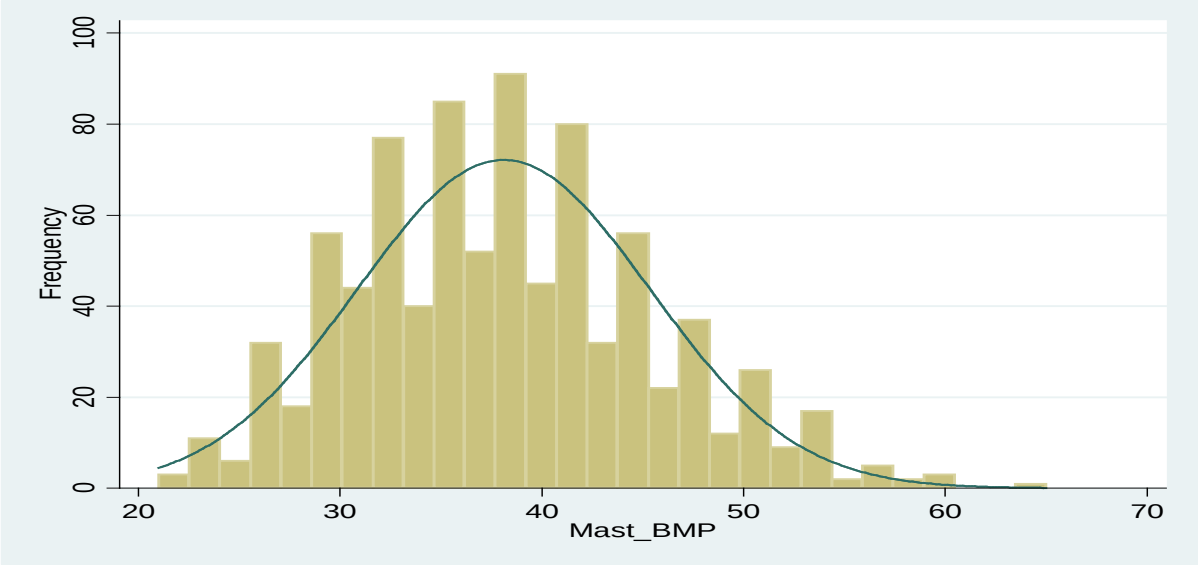
Type of contact / Provinces	E-mail	Postal	Total	Percentage (%) of sample
Alberta	315	268	583	18.33
Ontario	746	454	1,200	37.74
Québec	0	1,197	1,197	37.64
Prince Edward Island	112	88	200	6.29
Total	1,173	2,007	**3,180**	**100**

Table 2: Items in the measure of the mastitis dependent variable "willingness to adopt mastitis BMPs"

Question	Response categories	Mean	Std. Dev.
All our milkers wear milkers' gloves during every milking. (n=976)	1=Total agree; 4=Total disagree	2.11	1.24
I am very patient with dairy cows even when they don't obey me. (n=981)	1=Total agree; 4=Total disagree	1.83	.75
Circle how you would rate the amount of risk you take when managing iodine. (n=977)	1=No risk 4=High risk	2.04	.89
We always very carefully monitor our BMSCC test results. (n=973)	1=Total agree; 4=Total disagree	1.41	.67
We automatically check the SCC levels for individual cows as test results become available. (n=973)	1=Total agree; 4=Total disagree	1.51	.86
We strictly finish the prescribed duration of all antibiotic treatments. (n=985)	1=Total agree; 4=Total disagree	1.30	.66
We change brands or types of teat disinfectants on a regular basis. (n=990)	1=Total agree; 4=Total disagree	3.30	.86
We consider udder health parameters when selecting bulls for mating. (n=986)	1=Total agree; 4=Total disagree	2.13	.93
When a cow has a high cell count, we milk her either last or using separate equipment. (n=974)	1=All the time; 4=Very rarely	2.14	1.21
When a cow has a high cell count, we treat her directly with antibiotics. (n=971)	1=All the time; 4=Very rarely	2.32	1.12
For diagnosis of subclinical mastitis, we look at individual cell count records. (n=974)	1=All the time; 4=Very rarely	1.72	1.02
For diagnosis of subclinical mastitis, we use the California Mastitis Test. (n=971)	1=All the time; 4=Very rarely	2.62	1.17
For diagnosis of clinical mastitis, we closely observe the cow and her udder (n=981)	1=All the time; 4=Very rarely	1.35	.62
For diagnosis of clinical mastitis, We look for flakes on each cow's filter cup. (n=973)	1=All the time; 4=Very rarely	2.25	1.54
When the number of mastitis cases increases, we try to be more rigorous during udder cleaning and disinfection. (n=992)	1=All the time; 4=Very rarely	1.74	1.00
When the number of mastitis cases increases, we let the sanitizing solution stay on a little longer than recommended before milking. (n=990)	1=All the time; 4=Very rarely	3.22	1.08
I always want to know the latest news on mastitis prevention, diagnosis and treatment. (n=973)	1=Total agree; 4=Total disagree	1.64	6.68
When mastitis problems occur, I do not hesitate to contact my herd's veterinarian or another source of information. (n=975)	1=Total agree; 4=Total disagree	1.72	.80
When mastitis problems occur, I do not hesitate to contact my herd's veterinarian or another source of information. (n=990)	1=Total agree; 4=Total disagree	1.83	0.67

Reliability Alpha = 0.722 (n=864 Mean=38.106 Std. dev. = 7.249 Min=21 Max=65)

Graph 1: Distribution of the dependent variable, "willingness to adopt mastitis BMPs" (n=864)



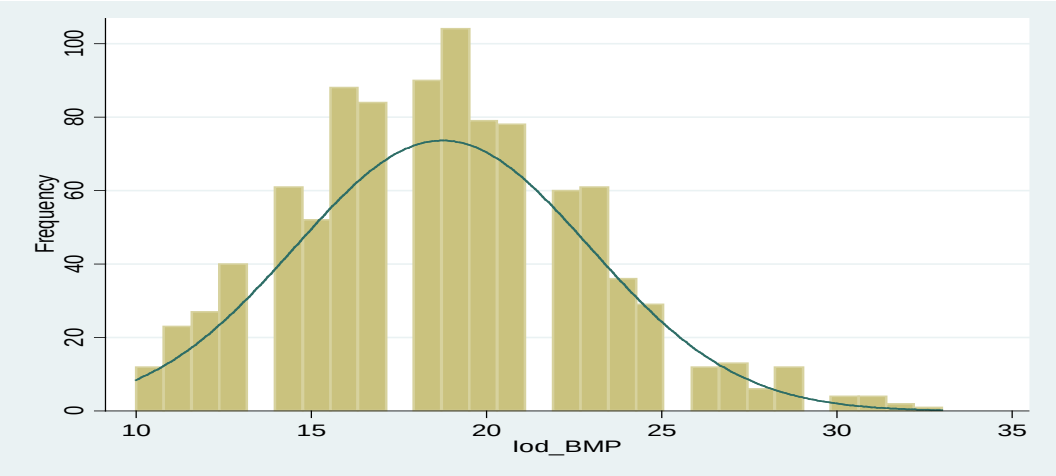
Note: 21=Highest level of adoption; 65=Lowest level of adoption

Table 3: Items in the measure of the iodine dependent variable "willingness to adopt iodine BMPs"

Question	Response categories	Mean	Std. Dev.
I would change teat disinfection products if it lowered the iodine level. (n=982)	1=Total agree; 4=Total disagree	2.02	.96
I would stop teat disinfection before milking in order to lower the iodine level. (n=982)	1=Total agree; 4=Total disagree	2.75	1.15
I would change the herd's feeding program if it lowered the iodine level. (n=980)	1=Total agree; 4=Total disagree	2.35	.93
Health Canada has established a maximum human threshold for dietary iodine. (n=984)	1=Total agree; 4=Total disagree	1.85	.76
Iodine excess in milk will lead to loss of consumer confidence in milk. (n=989)	1=Total agree; 4=Total disagree	2.06	.88
Health Canada has set a recommended maximum threshold for iodine in bulk tank milk. (n=987)	1=Total agree; 4=Total disagree	1.82	.80
Circle how you would rate the amount of risk you take when managing iodine (n=991)	1=No risk 4=High risk	2.03	.95
I would take actions if producers were penalized for excess iodine in bulk tank milk. (n=988)	1=Yes, I would; 4=No, I would not	1.28	.57
I would take actions if the health of consumers was at risk from excess iodine in milk. (n=988)	1=Yes, I would; 4=No, I would not	1.24	.50
I would take actions if consumer confidence in milk quality was at risk. (n=988)	1=Yes, I would; 4=No, I would not	1.29	.53

Reliability Alpha = 0.7231 (n=978 Mean=18.7454 Std. dev. = 4.204302 Min=10 Max=33)

Graph 2: Distribution of the dependent variable, "willingness to adopt iodine BMPs" (n=978)



Note: 21=Highest level of adoption; 65=Lowest level of adoption

Table 4: Description of independent variables

		N	Min	Max	Mean	Std. Dev.
	Variables about Mastitis					
Cow_Care[a]	Attention to cow welfare (α = 0.75)	963	1	4	1.56	.42
Mast_Ann[a]	Mastitis as an annoying disease (α = 0.70)	966	1	4	1.64	.44
Ms_Cau_Dif[a]	mastitis causes are difficult to influence	977	1	4	2.23	.87
Bad_Luck_Ms[a]	Bad luck plays an important role in a mastitis outbreak	976	1	4	2.89	.87
Less_Disinf_Use[a]	Less iodine-based teat disinfectant increase mastitis	990	1	4	2.42	.89
Prio_Mast_Iod[a]	Between iodine excess and mastitis, my priority is to control mastitis	984	1	4	1.76	.82
Iod_Safe_Mast[a]	Milk with excess iodine is safer to drink than milk with excess microbes	984	1	4	2.69	.87
No_Mast_Prev[a]	We don't have enough time to work on mastitis prevention	976	1	4	3.09	.86
Mast_Under_Cont[a]	I feel we control mastitis on my farm	990	1	4	1.85	.64
Other_Imp_Th[a]	I have more important things on my mind than managing mastitis	976	1	4	3.44	.71
Mast_Con[a]	We have standard mastitis treatment plans that we follow	990	1	4	1.97	.84
BMTSCC_Penalty[b]	At what BMSCC level should a penalty be imposed?	993	25	1000	408.14	100.81
BMTSCC_Satis[b]	At what BMSCC level are you quite satisfied?	993	30	900	176.98	67.84
BMTSCC_Con[b]	At what BMSCC level do you begin to be quite concerned?	993	20	800	266.02	80.15
Mast_Outbr[a]	A very serious outbreak of mastitis occurred at least once on my farm	976	1	4	2.15	1.02

Table 4: continued

	Variables about Iodine					
Iod_From_Udd[c]	Udder as a source of iodine residue in milk (α = 0.84)	988	1	9	2.3	1.2
Iod_From_Feed[c]	Cow feed as a source of iodine residue in milk (α = 0.88)	991	1	9	3.27	1.7
Iod_In_Fee_Cow[a]	Dairy cows need iodine in their feed to remain healthy	983	1	4	2.04	.78
Milk_Equip[c]	Milk equipment as a source of iodine residue in milk	992	1	9	3.51	1.59
Iod_As_Conc[e]	Iodine residue in milk as a concern for the producer	985	1	2	1.14	.34
BMT_Iod_Le_Apr[d]	Producer's appreciation of iodine residue in bulk milk tank	831	1	99	3.81	8.28
Cows_Drugs[c]	Cow drugs as a source of iodine residue in milk	992	1	9	3.8	1.78
	Variables about Information					
Search_Acti_Info[a]	Search actively information to improve farm management (α = 0.79)	971	1	4	1.74	.64
Know_Othr_Farms[a]	know a lot about udder health conditions on other dairy farms (α = 0.72)	989	1	4	1.87	.66
Know_Mastitis[a]	know enough about mastitis to effectively control its occurrence on my farm (α = 0.82)	974	1	4	1.83	.56
Inf_From_Org[f]	Usefulness of information from dairy producers organisation (α = 0.83)	387	1	4	2.34	.60
Info_From_Adv[f]	Usefulness of information from advisors (agronomist, Vet,…) (α = 0.70)	361	1	3.8	2	.51
Info_Med_Wshp[f]	Usefulness of information from media and workshop (α = 0.71)	512	1	4	1.98	.58
Care_Other_Opin[a]	Care about what other people think about how I manage my dairy	990	1	4	2.51	.94
Prio_Own_Exp[a]	Rely on my experience than on information from others	988	1	4	2.35	.74
Inf_Usef_Lab[f]	Usefulness of information from milk testing laboratory	794	1	4	1.6	.72
Inf_Usef_BMTSCC[f]	Usefulness of information about BMTSCC from provincial Federation/Board	762	1	4	1.83	.74
Inf_Usef_Vet[f]	Usefulness of information from veterinarian	911	1	4	1.47	.59
Inf_Dis_Proc1[g]	First principal source of advice for teat treatment procedure	982	1	8	2.33	1.95
Inf_Dis_Proc2[g]	Second principal source of advice for teat treatment procedure	790	2	8	5.2	2.37
Inf_Dis_Prod1[g]	First principal source of advice for choosing teats disinfectants	985	1	8	2.4	1.69
Inf_Dis_Prod2[g]	Second principal source of advice for choosing teats disinfectants	770	2	8	5.31	2.3
Inf_Cow_Trea1[g]	First principal source of advice while dealing with bacteriology test results	970	1	8	1.64	1.7
Inf_Cow_Treat2[g]	Second principal source of advice while dealing with bacteriology test results	737	2	8	6.07	2.42
Inf_Diet_For1[g]	First principal source of advice for cow diet formulation	977	1	8	2.95	1.6
Inf_Diet_For2[g]	Second principal source of advice for cow diet formulation	760	2	8	5.78	1.98
First_Fav_Inf[h]	First favorite source of information in general	837	1	15	2.31	2.93
Sec_Fav_Inf[h]	Second favorite source of information in general	796	2	16	8.34	3.99
Need_Inf_Mast[e]	Need more information about mastitis	957	1	2	1.56	.49
Recal_BMPs[e]	Recall receiving a list of recommended practices to control iodine	963	1	2	1.44	.49
Need_Inf_Iod[e]	Need more information about iodine	941	1	2	1.51	.5

Table 4: Continued

		N	Min	Max	Mean	Std. Dev.
	Producer and farm characteristics					
Cow_No_Feel[a]	Dairy cows are just animals with no feelings or emotions	974	1	4	3.52	.76
Stall_Clean[m]	Number of times per day when stall are cleaned	978	0	12	3.51	1.95
BMTSCC[b]	Bulk milk tank somatic cell count record	993	40	1000	209	95.9
DHI_Part[e]	Participation in "Dairy Herd Improvement" initiatives (i.e. Valacta or CanWest)	987	1	2	1.18	.38
Lact_Herd_Size[m]	Lactating herd size	993	2	1040	68.5	70.28
Milk_Prod_Cow[b]	Average level of milk production per year and per cow	993	3.8	20	9.40	1.58
Paid_Emp_Fu_Tim[m]	Number of paid employees in full time	993	0	6	1.34	1.25
Paid_Emp_Par_Ti m[m]	Number of paid employees in part time	993	0	6	.9	1.04
Paid_Milkers[m]	Total number of paid milkers	993	0	6	1.49	1.36
Unpaid_Milers[m]	Total number of unpaid milkers	993	0	6	1.08	1.27
Farm_Risk_Mgt[i]	Level of risk taken while managing the farm	956	1	4	2.6	1.7
Year_Prod[m]	Age of the producer	963	0	65	23.2	12
Prod_Sex[e]	Gender of the producer	966	1	2	1.11	.31
Annual_Income[j]	Approximate level of farm's total annual income before taxes in 2011	993	1	7	5	1.76
Agr_Tra_Type[k]	kind of training in agriculture	993	1	7	2.05	1.47
Iod_Dis[m]	Average level of iodine in udder disinfectants	993	0	2	.72	.51
Iod_Equip[m]	Average level of iodine in milk equipment disinfectants	993	0	1.75	.37	.71
Prod_prov[l]	Province where the farm is located	993	1	4	2.59	.83
BMT_Iodine[m]	Iodine residue level in bulk milk tank	993	19	2097	260	198

Note for independent variables description: scale of measurements are described by superscript, items with α levels are factor scores derived from PCA and reliability analyses
a: 1= totally agree; 2=somewhat agree; 3=somewhat disagree; 4=totally disagree
b: Continuous variables. Presented values have to be multiplied by 1000 / m: exact continuous values
c: 1=very likely source; 2=somewhat likely; 3=somewhat unlikely; 4=very unlikely; 9=don't know
d: 1=high; 2=moderate; 3=low; 99=I don't recall
e: 1=yes; 2=no / i:1=avoid all risk; 2=take small risk; 3=take some risk; 4=take substantial risk
f: 1= very useful; 2=quite useful; 3=limited use; 4=not useful
g: 1=my veterinarian; 2=Valacta or CanWest; 3=milking equipment company; 4=feed company advisor; 5=private herd advisor; 6=provincial dairy advisor; 7=other dairy farmers; 8=I decide this on myself / l:1=PEI; 2=Québec; 3=Ontario; 4=Alberta
h: In addition to the information sources mentioned to the previous point, seven other information sources were indicated as magazines, web sites, personnel letter from dairy organization, BMTSCC from provincial federation, milk testing laboratory.
j: 1=less than 24,999$; 2=25,000$ to 49,999$; 3=50,000$ to 99,999$; 4=100,000$ to 249,999$; 5=250,000$ to 499,999$; 6=500,000$ to 999,999$; 7= 1000,000$ and more
k:1=primary diploma; 2=high school diploma; 3=technical diploma; 4=college diploma; 5=university degree; 6=other

Table 5: Results from the OLS regression on Mastitis BMPs adoption

		Coef	Std. Err	t	Sig.
	Variables about Mastitis and Iodine				
Mast_Under_Cont	I feel we control mastitis on my farm	3.43	.739	4.65	.000
Bad_Luck_Ms	Bad luck plays an important role in a mastitis outbreak	1.47	048	3.05	.003
Mast_Outbr	A very serious outbreak of mastitis occurred at least once on my farm	.90	.40	2.22	.028
BMTSCC_Penalty	At what BMSCC level should a penalty be imposed?	.0000	.0000	2.05	0.04
BMTSCC_Satis	At what BMSCC level are you quite satisfied?	.0000	.0000	2.85	.005
	Variables about Information				
Search_Acti_Info	Search actively information to improve farm management	1.91	.78	2.46	.016
Inf_From_Org	Usefulness of information from dairy producers organisation	1.9	.77	2.47	.015
Info_Med_Wshp	Usefulness of information from media and workshop	-2.10	.85	-2.46	.016
Inf_Dis_Proc1	First principal source of advice for teat treatment procedure	1.04	.26	4.01	.000
Inf_Cow_Treat2	Second principal source of advice while dealing with bacteriology test results	.35	.16	2.19	.031
Need_Inf_Mast	Need more information about mastitis	2.67	.80	3.33	.001
	Producer and farm characteristics				
BMTSCC	Bulk milk tank somatic cell count record	-.0000	.0000	-2.64	.01
Paid_Emp_Par_Tim	Number of paid employees in part time	1.2	.41	2.93	.004
Paid_Milkers	Total number of paid milkers	-.81	.35	-2.28	.024
Agr_Tra_Type	kind of training in agriculture	1.25	.43	2.88	.005
BMT_Iodine	Iodine residue level in bulk milk tank	.007	.002	2.78	.006
Constante		-3.26	3.53	-0.92	0.35

Regression ANOVA d.f=17; sig.=0.000; Adj. R^2 =0.6237

Table 6: Results from the OLS regression on Iodine BMPs adoption

		Coef	Std. Err	t	Sig.
	Variables about Mastitis and Iodine				
Mast_Con	We have standard mastitis treatment plans that we follow	1.27	.34	3.64	.000
BMTSCC_Con	At what BMSCC level do you begin to be quite concerned?	.000	.000	4.3	.000
Iod_Safe_Mast	Milk with excess iodine is safer to drink than milk with excess microbes	-2.07	.40	-5.17	.000
Prio_Mast_Iod	Between iodine excess and mastitis, my priority is to control mastitis	-.76	.35	-2.18	.031
Iod_In_Feed_Cow	Dairy cows need iodine in their feed to remain healthy	.83	.37	2.23	.028
Iod_From_Udd	Udder as a source of iodine residue in milk	.60	.26	2.32	.022
	Variables about Information				
Inf_Dis_Proc1	First principal source of advice for teat treatment procedure	.59	.17	3.34	.001
Inf_Cow_Treat1	Second principal source of advice while dealing with bacteriology test results	-1	.26	-3.79	.000
Care_Other_Opin	Care about what other people think about how I manage my dairy	1.08	.29	3.75	.000
	Producer and farm characteristics				
BMTSCC	Bulk milk tank somatic cell count record	-.0000	.0000	-2.48	.015
DHI_Part	Participation in “Dairy Herd Improvement” initiatives (i.e. Valacta or CanWest)	-3.42	1.01	-3.39	.001
Iod_Equip	Average level of iodine in milk equipment disinfectants	-.96	.38	-2.53	.013
Prod_Sex	Gender of the producer	-3.2	.78	-4.1	.000
Constante		22.93	2.33	9.82	.000

Regression ANOVA d.f=13; sig.=0.000; Adj. R^2 =0.4647

Table 7: Distribution of the dependent variable, "willingness to adopt mastitis BMPs" across the four provinces (%) (n=864)

Level (scores)	PEI	Québec	Ontario	Alberta	Total
High level of adoption (21-30)	9,3%	**19,29%**	8,05%	14,39%	14,60%
Middle level of adoption (31-48)	76,74%	77,38%	75,48%	75,54%	76,48%
Low level of adoption (49-65)	13,95%	**3,33%**	16,48%	10,07%	8,92%
	100%	100%	100%	100%	100%

Chi-square=47, 7375; d.f. =6; sig. =0.000

Table 8: Distribution of the dependent variable, "willingness to adopt iodine BMPs" across the four provinces (%) (n=978)

Level (scores)	PEI	Québec	Ontario	Alberta	Total
High level of adoption (10-14)	16,67%	16,74%	12,58%	**23,95%**	16,68%
Middle level of adoption (15-24)	74,07%	76,65%	75,17%	69,46%	74,82%
Low level of adoption (25-33)	9,26%	6,61%	12,25%	**6,59%**	8,50%
	100%	100%	100%	100%	100%

Chi-square=16,8594; d.f. =6; sig. =0.01

Table 9: Distribution of approximate total farm income before taxes in 2011 by province (n=925)

	PEI	**Québec**	**Ontario**	**Alberta**	**Total**
$24,999 or less	0%	5,17%	1,77%	2,01%	3,35%
$25,000 to $49,999	0%	8,76%	2,48%	0%	4,97%
$50,000 to $99,999	8,16%	10,11%	6,74%	7,38%	8,54%
$100,000 to $249,999	**30,61%**	**26,29%**	**23,76%**	12,75%	23,57%
$250,000 to $499,999	**34,69%**	**29,44%**	**36,52%**	14,09%	29,41%
$500,000 to $999,999	20,41%	14,83%	20,21%	**34,90%**	20%
$1,000,000 or more	6,12%	5,39%	8,51%	**28,86%**	10,16%
	100%	100%	100%	100%	100%

Chi-square=150,0374; d.f.=18; sig.=0.000