Does Internet Use Affect Public Perceptions Of Technologies in Livestock Production?

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Abstract

Novel technology applications such as cloning and genetic modification in livestock production have not been widely supported by the public. In this study the relationships between attitudes towards animals, internet use and potential uses of genomics (and vaccination) in beef and pork are examined. The public's attitudes towards animals, based on an AAS score developed by Herzog et al. (1991) could affect how the public sees the use of genomic technologies in livestock production. Media coverage of technology, including use of the internet, may also play a role in attitudes towards new technologies. Public attitudes might impact acceptance of genomic technologies and influence their adoption by producers, hence influencing societal welfare. Understanding some of the factors influencing attitudes can assist in the development and adoption of technologies. Tobit and multinomial regressions for members of the Canadian public suggest that internet use (for the purposes of searching out information on science and technology) is a positive indicator of higher animal attitudes scores (being more protective of animals) which suggests that internet use has both a negative (indirectly through animal attitudes) and a positive (direct) relationship with the use of genomic technologies in livestock production (through the sign of the variable in the attitude towards genomics equations). Respondents' individual characteristics such as gender, knowledge of genomics applications prior to survey, income level, etc., are also related to their risk/benefit assessment of this livestock production technology.

1. Introduction

Emerging research indicates constant progress in improving and developing new technologies for livestock production. Meat production systems are changing, led by market demand for higher intrinsic quality, better animal welfare, care for the environment and sustainability (Verbeke et al., 2010). Some of these technologies which are primarily reproductive technologies (i.e. cloning, genomic applications) are appealing

to ranchers and farmers because they enable them to more quickly breed desirable traits into their herds (Paterson et al., 2003).

At the same time, the public remains concerned about which technologies are used in livestock production. Part of the concern focuses on whether consumers and their surrounding society value the food products produced by novel technologies in livestock, and whether they perceive any risks or benefits for their health and the environment (Costa-Font et al., 2008). Communication seems to be very important in the development of new technologies, in the sense that communication must address consumer perceptions to influence market acceptance and to enable consumers to make informed choices (Matin and Goddard, 2013).

1.1 Genomics a new emerging technology

Genomics defined as the science that studies the structure and function of genomes and in particular genes, has been shown to have great potential in genetic improvement of livestock. The emphasis has been on identifying genomic variation associated with desirable breed characteristics that have a major impact on livestock industry profit (Gibson et al., 2007). This use of genomic information in animals allows researchers to select the animals such that the progeny can be bred for specific traits. Genomic selection, which enables prediction of the genetic merit of animals using genome-wide SNP (Single Nucleotide Polymorphisms), has already been adopted by some livestock industries worldwide and is expected to double genetic gains for production and other traits (Hayes et al., 2013). Selective breeding based on genomic information allows producers to potentially lower prices, to increase the quality of products (i.e. meat or milk), and possibly to reduce susceptibility to diseases (Paterson et al., 2003; Wall et al., 2005).

Using genomic relationships can also improve the precision of estimated genetic parameters (heritability and genetic correlations between traits) (Veerkamp et al., 2011). The advantage of genomic selection over traditional selection is that animals can be

selected accurately early in life, based on their genomic characteristics, and can be selected for traits that are difficult or expensive to measure; fertility, disease resistance, methane emissions, and feed conversion are prime examples (Hayes et al., 2013; Meuwissen et al., 2001). Genomic selection also potentially shortens the time to genetically improve livestock in a particular direction due to decisions being made to include younger animals with/without a specific gene in breeding as opposed to waiting for their numerous progeny to express these traits over their lifespans. Genomics can enhance reproduction efficiency and increase longevity of animals. Consumers, on the other hand, may benefit from genomic selection by being provided with the meat that could come from a healthier animal, could be a safer product and could be pathogen free (Allen et al., 2013) sooner than traditional breeding might produce.

For instance, genomic information in pigs in particular, could allow the identification of specific genes which are linked to disease resistance. There are currently two major infectious diseases in pigs that are of global concern: PRRS (Porcine Reproductive and Respiratory Syndrome), and PCVAD (Porcine Circovirus Associated Disease). Selecting for genes that reflect disease resistance could reduce the spread and intensity of the diseases potentially. Also the cattle farming industry is benefiting from new applications of genomics science that enable more feed efficient cattle to be produced by breeding. Methane production from cattle is a large source of greenhouse gases and feed is one of the biggest costs facing livestock producers. Enhancing feed efficiency in cattle could have the effect of making beef production more environmentally and economically sustainable. Cattle producers might be able to take advantage of genomics, using genomic testing as a tool to increase the accuracy of predicting an animal's feed efficiency. It gives the farmers a more indicative idea of the type of cow they're breeding which could be more efficient converters of feed into meat, reducing greenhouse gases and improving farm profitability. For these applications producers also use vaccination (to reduce disease incidence or to increase productivity).

With these benefits mentioned above, research on the risk perceptions associated with the use of this novel technology is important. Without this effort, negative perceptions could

lead to a lack of support by the public, reduce potential health improvements and, ultimately, set back technological innovation for a significant period of time (Smiley et al., 2008). It has also been shown that consumers view high animal welfare standards at the production stage as an indicator that the resulting food is safe, healthy and of high quality (Fallon and Earley, 2008; Weddle-Schott, 2009).

1.2 Purpose of the study

The purpose of this study is to establish whether different sources of media influence respondents' attitudes towards animals and their attitudes towards the use of genomic technology. Previous research (Matin, 2014, Matin et al., 2014) has shown that an individual's attitudes towards animals does have a link to their willingness to pay for meat produced with certain attributes and that animal attitudes influence the risk benefit perceptions of the public around specific uses of genomics. In this paper the use of the internet (and other media) is examined as one influence on an individual's animal attitudes and attitudes towards use of genomics.

Animal attitudes have been measured in a variety of ways including the animal attitude scale (AAS) that is based on statements about perceptions about the use of animals and how they are treated (e.g. Herzog et al., 1991; Armstrong and Hutchins, 1996). Previous research (Matin et al., 2014) suggests that the public's attitude towards animals (based on an AAS developed by Herzog et al., 1991) is an important indicator of attitudes towards the use of technologies in livestock production. There are differences in the ways people used to define good treatment of animals. Some people regard eating flesh from animals, use of animals in research and activities such as sport hunting as being cruel and unreasonable (Mathews and Herzog, 1997). The AAS developed by Herzog et al. (1991) assesses individual differences in attitudes toward the treatment of animals. One might expect that people with higher animal attitudes might like the use of some technologies in animal production if the technologies can make life easier for the animals, but it appears that higher animal attitudes are associated with distaste for the use of even these relatively benign technologies (Matin, 2014).

Although there is information on the link between animal attitudes and approval of the use of technologies, there is less information available about the sources of information used by the public in either forming their attitudes about animals or forming their attitudes about technology use. Decades of research have shown that media can be a primary source of information about advances in science and technology and can increase the perceived importance of an issue among audience members. In addition to increasing audience awareness of scientific issues, media can also influence the formation of perceptions or help in agenda setting (Scheufele and Tewksbury, 2007).

In this research the following questions are examined: I) To analyze whether or not internet use, as an example of a prevalent media source, helps explain the AAS and the attitudes towards the use of two technologies in livestock production – the use of genomic information and the use of vaccination in two specific contexts to reduce diseases in pigs and to increase feed efficiency in cattle. II) To analyze other factors that drive people's perceptions about the benefits and risks to their health of using these two different applications in livestock production in Canada.

2. Literature review

Media plays a key role in society and is often a source used by individuals to gather more information on a topic. News media affects both personal values and decision making. People may be influenced by biased portrayals of issues in the media (Flynn et al., 1993). These biases, if true, can affect individual perceptions and in the aggregate can sway policy outcomes (Flynn et al., 1993). It may be more likely for the media to present a controversial opinion than a wider consensus of scientific results because it will garner more attention (Alm et al., 2010). When the media uses negative examples, it can skew public focus toward one aspect of a problem and cause a loss of attention to other aspects of the issue (Stone, 1997). According to Scheufele and Tewksbury (2007) there is a strong correlation between the emphases that mass media gives to certain issues and the importance the mass audience attributes to these issues.

As mentioned earlier, despite the fact that novel technologies such as genomics have progressed rapidly, their market acceptance is likely to be influenced by media coverage. Media can play a very important role in shaping the awareness and opinion formation of public in terms of novel food technologies (Lyndhurst, 2009; Dudo et al., 2011).

Previous studies suggest that even though consumers have little knowledge about newly emerged food technologies in Europe, US and Canada, the majority of media representation seems to portray positive views about these technologies (Hallman and Condry, 2006; Neresini, 2000; Holliman, 2004; Gaskell et al., 2005; Dudo et al., 2011; Wilkinson et al., 2007). For instance, Hallman and Condry (2006) indicated that in terms of media coverage in US, 46% of the coverage supports novel food technologies, 21% opposes, 21% of the coverage includes balanced sources, discussing both positive and negative aspects of novel foods, and 12% are neutral, indicating no evaluative statements in their coverage. In the UK the media views are optimistic about the benefits of novel technologies (e.g. nanotechnology) in food industry, but at the same time there is anxiety shown about its potential risks (Wilkinson et al., 2007). The media in the Netherlands and Denmark have predominantly covered the positive and beneficial aspects of these novel technologies (i.e. nanotechnology) in food industry (Kjargaard, 2010; Te Kulve, 2006). Previous research has also revealed that the mass media is important in distributing information about the environment, science, technology and health to the majority of adult Canadians (Weigold, 2001). In Canada with regard to media coverage, the novel food technologies, which are early in their developments such as nanotechnology, are predominantly discussed with a focus on benefits and scientific coverage of the issues (Tyshenko, 2014).

In the meat production industry, over the past several years, many negative stories related to meat production have made the headlines in the mainstream media. Some of the most notable cases include BSE, E coli and Salmonella outbreaks, inhumane treatment of livestock, and the contribution of livestock production to global warming (Goodwin and Shoulders, 2013). The media can influence consumers' perceptions and allows industry

to strategize how to shape future communication about possible incidents in meat production industry. Consumers often look to media for information concerning food issues; therefore, to understand how the media influences consumers' opinions of meat produced by novel technologies, it is necessary for the meat industry to be aware of media coverage (Meyers and Abrams, 2010). In the US the media coverage surrounding new technologies in meat production showed that current livestock production problems and the benefits of new technologies (such as meat that could come from a healthier animal which is either less susceptible to diseases or produces less methane) were themes commonly discussed by the media (Meyers and Abrams, 2010; Goodwin and Shoulders, 2013). This shows that consumers are being reminded of commonly perceived problems associated with conventional livestock production, while being offered a solution to the problems through innovations in meat production such as a safer, pathogen free meat product (Goodwin and Shoulders, 2013). At the same time considerable research still needs to be conducted on effective genomic tools for identification of disease resistance genes in pigs and genetic improvement for feed efficiency in cattle (Zhao et al., 2012).

Concerning genomics in the context of Canadian media, the articles covering “genomics” (human or non-human), rather than “genome”, were found to be more informative, featuring fewer issues, and discussing more economy-related benefits (e.g. more efficient, less costly, and healthier livestock production performance). Also some benefits such as health (in general) (human or non-human) and health prevention were also frequently discussed in the news with regard to genomics (Racine et al., 2006). In general, Canadian media reflects optimism about genomics as it is growing and expanding scientific endeavor. For example, Canadian media reports about the advances that have been achieved from the viewpoints of researchers, government, and the industries involved (Racine et al., 2006).

The role of mass media in alerting the public to new risks or highlighting the uncertainty of existing risks is significant and risk perceptions may be distorted through the process of social amplification or attenuation of risk (Lewis and Tyshenko, 2009; Tyshenko, 2008). Also, internet news is the most easily accessed and often the primary resource for

the public to use to obtain information on new scientific breakthroughs and innovation (Tyshenko, 2014). Devereaux et al. (2009) showed that in Canada the internet is being used to find information about newly emerging technologies more commonly than any other means of media. Understanding the impact of internet use on public perceptions and the relation to risks and benefits of new technologies associated in livestock production such as genomics can help future policy makers and researchers as how to communicate further advances in technologies related to livestock production.

2.1 Genomics and vaccination in Canadian news media

Genomic information used in selective breeding, in pigs in particular could allow the identification of specific genes which are linked to disease resistance. Selecting for genes that reflect disease resistance could reduce the spread and intensity of the diseases potentially. Also the cattle farming industry is benefiting from new applications of genomics science that enable more feed efficient cattle to be produced by breeding. Methane production from cattle is a large source of greenhouse gases. Feed is one of the biggest costs facing livestock producers. Vaccination is considered to be an alternative for either combating diseases in pigs or reducing microbes in the cattle rumen that can suppress methane emission and increase feed efficiency (Wedlock et al., 2013). It is quite likely that these applications like other uses of vaccination and selective breeding are not well understood by the public and there is likely little media coverage of these two issues. As a result, a broad look at the media coverage in Canada regarding these applications could help to understand the extent and existence of the coverage.

In order to better understand how much media attention is given to genomic applications and vaccination to humans and animals, and their related issues two Canadian national newspapers are analyzed for frequency and content covering. The Canadian news analyzed for genomics and vaccination topics consists of two major national newspapers archived articles of “The Globe and Mail”, and “ The National Post” during the period of the past ten years. National newspapers are used as a proxy for broader media coverage

since it is difficult to search TV coverage or radio and searching all newspapers results in enormous duplication.

A search in Factiva yielded 147 articles related to genomics, and 520 articles related to vaccination for humans and non-humans in “The Globe and Mail” newspaper. In the “National Post” newspaper, 91 articles were published related to genomics and 369 articles covered vaccination topics (both humans and non-humans). Figure 1 shows the distribution of news content in the past ten year period for these two national newspapers. As can be seen the genomics topic is less frequently covered in these two newspapers as compared to the vaccination topic (humans and non-humans). A search in “La Presse” newspaper from Quebec province also shows that during the past 10 years, 130 news topics were related to genomics, whereas, 352 topics covered vaccination content related to human and non-human issues.

[Figure 1]

A second search in Factiva for content indicates that more than 90% of the articles covered by “The Globe and Mail” with regard to vaccination were health related to humans and animals and include associations such as Health Canada, Alberta Health Services, Public Health Agency of Canada, Canadian Animal Health Institute, etc. Also around 5% of the news published about vaccination related to livestock farming and the food industry. With regard to genomics, 47% of the published news was related to health in both humans and animals, and 14% was related to research and development. 7% of the news published covered genomics in livestock production, food, and traceability topics. The industries mentioned in the articles were frequently biotechnological and pharmaceutical institutions.

In the “National Post” newspaper with regard to genomics, 36% of the news content is related to health (human and animals), and 27% of the contents covered the research and development of genomics. Around 5% of the news published covered livestock genomics. In vaccination related issues, 83% of the press content is related to health issues, and 9% of the news covers vaccination issues in livestock production and the food

industry. Figure 2 shows the news content distribution for genomics and vaccination in livestock content in the past ten years for the two national newspapers.

[Figure 2]

Due to the breadth of the genomics and vaccination topics, an internet search can also help to understand how different news agencies in Canada (Such as CBC, Vancouver Sun, Metro news, etc.) cover these topics. Topics such as plant and/or livestock genomics are not frequently covered by other news agencies than the "National Post" and "The Globe and Mail" (6 articles in five-page search). Many of the news articles covered by other Canadian news agencies, with regard to vaccination, focuses on disease prevention for both animals and humans. However, livestock vaccination was more frequently covered than the genomics topic in the animal farming industry in Canadian news (more news articles were available which have covered livestock vaccination than livestock genomics).

A quick search for "livestock genomics" as a topic in Twitter, a very recent source of news for scientific and technological advances, however, showed quite surprising results. More than 200 tweets could be seen from Genome Canada, Alberta Genome, Canada Government News, and other companies and university scholars discussing the issues of animal breeding, livestock production, disease prevention, etc. in the period 2009 to 2014. More than 500 tweets were also seen related to livestock vaccination from 2008 to 2014 discussing vaccination efficiency, immunization, disease spread, cost of vaccination, etc. This shows that twitter, as a means of media should also be considered as a high volume, easily accessible source of information.

3. Data

Two online surveys conducted in 2012 in Canada for general household shoppers including: risks and benefits of genomic selection for disease susceptibility in pigs, and genomic selection for feed efficiency in cattle. The data were collected through a

marketing research company. The first survey was aimed at assessing people's perceptions and attitudes towards the use of genomics and vaccination in increasing the resistance of pigs to PCVAD (Porcine circovirus-associated disease) and PRRS (Porcine reproductive and respiratory syndrome) and the sample size used was 1568 respondents. The second survey was aimed at assessing people's perceptions and attitudes towards the use of genomics for increased feed efficiency and vaccination for increased feed efficiency/methane reduction in cattle with a sample size of 1663 respondents. More people in each survey were surveyed but only those who actually completed the risk benefit assessments (based on their declared meat eating behaviour) are counted in the analyses. Descriptive statistics on the characteristics of respondents in the two surveys are summarized in Table 1. A majority of the respondents in the two surveys (71% in the beef survey and 64% in the pork survey) are females, are somewhat older and have an average of college/ undergraduate degree in terms of education. Most respondents consume meat and fish products (89% in the beef survey and 88% in the pork survey) as opposed to no meat or no fish or neither meat nor fish. The excess percentage of females isn't surprising given the fact that the criteria of selection was primary household shoppers.

[Table 1]

3.1 Internet and Media Use

Respondents in the pork and beef surveys were required to answer a series of questions about how many days over the past week did they watch TV news, listen to radio news, read a magazine, use internet for news, and use internet for science and technology information search. The results suggest that of the Canadian respondents in the pork survey, 65% made use of the internet for science and technology information news more than three times a week as compared to use of national TV (8%), 32% used the internet for general news, national newspaper (8%), local newspapers (6%), regional TV (6%), radio (5%), and magazines (2%). In the second Canadian survey (beef) 59% of the respondents made use of the internet to search for science and technology information more than three times per week as compared to 8% who read national newspapers and

5% who read local newspapers, 12% who watch national TV, 6% who watch local TV, 7% who listen to radio, 37% who use the internet for news, and 3% who read magazines.

A majority of respondents use several media as a source new or information about science and technology. For instance, in the pork survey, 86% of the respondents use a combination of internet for the purpose of science and technology information, national TV, national newspaper, and radio to get their information regarding science and technology, whereas 77% use the internet for the science and technology information search as well as local newspaper, and local TV as a source of information. Likewise, in the beef survey, 79% of the respondents use a combination of internet (to search for science and technology information topics), national TV, and national newspaper. Only 13% of the respondents use local TV and local newspapers as their sources of information. The summary of mean and standard deviations of respondent who use for each different media use questions, and also mean and standard deviations and number of respondents who use a combination of media (internet (to search for science and technology information topics) plus internet for general news only; internet (to search for science and technology information topics) plus national TV; and internet (to search for science and technology information topics) plus national TV plus national newspaper (as a combination of three media sources), and internet (to search for science and technology information topics) plus national TV plus national newspaper plus local TV (as a combination of four media sources)) frequency uses can be seen in Table 2. The respondents were asked how many days per week they use each source of media. The responses were set to 0= not at all, and 4= more than three times. . As can be seen the number of respondents decreases as the combination of media uses is added, implying that fewer respondents use many media sources.

[Table 2]

3.2 Attitudes towards the use of genomic information and/or vaccination in selective breeding of animals

Employing the benefit risk ratio approach of Vandemoere et al. (2011) and later used by Matin et al. (2012) and Matin et al., 2014, respondents were asked how risky and how

beneficial they perceive using genomic information to undertake selective breeding (or vaccination) for increased feed efficiency of cattle in the beef survey and disease resistance in pigs in the pork survey are for human health. The choices were as follows: 1- not at all risky (not at all beneficial) to 5- very risky (very beneficial).

Then, responses to the risk statements are subtracted from the responses to the benefits statements. Respondents were classified into three groups: supporters (if benefits outweighed risks), doubters (if benefits were equal to risks) and opponents (if risks outweighed benefits). The distribution of differences between perceptions about human health benefits and risks of the use of genomics for disease resistance in pigs and increased feed efficiency in cattle and vaccination for disease prevention in pigs and methane reduction in cattle are summarized in Figure 3.

[Figure 3]

37% of the respondents supported the use of genomic information in pigs while about 33% of the respondents supported the use of vaccination for disease resistance (Table 3). About 23% and 13% of respondents supported the use of genomic information for increased feed efficiency in cattle and vaccinations for reduced methane production in cattle, respectively. Most respondents were in the “doubter” group with regards to perceptions about the human health risks and benefits of using genomic information in selective breeding and vaccination of pigs that are disease resistant. In the beef survey about 41% of respondents were in the “doubter” group with respect to their perceptions about the human health risks and benefits of using genomic information for increased feed efficiency in cattle while most of the respondents opposed the use of vaccination for reducing methane production in cattle.

[Table 3]

3.3 Animal Attitude Scale (AAS)

Elements of AAS developed by Herzog et al. (1991) are used to assess differences in people’s attitudes with respect to treatment of animals. It is composed of items which subjects rate on a five-point Likert scale (1- strongly agree to 5- strongly disagree). The

items are scored so that a high score indicates pro-animal welfare attitudes. The thirteen statements used in the calculation of the AAS for the pork and beef surveys are shown in Table 4. Questions 3, 4, 5, 6, 9, 10 were reversed to assess whether the individual supported the use and good welfare of animals. Results on net agreement percentages (Roselius, 1971) (Figure 4) show that most people agreed that one of the worst things someone can do is to hurt a defenseless animal and that the slaughter of whales and dolphins should be immediately stopped even if it means some people will be put out of work. Most people did not agree with the statement which stated that "I do not think that it is perfectly acceptable for cattle and hogs to be raised for human consumption" and that "hunting wild animals for food is morally wrong". Results show that most people value animal welfare i.e. they have positive attitudes towards animals. After reversing responses to certain statements, responses to the questions outlined were summed in order to create a single AAS score. Cronbach's alpha values for the thirteen statement scale were 0.775 for the beef survey and 0.774 for the pork survey which indicates high internal consistency. Given a maximum AAS score of 65, the mean AAS score is 42.04 (sd = 7.73) for the beef survey and 41.96 (sd = 8.00) for the pork survey which shows that people generally support good treatment of animals.

[Table 4]

[Figure 4]

4. Results

4.1 Multinomial and Tobit regression results

Multinomial regressions (opposers, doubters and supporters of genomics and vaccination) were used to explain underlying factors affecting the AAS, and use of internet to search information about science and technology, held by each respondent and their position on the risks or benefits of use of genomics and vaccination for disease resistance in pigs and increased feed efficiency.

The AAS score for each respondent was derived as a single score by summing the responses to the thirteen statements outlined in Table 4 (after revising certain statements reciting the good welfare of animals), and the internet use (for searching information

about science and technology) variable is considered as the people who use internet more than three times per week (Table 2).

Independent variables included in the regressions are the animal attitude scale, whether the respondent eats meat or fish, self-rated knowledge of science and technology, whether the respondent had heard about biotechnology and genomics prior to surveys, age of the respondent, whether the respondent has trust in people in general, gender, presence of children less than 18 years of age in the household, marital status, education, regional variable (Quebec), income, living in a city as opposed to rural living, and use of internet more than three times a week for science and technology information as opposed to other sources of media.

The results presented in Table 5, show that animal attitudes significantly explain public negative opinions about the risks and/or benefits of use of genomics and vaccination for improved disease resistance in pigs and increased feed efficiency in cattle. People who frequently (more than three times) use the internet for searching information on science and technology, are more likely to support or doubt than oppose the use of vaccination both for disease prevention in pigs, and for reduced methane production in cattle. The internet use variable was not significant in explaining the support or opposition of the Canadian consumers for the use of genomics for disease prevention or reduction in methane production. One possible justification could be, as discussed earlier, in major Canadian national newspapers, the news articles related to livestock genomics were covered less frequently than livestock vaccination topics.

People who stated that science and technology are beneficial for society are more likely to support or doubt than oppose the use of genomics for improved disease resistance in pigs and increased feed efficiency in cattle or vaccination for disease prevention in pigs and reduced methane production in cattle. People who have not heard about genomics prior to the survey are more likely to support than oppose the use of vaccination to reduce methane emissions in cattle.

Males are more likely to be supporters or doubters than opposing the use of genomics for improved disease resistance in pigs and increased feed efficiency in cattle or vaccination for disease prevention in pigs and feed efficiency in cattle. Other demographic variables such as trust, whether they have heard about biotechnology, level of income, living in city, living in the province of Quebec, also influenced public perceptions of the use of genomics and/or vaccination in livestock production.

It is useful to know how frequently the group of people who had/had not heard of genomics use the internet for searching information on science and technology. In the pork survey, those who have heard about genomics prior to the survey use the internet more frequently to seek information about science and technology topics (mean value of 2.32) than those who have not heard previously about genomics (mean value of 1.76 for the internet use). The Welch's t-test indicates that the two means are statistically different (p-value 0.05) from each other. In the beef survey, the mean value of internet use for that group of respondents who had not heard about genomics prior to the survey is 1.83, and for those who had heard is 2.47. The Welch's t-test also indicates that the two mean in the beef survey are statistically different (p-value 0.05) from each other.

[Table 5]

When sample data are bounded by values embedded in, for example, survey questions, then it may not be appropriate to use ordinary least squares regression which assumes normally distributed dependent variables. The AAS is truncated at a maximum value of 65 and a minimum value of 13. As a result OLS does not seem appropriate to examine the determinants of AAS type of data (Greene, 2008). By using OLS, estimated parameters might be biased. The regression model that is commonly used to estimate truncated distributions is the censored regression model or the Tobit model.

Tobit regressions were employed to examine whether or not use of internet for the purpose of searching out information on science and technology is an indicator of attitudes towards animals in the pork and beef surveys. Other socio-demographic

variables included in the Tobit analysis are self-rated knowledge of science and technology, whether the respondent had heard about biotechnology and genomics prior to surveys, age of the respondent, whether the respondent has trust in people in general, gender, presence of children less than 18 years of age in the household, marital status, education, regional variable (Quebec), income, living in a city as opposed to rural living.

Our findings (Table 6) suggest that internet use is indeed a positive indicator of higher animal attitudes scores (being more protective of animals). But, as reported above, this internet use also increases the probability that the respondents are more likely to be supporters and/or doubters rather than opposers of the use of vaccination in pigs for disease reduction or feed efficiency in cattle. This suggests that internet use has both negative (indirectly through animal attitudes) and positive (direct) relationships with the use of technologies, particularly vaccination for the purposes defined in this study, in livestock production. Also in the pork survey, being younger, females, and living in the city are indicators of being more protective towards animals. In the beef survey, people who cannot trust others, and believe that science and technology would not make the society better off are less protective towards animals (negative indicator of animal attitude scores).

[Table 6]

Conclusion

Two national surveys provided Canadian consumers with questions regarding their attitudes towards animals, use of internet (to search for science and technology information) and their perceptions about the benefits/risks of genomic information in selective breeding for disease resistance in pigs and increased feed efficiency in cattle and vaccination for disease prevention in pigs and reduced methane production in cattle. The results of multinomial and Tobit regression analyses indicate that the Canadian consumers' attitudes towards animals and use of genomics and/or vaccination can be impacted by frequent use of the internet as a source of information. Frequent use of the internet indicates higher pro-animal attitudes. Higher pro-animal attitudes imply lower

interest in genomics or vaccination for the uses defined in this study. In addition, higher use of the internet for searching out science information resulted in lower interest in vaccination – a double effect a direct effect and an indirect effect through animal attitudes. The growth of genomics as a potential innovative technology to improve livestock production and enhance meat quality has raised some social concerns as 63.4% and 76.7% of the Canadian respondents in the pork and beef surveys, respectively, were opposers and doubters towards using genomic applications in pigs and cattle. 67.1% and 86.9% of the respondents in the pork and beef surveys respectively, were opposers and doubters of vaccination although it is a more common technology as compared to genomics.

Monitoring internet coverage of science and agriculture issues may be important to understanding something about popular opinions towards the use of new technologies. As this study indicated a majority of Canadians seek their information on science and technology via internet (Table 2) possibly because this is searchable more than other media sources. Further research could illustrate whether particular internet sources such as social media provide better understanding of the determinants of attitudes towards science and technology.

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References

Alm, L. R., Burkhart, R. E. and Simon, M. V. (2010) Turmoil in American public policy: Science, democracy and the environment. Santa Barbara, CA: Praeger.

Armstrong, J.B. and Hutchins, M.E. (1996) Development of an attitude scale to measure attitudes toward humans' use of nonhuman animals. *Perceptual and Motor Skills*, **82**, 1003-1010.

Costa-Font, M., Gil, J.M. and Traill, W.B. (2008) Consumer acceptance, valuation of and attitudes towards genetically modified food: Review and implications for food policy. *Food Policy*, **33**(2): 99-111.

Devereaux, Z., Mogoutov, A., Theoret, C.G. and Allard, C. (2009) Mapping public opinion and discourse about nanotechnology in Canada and OECD states. Data analysis report - phase II.
[http://nexalogy.com/wp-content/uploads/2012/07/MAPPING-NANOTECH-CANADA-2008-FINAL-TOTAL.pdf] [Accessed on May 2014]

Dudo, A., Choi, D.H. and Scheufele,D.A. (2011) Food nanotechnology in the news, coverage patterns and thematic emphases during the last decade. *Appetite*, **56**, 78-89.

Fallon, R.J. and Earley, B. (2008) Animal welfare guidelines for beef cattle farms, Teagasc, Ireland.
[http://www.teagasc.i.e./publications/2008/20081022/animalwelfareguidelines.asp]

Flynn, J., Slovic, P. and Mertz, C. (1993) The Nevada initiative: A risk communication fiasco. *Risk Analysis*, **13**(5): 497-502.

Gaskell, G., Eyck, T., Jackson, J. and Veltri,G. (2005) Imagining nanotechnology; Cultural support for technological innovation in Europe and the United States. *Public Understanding of Science*, **14**(1): 81-90.

Gibson, J.P., Ayalew, W., Hanotte, O. (2007) *Measures of diversity as inputs for decisions in conservation of livestock genetic resources*. Managing biodiversity in agricultural ecosystems, pp. 117-140

Goodwin, J.N. and Shoulders, C.W. (2013) The future of meat: A qualitative analysis of cultured meat media coverage, Meat Science, 95(3):445-450.

Hallman, W. K. and Condry, S. C. (2006) Public opinion and media coverage of animal cloning and the food supply: Executive summary. Rutgers, the State University of New Jersey, New Brunswick NJ. Food Policy Institute, 08901. FPI Research Report.

Hayes, B.J., Lewin, H.A. and Goddard, M.E. (2013) The future of livestock breeding: genomic selection for efficiency, reduced emissions intensity, and adaptation. *Trends in Genetics*, **29**(4): 206-214.

Herzog, H.A., Golden, L.L. (2009) Moral emotions and social activism: the case of animal rights. *Journal of Social Issues*, **65**, 485-498.

Herzog, H.A., Betchart, N., Pittman,R. (1991) Sex role identity and attitudes toward animals. *Anthrozoös*, **4**, 184-192.

Holliman, R. (2004) Media Coverage of Cloning: A Study of Media Content, Production and Reception. *Public Understanding of Science*, **13**(2):107-130.

Kjærgaard, R. S. (2006) Making a small country count; Nanotechnology in Danish newspapers from 1996 to 2006. *Public Understanding of Science*, **19**, 80-97.

Lewis, R.E. and Tyshenko, M.G. (2009) The impact of social amplification and attenuation of risk and the public reaction to mad cow disease in Canada. *Risk Analysis*, **29**(5):714-728.

Mathews, S. and Herzog, H.A. (1997) Personality and attitudes toward the treatment of animals. *Society & Animals*, **5**, 169-176.

Matin A.H., Goddard E., Muringai V. (2014) Public perceptions and attitudes towards the use of genomic information and vaccinations in animals. *Animal Welfare* (Submitted).

Matin, A.H. and Goddard, E. (2013) A Comparative analysis of Canadian consumers' WTP for novel food technologies (Case of juice produced by nanotechnology & pork chops using genomic information). AAEA & CAES Joint Annual Meeting, August 4-6, Washington, DC.
[http://ageconsearch.umn.edu/bitstream/150461/2/Anahita%20Matin%20final%20AAEA%20CAES%202013.pdf] [Accessed on Dec 2013]

Matin, A.H., Goddard, E., Vandermoere, F., Blanchemanche, S., Bieberstein, A., Marette, S. and Roosen, J.(2012) Do environmental attitudes and food technology neophobia affect perceptions of the benefits of nanotechnology? *International Journal of Consumer Studies*, **36**, 149-157.

Meuwissen, T.H.E., Hayes, B.J. and Goddard, M.E. (2001) Prediction of total genetic value using genome-wide dense marker maps. *Genetics*, **157**, 1819-1829.

Meyers, C. and Abrams,K. (2010) Feeding the debate: A qualitative framing analysis of organic food news media coverage. *Journal of Applied Communications*, **94**(3-4): 22-36.

Neresini, F. (2000) And man descended from the sheep: the public debate on cloning in the Italian press. *Public Understanding of Science*, **9**(4):359-382.

Paterson, L., DeSousa, P., Ritchie, E., King, T. and Wilmut,I. (2003) Application of reproductive biotechnology in animals, Implications and potentials, Applications of reproductive cloning. *Animal Reproduction Science*, **79**, 137-143.

Racine, E., Gareau, I., Doucet, H., Laudy, D., Jobin, G. and Schraedley-Desmond, P. (2006) Hyped biomedical science or uncritical reporting? Press coverage of genomics (1992–2001) in Québec. *Social Science and Medicine*, **62**(3): 1278-1290.

Scheufele, D.A., Tewksbury, D. (2007) Framing, agenda setting, and priming; The evolution of three media effects models. *Journal of Communication*, **57**(1): 9-20

Stone, D. (1997). Policy paradox: The art of political decision making. New York, NY: W.W. Norton & Company.

Te Kulve, H. (2006) Evolving repertoires, nanotechnology in daily newspapers in the Netherlands. *Science in Culture*, **5**(4): 367-382.

Tyshenko, M.G. (2008) The social amplification of risk and SARS as a risk issue [Chapter 5]. In: SARS unmasked: risk communication of pandemics and influenza in Canada. Montreal, Quebec: McGill-Queen's University Press.

Tyshenko, M.G. (2014) Nanotechnology framing in the Canadian national news media. *Technology in Society*, **37**, 38-48.

Verbeke, W., Pérez-Cueto, F.J.A., de Barcellos, M.D., Krystallis, A. and Grunert, K.G. (2010) European citizen and consumer attitudes and preferences regarding beef and pork. *Meat Science*, **8**, 284-292.

Veerkamp, R.F., Mulder, H.A., Thompson, R. and Calus, M.P.L. (2011) Genomic and pedigree-based genetic parameters for scarcely recorded traits when some animals are genotyped. *Journal of Dairy Science*, **94**, 4189-4197.

Wall, R.J., Powell, A.M., Paape, M.J., Kerr, D.E., Banermann, D.D., Pursel, V.G., Wells, K.D.,Talbot, N. and Hawk, H.W. (2005) Genetically enhanced cows resist intramammary Staphylococcus aureau infection. *Nature Biotechnology*, **23**, 445-451.

Weigold, M.F. (2001) Communicating science: a review of the literature. *Science Communication*, **23**:164-93.

Weddle-Schott, L. (2009) Communication of animal welfare key to consumer trust. University of Minnesota Beef Team.
[http://www.farmandranchguide.com/articles/2009/01/31/ag_news/livestock_news/live4.txt]

Wilkinson, C., Allan, S., Anderson, A. and Petersen, A. (2007) From uncertainty to risk? Scientific and news media portrayals of nanoparticle safety. *Health Risk and Society*, **9**(2):145-157.

Table 1: Socio-Demographic Characteristics of Canadian National Survey Respondents (N=1568, Pork Survey; N=1663, Beef Survey)

Variable	Definition	Pork Survey (2012) (%)	Beef Survey (2012) (%)
Gender	Male Female	36 64	29 71
Child	If child under age of 18 living in household	25	21
Trust	If people can be trusted	45	49
Urban Areas	If resides in a city >100.000 inhabitants/ or in a town > 10.000 inhabitants	80	86
Rural	If resides in the countryside/rural district	20	14
Quebec	If resides in Quebec	25	25
Marital status	If married	64	65
Heard of Biotechnology *prior to survey*	If yes	13	21
Heard of Genomics *prior to survey*	If yes	39	44
Belief in Science and Technology	Scale of agreement from 1 (society is a lot worse off) to 10 (society is a lot better off) (Mean in %)	63	65
Extent of knowledge about science and technology developments	Scale of agreement from 1 (you have little knowledge) to 10 (you know a lot) (Mean in %)	44	46
Animal Attitude Scale (AAS)	Summated scale from 13 to 65 (Mean reported)	41.9	42.1
Age	Age in Years (Mean Reported)	49.7	53
Education	Years; 8 if elementary school; 12 if secondary high school;14 if college degree ; 16 if university degree and post graduate (Mean reported)	13.8	14.5
Income	Annual household income in $1,000 (mean reported)	59.6	68.4
Internet Use	Over the past week how many times did you use the internet to search for information on a topic related to science or technology (more than three times)(%)	65	59

Table 2: Over the past week, how many days did you use the following media sources (0-Not at all, 1- once, 2-twice, 3-three times, 4-more than three times)

	Pork Survey		Beef Survey	
	Mean Score (Standard Deviation)	**N**	**Mean Score (Standard Deviation)**	**N**
Watch the national news on TV	1.94 (1.59)	1568	2.17 (1.67)	1663
Watch the local news on TV	1.82 (1.52)	1568	1.11 (1.45)	1663
Listen to talk radio about news issues	1.67 (1.29)	1568	1.59 (1.7)	1663
Read the front section of a national newspaper such as the Globe and Mail, National Post	1.89 (1.56)	1568	2.01 (1.6)	1663
Read the front section of a local newspaper	1.65 (1.15)	1568	0.87 (1.14)	1663
Read a newsmagazine	1.29 (0.67)	1568	0.82 (1.12)	1663
Use the internet for news	1.87 (1.44)	1568	2.11 (1.59)	1663
Use the internet to search for information on a topic related to science or technology	2.53 (1.6)	1568	2.29 (1.63)	1663
Combination of Media Sources				
Use the internet to search for information + Use the internet for news	2.02 (1.07)	1412	2.13 (1.08)	1530
Use the internet to search for information + Watch the national news on TV	1.92 (0.99)	1396	2.05 (0.99)	1508
Use the internet to search for information + Watch the national news on TV + Read the front section of a national newspaper	1.54 (0.89)	1282	1.68 (0.93)	1410

Use the internet to search for information + Watch the national news on TV + Read the front section of a national newspaper + Watch the local news on TV	1.77 (0.9)	1260	1.88 (0.92)	1382

Table 3: Genomic Information and Vaccination Attitudes Categorizations in Pork and Beef Surveys

		(# of Respondents)%
Use of genomic information for disease resistance in pigs		
Supporters	(Benefits > Risks)	574 (36.6%)
Doubters	(Benefits = Risks)	662 (42.2%)
Opponents	(Risks > Benefits)	332 (21.2%)
Vaccination for disease prevention in pigs		
Supporters	(Benefits > Risks)	516 (32.9%)
Doubters	(Benefits = Risks)	640 (40.8%)
Opponents	(Risks > Benefits)	412 (26.3%)
Use of genomic information to increase efficiency for selective breeding in cattle		
Supporters	(Benefits > Risks)	388 (23.3%)
Doubters	(Benefits = Risks)	692 (41.6%)
Opponents	(Risks > Benefits)	583 (35.1%)
Vaccination to reduce methane production in cattle		
Supporters	(Benefits > Risks)	217 (13.1%)
Doubters	(Benefits = Risks)	592 (35.6%)
Opponents	(Risks > Benefits)	854 (51.3%)

Note: Categorization adopted from Vandermoere et al. (2011)

Table 4: Assessment of Animal Attitudes

No.	Statement
i	It is morally wrong to hunt animals for sport
ii	Wild animals, such as mink and raccoon, should not be trapped so that their skins can be made into fur coats
iii	There is nothing morally wrong with hunting wild animals for food
iv	I think people who object to raising animals for meat are too sentimental
v	I think it is perfectly acceptable for cattle and hogs to be raised for human consumption
vi	Basically, humans have the right to use animals as we see fit
vii	The slaughter of whales and dolphins should be immediately stopped even if it means some people will be put out of work
viii	I sometimes get upset when I see wild animals in cages at zoos.
ix	Too much fuss is made over the welfare of animals these days when there are many human problems that need to be solved
x	Continued research with animals is necessary if we are ever to be able to conquer diseases such as cancer, heart disease and AIDS.
xi	It is unethical to breed purebred dogs for pets when millions of dogs are killed in animal shelters each year.
xii	The production of inexpensive meat, eggs and dairy products justifies maintaining animals under crowded conditions
xiii	One of the worst things someone can do is to hurt a defenceless animal

Note: Questions were adopted from Herzog et al. (1991)

Table 5: Multinomial Logit Regression Results

Comparison group	Independents	Pork		Beef	
		Coefficients (SE)	**Coefficients(SE)**	**Coefficients(SE)**	**Coefficients(SE)**
		How Risky/ Beneficial do you consider the use of genomic information to undertake selective breeding for disease resistance in pigs to be for your health?	How Risky/ Beneficial do you consider the use of vaccination for disease prevention in pigs to be, for your health?	How Risky/ Beneficial do you consider the use of genomic information to undertake selective breeding for increased efficiency of cattle to be for your health?	How Risky/ Beneficial do you consider the use of vaccination for reduced methane production in cattle, to be for your health?
Doubters (1)					
	Animal Attitude Scale	-0.01 (0.01)	-0.02** (0.01)	-0.03***(0.01)	-0.02*** (0.01)
	People who eat meat and fish (yes)	0.63*** (0.21)	0.09 (0.20)	0.01 (0.18)	-0.23 (0.18)
	Self-rated knowledge of science &technology	-0.01 (0.04)	-0.04 (0.03)	-0.002 (0.03)	-0.04 (0.03)
	Science and technology is beneficial	0.16*** (0.04)	0.09*** (0.03)	0.17*** (0.03)	0.09*** (0.03)
	Heard of biotechnology (yes)	-0.45** (0.23)	-0.06 (0.22)	-0.11 (0.16)	-0.12 (0.15)
	Heard of genomics (yes)	-0.43***(0.16)	-0.21 (0.15)	-0.31** (0.13)	-0.44*** (0.13)
	Age	-0.14** (0.06)	0.020 (0.05)	0.01 (0.04)	0.05 (0.04)
	Trust (generally trust people)	0.14 (0.15)	0.03 (0.14)	-0.2* (0.12)	-0.02 (0.12)
	Gender (male)	0.35** (0.16)	0.13 (0.15)	0.04 (0.14)	0.34*** (0.13)
	Presence of children under 18 in household (yes)	-0.1 (0.17)	0.10 (0.16)	0.10 (0.16)	0.26* (0.15)
	Marital status (married)	-0.02 (0.09)	-0.02 (0.08)	-0.16 (0.13)	-0.10 (0.13)
	Education	0.03 (0.05)	-0.03 (0.04)	-0.02 (0.03)	-0.04 (0.03)
	Quebec	-0.02 (0.16)	-0.83***(0.15)	-0.04 (0.14)	-0.62***(0.14)
	Income	0.03 (0.05)	-0.06 (0.04)	0.04 (0.04)	-0.03 (0.03)
	Living in a city	-0.07 (0.14)	0.32** (0.14)	0.01 (0.13)	0.08 (0.12)
	Internet Use	-0.04 (0.06)	-0.12** (0.05)	-0.02 (0.04)	-0.01 (0.04)
	Constant	0.51 (0.84)	1.57** (0.79)	0.37 (0.70)	1.02 (0.67)

Supporters (2)					
	Animal Attitude Scale	-0.03***	(0.01)	-0.03*** (0.01)	-0.04*** (0.01)	-0.02** (0.01)
	People who eat meat and fish (yes)	0.12	(0.21)	-0.10 (0.21)	0.04 (0.23)	-0.31 (0.25)
	Self-rated knowledge of science &technology	0.03	(0.04)	-0.09** (0.04)	0.05 (0.04)	-0.04 (0.04)
	Science and technology is beneficial	0.35***	(0.04)	0.27*** (0.04)	0.35*** (0.04)	0.25***(0.04)
	Heard of biotechnology (yes)	0.07	(0.22)	0.30 (0.22)	0.10 (0.18)	-0.09 (0.21)
	Heard of genomics (yes)	-0.03	(0.17)	-0.22 (0.16)	0.07 (0.16)	-0.32* (0.18)
	Age	-0.02	(0.06)	0.02 (0.06)	-0.001 (0.01)	-0.03 (0.01)
	Trust (generally trust people)	0.27*	(0.15)	0.18 (0.15)	0.15 (0.15)	0.26* (0.17)
	Gender (male)	0.25	(0.17)	0.47*** (0.15)	0.39** (0.16)	0.58***(0.17)
	Presence of children under 18 in household (yes)	-0.32*	(0.18)	0.07 (0.17)	-0.16 (0.19)	0.11 (0.22)
	Marital status (married)	-0.10	(0.09)	-0.08 (0.09)	-0.13 (0.16)	0.11 (0.18)
	Education	0.03	(0.05)	-0.01 (0.05)	-0.02 (0.04)	-0.04 (0.05)
	Quebec	0.13	(0.17)	-0.80***(0.16)	0.26 (0.17)	-0.38** (0.2)
	Income	0.02	(0.05)	-0.11** (0.05)	0.05 (0.04)	-0.07 (0.05)
	Living in a city	-0.24	(0.15)	0.18 (0.15)	-0.09 (0.15)	-0.12 (0.17)
	Internet Use	-0.06	(0.06)	-0.01 (0.06)	-0.08 (0.05)	-0.11** (0.06)
	Constant	-0.67	(0.90)	0.73 (0.86)	-1.04 (0.85)	-0.87 (0.96)
# of Observations		1568		1568	1663	1663
Scaled R-squared		0.137		0.119	0.125	0.082
Log likelihood function		223.05		192.29	215.92	138.76
# of Choices		4704		4704	4989	4989

Note: ***, **, * = Significant at 1%, 5%, 10% level of significance

Table 6: Tobit Regression Results (Pork and Beef Surveys) (AAS as Dependent variable)

Independents	Pork		Beef	
	Coefficients (SE)		Coefficients(SE)	
Constant	49.02***	(2.06)	51.75***	(1.85)
People who eat meat and fish (yes)	-0.16	(0.60)	-0.79	(0.58)
Self-rated knowledge of science &technology	0.03	(0.11)	-0.04	(0.09)
Science and technology is beneficial	-0.38***	(0.09)	-0.45***	(0.09)
Heard of biotechnology (yes)	0.37	(0.62)	0.06	(0.48)
Heard of genomics (yes)	-0.19	(0.45)	0.07	(0.41)
Age	-0.28*	(0.17)	-0.03**	(0.02)
Trust (generally trust people)	-0.58	(0.41)	-1.23***	(0.38)
Gender (male)	-3.74***	(0.42)	-3.71***	(0.42)
Presence of children under 18 in household (yes)	-0.71	(0.48)	0.19	(0.49)
Marital status (married)	0.05	(0.25)	-0.89**	(0.42)
Education	0.03	(0.13)	-0.04	(0.11)
Quebec	0.21	(0.46)	-1.28***	(0.44)
Living in a city	1.08***	(0.41)	0.04	(0.11)
Income	-0.32**	(0.13)	0.18	(0.40)
Internet Use	0.33**	(0.16)	0.24**	(0.14)
Sigma	7.66***	(0.14)	7.33****	(0.13)
# of Observations	1568		1663	
Log likelihood	-5419.22		-5673.53	

Note: ***, **, * = Significant at 1%, 5%, 10% level of significance

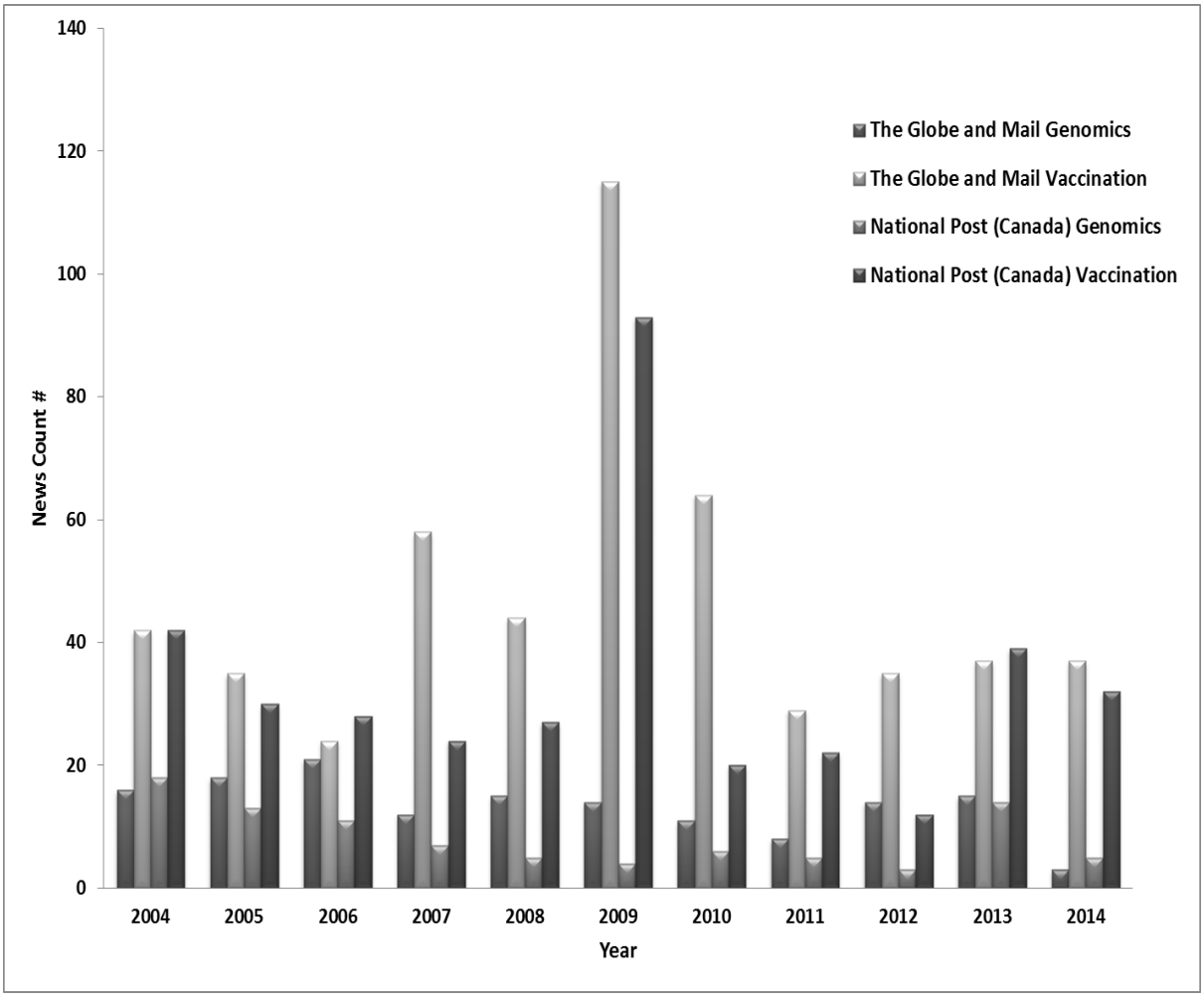

Figure 1: Media News Coverage on Genomics and Vaccination

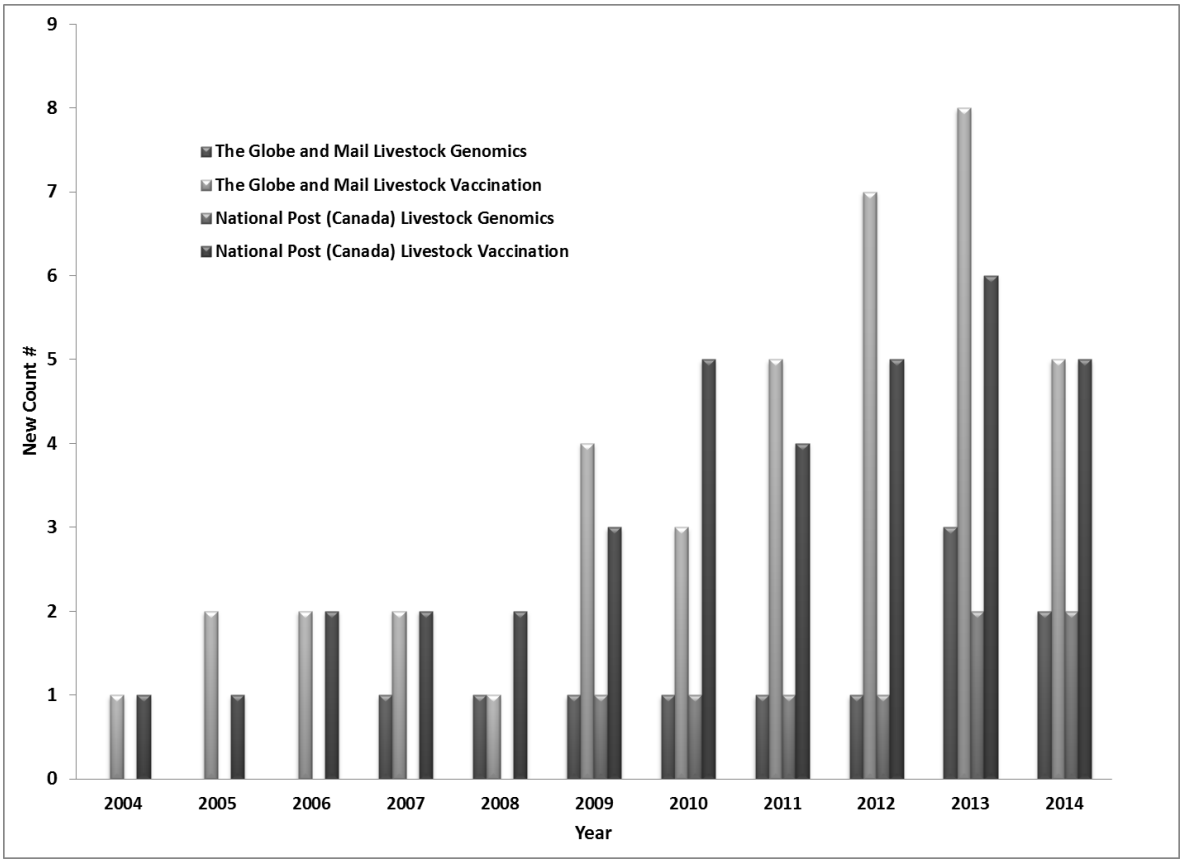

Figure 2: Media News Coverage on Livestock Genomics and Vaccination

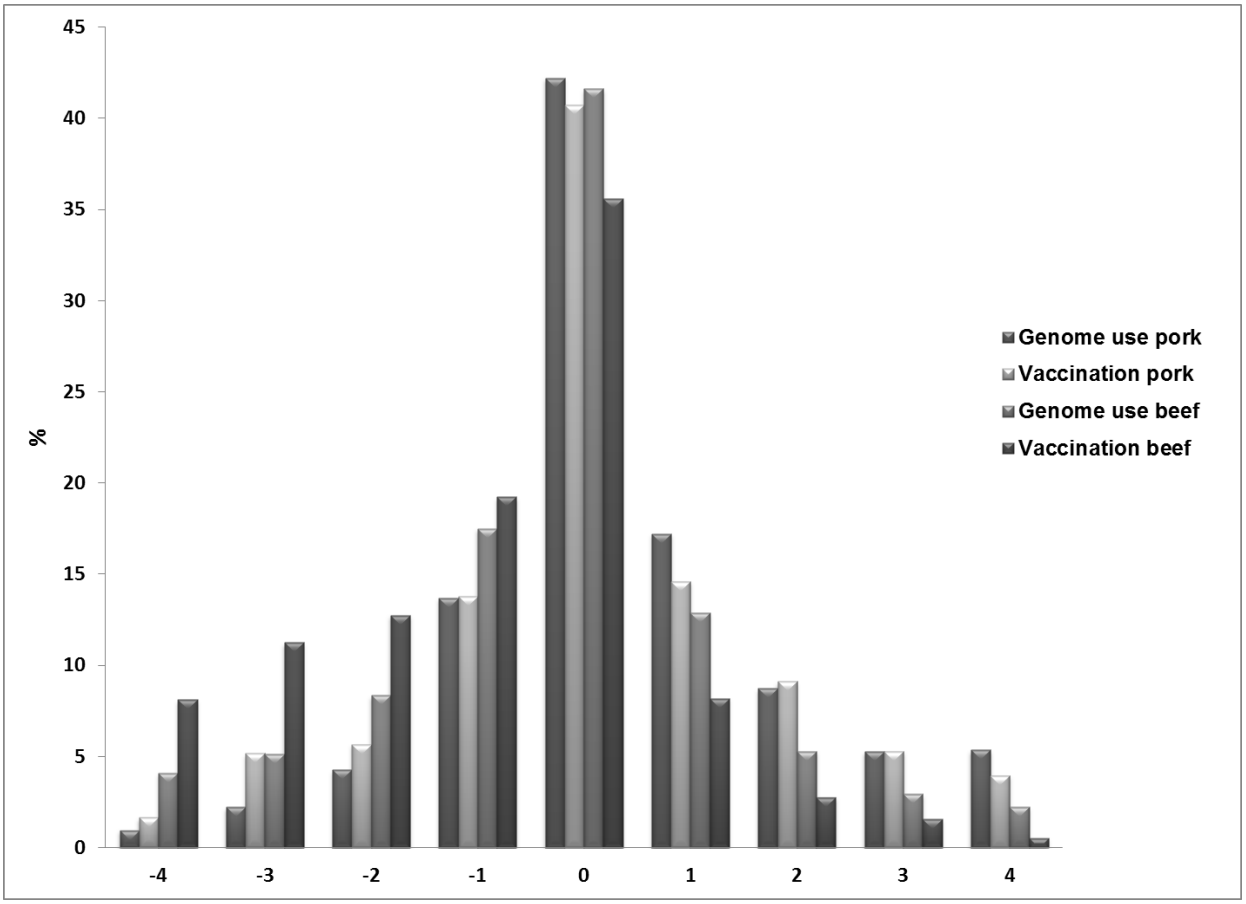

Figure 3: Benefit/Risk Assessment for Pork and Beef (based of on the % of respondents)

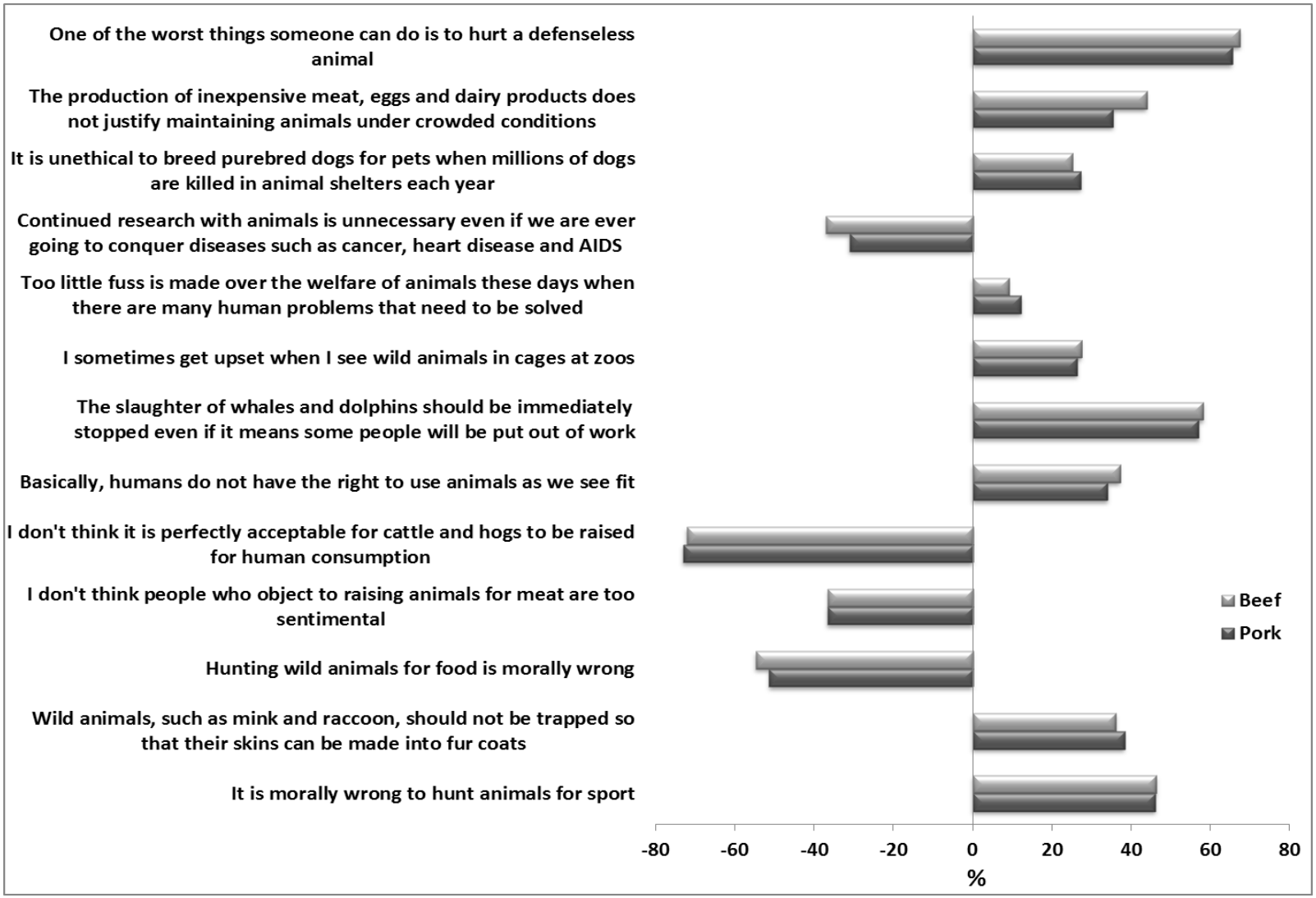

Figure 4: Animal Attitude Score (*Net Agreement Percentage*)