Consumer preferences for the genomic selection for particular traits in breeding dairy cows in Canada

by

Jiwon Kim

A thesis submitted in partial fulfillment of the requirements for the degree of

Master of Science

in

Agricultural and Resource Economics

Department of Resource Economics and Environmental Sociology
University of Alberta

Abstract

This study examines Canadian public preferences for the use of genomic selection in breeding dairy cows for four main traits– feed efficiency, methane emission reduction, enhanced disease resilience, improved cow fertility as well as the use of antibiotics. Since this research information might be helpful to guide farmers to tap into consumer preferences and make better decisions which can beneficial for both animal, environment and themselves, this study identified the characteristics of individuals who are more or less in favor of one or more traits as well as public preferences for the four main traits and the use of antibiotics. Based on the survey results, two approaches, conditional logit and latent class models which can capture respondent heterogeneity were estimated, and heterogeneity does exist across survey respondents. Given the analyses, the feed efficiency trait was preferred the most based in the conditional logit models. On the other hand, the enhanced disease resilience and feed efficiency traits are preferred the most based on the latent class model. Furthermore, as the latent class model may reflect the reality well through exploring heterogeneity, there were nine identified classes of respondents with different preferences. There are variations across classes with respect to environmental self-assessed knowledge, myths of nature, animal husbandry, and on top of gender, number of children under age 18 across the nine classes. Lastly, the predicted shares for dairy products produced with genomic selective breeding with each of the four traits was predicted. There is around 67.3~74.6% market demand for the dairy products produced with the enhanced disease resilience trait. Regarding the feed efficiency trait, the expected market demand is around 51.9~54.9%, while around 8.5~9.2% for the improved fertility trait. Also, there is about

34.7~41% market demand for the dairy products which have the methane emission reduction attribute. When it comes to the use of antibiotics, around 48.4~55.3% people like the therapeutic use of antibiotics as opposed to no antibiotics.

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction

1.1 Introduction

The dairy industry has evolved with diverse genetic improvements that have enhanced productivity, herd health and other related traits, but may also have contributed to problems with fertility (Crowe, 2018). These applications of genetic selection in the dairy industry have provided benefits to multiple actors such as farmers, processors and consumers, in terms of more milk at lower cost. The dairy industry is faced with new challenges as circumstances rapidly change. Challenges such as climate change may increase stress on animals and encourage disease spread. Reduction of greenhouse gases is critical particularly for ruminant cattle industries, while at the same time, the fast growing global population results in an increasing global demand for dairy products. In addition, consumers have an interest in social/ethical issues such as animal welfare (Beef and Pork Consumer Trend report, 2019) and environmental footprints such as greenhouse gases, but also antibiotic and hormone use in production. According to the Beef and Pork Consumer Trend report, 50% of consumers who often eat beef said it is important they eat beef that came from animals treated humanely, while 44% of frequent pork consumers said it is important they eat pork from animals treated humanely. Moreover, nearly three-quarters of consumers responding to a survey conducted by The Hartman Group said that when making purchasing decisions, it is important that the company treats animals humanely. Top animal welfare practices cited as being likely to increase product purchases included animals not mistreated while alive, animals raised in as natural an environment as possible, and animals not given antibiotics and hormones (Natural Products Insider, 2018).

These new challenges require a paradigm shift in the dairy industry, which can address broader social and environmental matters in breeding and production decisions. Therefore, if the industry is successful in dealing with these new challenges without impeding any farmer's ability to generate profits, a sustainable dairy industry could be enhanced. From this perspective, this research will address the priority issues for the Canadian dairy consuming public that may provide useful information to dairy farmers that they can use in breeding and production decisions. Public behavior and interests in dairy production can be assessed through an online survey including a stated choice experiment targeting the Canadian public. Namely, this research points to derive the proper direction for the dairy industry producers, on how to improve their breeding decisions, contingent on the customer's preferences for several potential applications of genomic selective breeding and antibiotic use in the industry. Our findings will allow us to identify a resilient dairy industry approach which is more resource-efficient with a lower environmental burden without hampering the productivity, health or fertility of dairy cows and ultimately the industry.

1.2 Dairy Industry

The dairy industry is one of Canada's most critical food industries because the Canadian dairy industry consists of roughly a $19.9B contribution to GDP and also $3.8B a year in tax revenue at the federal, provincial and regional levels, as well as sustaining 221,000 full-time jobs across the country in 2015 (Canadian Dairy Information Centre, 2019). Dairy genetics sales and exports are also main sources of revenues: Canada's exports of dairy genetics rose by 45% in value during the last decade, to a total value of $149M in 2017 (Canadian Dairy Information Centre, 2019).

According to the Food and Agriculture Organization of the United Nations (FAO UN), the share of fresh dairy products, which are unprocessed or only slightly processed (i.e. pasteurized or fermented) in world consumption is expected to increase over the coming decade due to strong demand growth in India, Pakistan and Africa, driven by income and population growth. World per capita consumption of fresh dairy products is projected to increase by 1.0% p.a. over the coming decade (FAO UN. Dairy and Dairy products, 2020). Because cow's milk is one of the largest proportions (81%) of the world milk production, (additional 15% from buffalo, 4% from goat, sheep etc. (FAO UN. Dairy and Dairy products, 2020), this study focuses on cows in the Canadian dairy industry. In the case of the Canadian dairy industry, Holsteins, 93% of the national herd in Canada, comprise the largest number of cows in milk production, and produce 10,909 kg milk per cow (Canadian Dairy information center, 2019). In addition, consumers' demand patterns are affecting dairy production, arising from expectations about more eco-friendly or animal welfare friendly products. The "Traditional" value drivers of price, taste, and convenience have been complemented by newer and "Evolving" drivers such as health and wellness, safety, social impact, and experience (Burke, 2018). Given the current contribution of the Canadian dairy industry to the broader economy, it is worth mentioning that there is significant growth in the demand for dairy substitutes which could erode the traditional dairy markets in the future. Satisfying consumer demands for attributes which align with the public's attitudes, values and interests is critical to maintaining consumer interests in traditional dairy products.

1.3 Overview of Genomics

An organism's complete set of DNA, which contains the information needed to build the

entire body is called its genome. A gene traditionally refers to the unit of DNA that carries the information that determines many of the features and characteristics of organisms. Genomics is the study of these genes and genetic characteristics of organisms like plants, animals, and humans. The Human Genome Project and the sequencing of the SARS virus are examples of research in Genomics related to people. Similar research is identifying genes and traits in crops and livestock, to better understand things such as susceptibility to disease or drought.

For approximately 30 years, DNA markers have been used in many species for a broad spectrum of genetics research and diagnostic applications, such as parentage verification. Parentage verification began almost 50 years ago with the analysis of blood groups, but transitioned to genetic markers by the 1990s for dairy cattle (Wiggans, 2017; Spelman, 2002; Storment, 1967). Through the early and mid-2000s, such genomic selection had only modest commercial success for livestock because of the cost of generating appropriate data sets as well as difficulties in the identification of major genes related to quantitative traits (Andersson, 2001; Misztal. 2006). However, the cost of genotyping, which is the process of determining differences in the genetic make-up of an individual has decreased, in the case of the cattle industry from $139 per animal in 2011 to $37 in 2017 (Moser, 2019). American and Canadian Angus associations undertake joint genetic evaluation and include over 635,000 genotyped animals in their databases in 2019 (Moser, 2019). With respect to Holstein cows for the dairy industry, the genotyping cost is CAD $33 in 2020 according to Holstein Canada. The primary benefit of increased genotyping is for cattle farmers to have more accuracy for genetic predictions for young animals. That is, in dairy cattle, genomic selection leads to higher accuracies of predicted genetic merit for young animals, which in

turn typically leads to shorter generation intervals through higher contributions from young genetically superior bulls and heifers (Matthews, 2019). The genomic selection revolution began with two developments. The first was sequencing of the bovine genome, which led to the discovery of many thousands of DNA markers, in the form of SNP[1] (Hayes, 2009). The second development was the demonstration that it was possible to make very accurate selection decisions when breeding values were predicted from dense marker data alone, using a method termed genomic selection (Meuwissen et al., 2001).

This paper focuses on genomic selection in the dairy industry, a technique which uses genetic information, but is not about genetic sequencing or genetic modification etc. In practice, genomic selection refers to selection decisions based on genomic estimated breeding values (GEBV), so the farmers can identify genetically superior animals at a much earlier age (Schefers, 2012). The GEBV can be calculated by estimating single nucleotide polymorphisms (SNP) effects from prediction equations, which are derived from a subset of animals in the population i.e., a reference population, that have SNP genotypes and phenotypes for traits of interest (Schefers and Weigel, 2012; Jones, 2017). That is, the genomic selection is the concept that information from a large number of genetic markers distributed across the genome can be used to capture diversity within that genome, and is sufficient to estimate breeding values without having precise knowledge of where specific genes are located (Meuwissen et al., 2001; Jones, 2017).

Traditionally, the farmers relied on using natural service from bulls kept on the farm to breed their cows, however artificial insemination (AI) has been revolutionized in the mid 20 th century (Jones, 2017). Therefore, the farmers purchase genotyped bulls' semen using of AI

[1] Single nucleotide polymorphisms is a substitution of a single nucleotide(organic molecules) at a specific position in the genome that is present in a sufficiently large fraction of the population.

and making their cows pregnant in the dairy industry. In other words, the AI is the technique in which semen is collected from a specified bull and is introduced into the female cow's reproductive tract at the proper time of her estrous cycle with the help of instruments (Jones, 2017). Van Doormaal and Kistemaker (2003) suggests that approximately 75% of Canadian dairy cattle are bred using AI, but cautions that this may be an underestimation. The reason why it is hard to measure the accurate statistics about the AI is that some have been done by AI technicians, but others have been conducted by farmers.

According to the Canadian Dairy Network the sire usage less than 2 years of age has been decreasing, while the usage between 2-4 years has been increasing for the artificial insemination of Canadian dairy cattle.

Table 1. Artificial Insemination Sire Usage by age at Insemination

	2008	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*
Less than 2 years	30.7 %	30.6 %	28.3 %	29.3 %	30.1 %	31.8 %	33.9 %	27.4 %	29.9 %	23.2 %	26.1 %	16.9 %
Between 2-4 years	4.6%	7.5%	11.2 %	8.4%	10.4 %	15.1 %	18.2 %	28.8 %	28.5 %	30.9 %	34.4 %	44.4 %
Between 5-8 Years	45.4 %	43.2 %	45.8 %	51.9 %	51.8 %	45.6 %	34.0 %	33.4 %	32.7 %	37.9 %	33.0 %	30.8 %
Between 9-11 years	17.0 %	16.7 %	13.1 %	8.7%	5.7%	5.8%	12.1 %	9.0%	7.7%	6.5%	4.5%	5.1%
More than 12 years	2.3%	1.9%	1.7%	1.6%	1.9%	1.7%	1.8%	1.4%	1.2%	1.5%	2.1%	2.9%

Source : Canadian Dairy Network

The advantage of this genomic selection over traditional selection is that animals can be selected accurately early in life based on their genomic characteristics. They 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). Therefore, genomic selection allows for increased intensity of selection as breeders can use genomic testing to screen a larger group of potentially elite animals (Schefers and

Weigel, 2012). For example, in case of American dairy cattle, this genomic selection has been demonstrated to ramp up genetic gain by 50 to 100% for yield traits and from three to four times for lowly heritable traits (Gracia-Ruiz, 2016). On the other hand, consumers 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). Even, genomic selection can have a positive influence on mitigating methane emissions in dairy industry. Livestock production is connected with the release of methane produced by anaerobic microbial metabolism in the digestive tract and in manure (Moss et al., 2000). This livestock sector is responsible for 35~40% of annual methane emissions the results from enteric fermentation in ruminants and farm animal manure (Steinfeld et al., 2006). Methane production is largely dependent on diet quality and feed intake. Animals superior for residual feed intake consume less feed than average for their weight and level of performance (Hegarty et al., 2007). Thus, cattle selected for higher efficiency of feed utilization produce less methane per kg than cattle selected for lower efficiency. Genomic selection can be used to improve this residual feed intake as a feasible means of reducing the daily methane production of cattle. In addition, selective breeding can directly reduce methane emissions, independently from the feed efficiency trait.

1.4 Factors influencing consumer preferences

1.4.1 Animal welfare

A diverse group of stakeholders, including citizens, farmers, public authorities, and the food industry, is increasingly confronted, interested, or concerned with the welfare of production

animals (Verbeke, 2009). The use of genomic technology in cattle has brought about ethical issues whether the selective breeding by genomic technology increase the quality of the animal's life, not just economic benefits for stakeholders. Health problems associated with selective breeding have been noted in several species (Rauw et al., 1998). In dairy cows, high milk yield is related to both with significantly raised levels of mastitis and reproduction problems (Olsson, 2006). Therefore, rapid growth, a result of selective breeding for productivity, has the potential to result in a negative impact on cow health. Results from consumer studies illustrate a sense of public concern about farm animal welfare (Serpell, 2004; Mejdell, 2006), and a positive intention to purchase premium welfare products expressed in terms of self-reported willingness to pay (Taylor and Signal, 2009; Vanhonacker and Verbeke, 2009; Van Loo et al., 2013, 2014).

1.4.2 Attitude about technology

In accordance with previous studies, depending on risk attitudes, the farmers have different approaches to new technology adoption (Hailu, 2016). While risk-averse farmers are generally expected to have greater incentives to adopt risk-reducing technologies, a number of empirical studies find evidence to suggest a positive relationship between risk aversion and adoption such as Gillespie et al. (2004) for certain breeding technologies (Hailu, 2016). On the contrary, other studies suggest that risk-averse individuals are less likely to adopt new technologies (Knight et al., 2003; Abadi et al., 2005; Liu, 2013), despite their risk-reducing nature (Hailu, 2016). Compared to previous studies, this research will focus on consumer side, which mean how consumers will behave on the basis of their beliefs about

technology.

1.5 Objective

The overarching objective of this research is to understand more about Canadian public preferences for the use of genomic selection in breeding dairy cows for particular traits. The use of this information might be useful in directing farmer decision making, but even before that could be useful in helping to direct research efforts and funding of research priorities. To address this objective, the following specific research objectives will be addressed:

1) identifying public preferences for four future dairy cow traits of interest – feed efficiency, methane emission reduction, enhanced disease resilience and improved cow fertility.
2) identifying the characteristics of individuals who are more or less in favor of one or more traits – including characteristics such as beliefs about technology, trust, beliefs about animal welfare, use of antibiotics in livestock production and environmental attitudes as well as demographic characteristics.
3) predicting the potential market shares for dairy products produced with genomic selective breeding with each of the four traits.

To understand the public's thoughts, the stated preference experiment was conducted targeting the Canadian dairy product consumers to reveal their choices, and elicit willingness to pay (WTP) for different attributes. Based on the public's preferences, this research suggests guidelines that the dairy industry farmers can use to make the better decision which can bring about benefits to animals and environment as well as be of economic interests to them.

Chapter 2: Literature Review

2.1 . Introduction

According to the previous research survey (Massagila, 2018), the younger consumer between 20s to 30s or millennials perceived highest quality and greater health as distinguishing characteristics of animal welfare friendly beef. While, the conventional consumer above 40s expressed the higher animal welfare beef to have a higher ethical value and to be more environmentally sustainable. However, both groups agreed that the application of labels with adequate and detailed information is the best method for consumer to use to identify animal welfare standards achieved in production (Massagila, 2018). This labelling communication for product characteristics is becoming an increasingly common marketing strategy, giving labels such as "animal welfare friendly" and "animal-friendly" a higher quality association during meat choice (Heerwagen et al., 2015; Van Wezemael et al., 2010; Napolitano et al., 2010; Janssen and Hamm, 2012). Therefore, the prior studies have explained that consumers are familiar and get information when choosing their products by reading the label. Therefore, this paper concentrates and analyzes information effects (without specifying how this information might be provided at the national market level) targeting the Canadian dairy product customers as to how their choices and preferences can be different when facing diverse information on production practices. In addition, we investigate the role of previous knowledge about biotechnology and environmental attitudes on the decisions that consumer might make. To grasp the public's thoughts, the survey contains a stated preference exercise to understand more about the relative importance of different genomically selected traits when choosing cow's milk or

other dairy products.

2.2 . Survey

The survey is a representative tool to comprehend people's attitudes and relevant characteristics of their choices. There are several types of survey such as mail, telephone, online and in-person surveys which could be used to collect the information. For this study, an online survey was conducted targeting the Canadian public.

Table 2. Pros and Cons of different survey methods

Survey type	Pros	cons
Telephone Surveys	More Accurate results Real-time High response rates Valuable verbatim comments in the customer's own voice Less bias as talking to automated machine	Limited question format More expensive than some other survey types Audible only so no graphs or matrix Not longs questions (5 or 6 questions)
Online Surveys	Widely Used Can reach large numbers Economic per-invitation basis Automatic data input	Can result in biased results Can result in limited sector responses Often too long Inappropriate for some elderly customers
Email Surveys	Widely Used Can reach large numbers Economic per-invitation basis Automatic data input Collect a large sample sizes Takes little time to send Can embed metadata in response	Slow responses Spam can affect opt-in rate
SMS	Can have multiple completion options like call-back or smartphone survey	Tedious to answer multiple questions using

Surveys	Response rates usually high Can respond when convenient Fast responses	SMS only

Source : 25 Pros and Cons of different survey methods (Weaser, 2017)

An online survey does have its own problems such as strategic choices and often uses market research company maintained panels of respondents to reduce the costs. Above all, survey fraud is the heaviest disadvantage of an online survey, stemming from the that the fact that there are people who answer online surveys to get the incentive (usually in the form of money) after they completed the survey, not with a desire to contribute to the advancement of the study (Mahmutovic, 2021). However, it represents an affordable way to develop large samples for particular analyses. According to Walter et al. (2019), online panel data collected by a recruited large pool of respondents of companies who agree in advance to participate in survey studies on a variety of different topics are suitable for many exploratory research questions in the field of applied psychology with appropriate caution. The appropriate caution can be the careful consideration of the purposes of the study and the population sampling frame, the incentives used to select and motivate respondents, and the data screening procedures using to eliminate poor responders (Walter et al., 2019).

2.3 . Stated preference (SP)

The SP method mainly consists of a survey-based method with hypothetical questions where participants should state their maximum willingness to pay (WTP) or their minimum willingness to accept (WTA) and is used particularly to identify choices in the case of non-use values (Carson, 2000; Fuguitt and Wilcox, 2005). In marketing, SP is used to identify

the positive attributes of new or novel products where revealed preference data is not available. However, this approach is on the basis of hypothetical situations. Therefore, in the SP method, reliability which is referred to the stability of findings and validity which is represented as the truthfulness of responses is needed (Haradhan, 2017; Altheide and Johnson, 1994). The validity and reliability increase transparency, and decrease opportunities to insert researcher biases into qualitative research (Singh, 2014). The most frequently SP used methods are contingent valuation (CV) and discrete choice experiments (CE). In case of the CV, it is more focused on a whole effect which is generally comprised of a baseline or status quo circumstance versus a change, which means respondents vote on a proposed change at a specified cost. Thus, CV is often used as a referendum to select preferred policy decisions. While in the CE, the respondents select attributes and levels for each attribute among two or more multi-attribute alternatives. That is, by conducting the CE method, it is possible to understand information on the value of individual attributes. Thus, the choice between CV and CE should be based on respondent perceptions of the change being valued, the decision or objective being considered, and the type of information required (Johnston et al., 2017). When it comes to this study, as the analysis about individual attributes available from different selective breeding decisions, among multi-attributes alternatives is needed, the CE method was conducted (Johnston et al., 2017).

To estimate the CE stated preference data, there is a basic model assumption, that of a random utility model (RUM). The RUM models aim to model the choices of individuals among discrete sets of alternatives (Horowitz, 1994). It is assumed that the preferences of an individual among the available alternatives can be described by a utility function (Horowitz, 1994). The utility of an alternative depends on attributes of the alternative and

individual that the researcher observes and attributes that the analyst does not observe (Horowitz, 1994). Observed parts are represented in the utility function by explanatory variables, whereas unobserved ones are represented as random variables. This random utility model gives the probability with which each alternative is chosen.

2.4 Attributes related to this study

This paper estimates dairy breeding traits' impacts on consumer preferences. In addition, this study analyzes how the customers make their choices about the provided genomic selection information and use of antibiotics depending on trust, as well as environmental attitudes etc.

According to Grunert (2000), consumer acceptance is the final criterion for new dairy products on the marketplace, and from the consumer point of view, quality of a dairy product involves much more than sensory properties of the product. Quality is a complex concept, and in order to understand a consumer-oriented concept of quality it is helpful to distinguish among various quality dimensions (Grunert, 2000). Product characteristics are concrete attributes of the product, while purchase motives are abstract entities which motivate consumer behavior across a wide range of products (Grunert, 2000). Quality dimensions can be defined as product-specific characteristics which customers build on the basis of the product, and which they believe increase the usefulness of the product in fulfilling purchase motives (Grunert, 2000). One of the ways to classify quality dimensions, is into search, experience, and credence dimensions (Nelson, 1970; Nelson, 1974; Darby and Karni, 1973). Search dimensions are those ones by which the buyer can ascertain the quality at the time of purchase, like the appearance of a cheese or price. Experience dimensions represent the

quality that can be ascertained only after the purchase and for food, eating, like the taste of the cheese. Lastly, credence dimensions are those dimensions by which the average consumer can never ascertain the quality for him-/herself, but has to trust the judgement of others like whether the cheese is healthy or organically produced. This paper's analysis will mainly focus on credence dimensions such as genomic selective breeding traits, credence attributes of dairy products not verifiable by respondents either before or after consumption

The dairy industry is under constant pressure to further improve production efficiency and a great emphasis is being placed on reducing the negative effects of dairy production on the environment (Kock et al., 2018). Emissions of greenhouse gas and nutrient losses to the environment should be reduced (Connor, 2015). Improving feed efficiency provides a way to tackle both challenges. (Kock et al., 2018). Besides, within animal production, there has been little or no concerted effort to use long-term breeding strategies to mitigate greenhouse gas emissions from ruminants (de Haas, 2017). Several small-scale projects have been undertaken or are currently under way (mainly nationally funded), but they are too small to draw definitive conclusions or make any meaningful contribution to national breeding strategies (Chagunda et al., 2009; Garnsworthy et al., 2012; Lassen and Lovendahl, 2016); successful animal breeding strategies require measurements in a large population (de Haas, 2017).

Also, up to the early 2000s, dairy genetic selection programs in dairy producing countries traditionally selected predominantly for milk yield often at the expense of other dairy relevant traits, including fertility and health (Crowe, 2007; Wickham et al., 2007; Berry et al., 2014). Breeding programs in the early part of this century started to include fertility (e.g., by including traits such as longevity and calving intervals) and health as part of the

selection traits. Inclusion of these traits has served to reverse some of the earlier trends that gave rise to reduced fertility (Crowe, 2018). Over the last 15 years it is now recognized that trends in both longevity (increased) and calving intervals (decreased) have improved (Berry et al., 2014). A major challenge for breeding programs in terms of incorporation of fertility traits has been to develop phenotypes that have reasonable heritability (Crowe, 2018). Therefore, based on the previous literatures, this study will cover four genomic traits, which are feed efficiency, reduced methane emissions, improved fertility and enhanced disease resilience.

Antibiotics use in animal agriculture has been implicated in the emergence of antibiotic resistance, a global public health threat. Antibiotics have been commonly used to deal with mastitis and metritis because these two diseases are the most prevalent affecting dairy cattle (Halasa et al., 2007; Liang et al., 2017). Both mastitis and metritis bring about milk loss (Rajala, 1998; Grohn et al., 2004), reproduction loss (Hertl et al., 2010), and increased culling of animals (Heikkila et al. 2012) and thereby contribute to large economic losses for the dairy industry. It is estimated that the yearly economic loss due to mastitis for the US dairy industry is around $2 billion (Bewley, 2014). The total cost due to a case of metritis is approximately $350 (Overton and Fetrow, 2008). Livestock production is the largest user of antibiotics globally, and higher levels of use result in the evolution of antibiotic-resistant bacteria which then can be spread to people in a variety of ways (Goddard, 2019). There are significant and growing public health crisis arising from antibiotic resistant bacteria (World Health Organization, 2017; Goddard, 2019). This concern is also one factor influencing product purchase decisions for livestock products emanating from production systems with lower antibiotic use (Goddard, 2019).

The choice of particular bundles of attributes (genomic selective breeding and antibiotic use) is assumed to be related to individual respondent's demographic characteristics, attitudes and beliefs.

2.4.1 Moral Foundations Theory

Graham et al. (2011) suggested it is difficult to identify how people measure moral concerns when people disagree about what "morality" means. To address this problem, they created the Moral Foundations Questionnaire (MFQ), a measure of the degree to which individuals endorse each of five intuitive systems posited by Moral Foundations Theory : Harm/care, Fairness/reciprocity, Ingroup/loyalty, Authority/respect, and Purity/sanctity (Haidt and Graham, 2007; Shweder, Much, Mahapatra and Park, 1997). These moral foundations have been found to influence consumer behavior in different contexts (Vainio and Mäkiniemi, 2016; De Backer and Hudders, 2015). Moral foundations are grouped into individualizing moral foundation beliefs and binding moral foundation beliefs (Graham et al., 2011). Individualizing moral foundations can be characterized as attitudes towards harm/care and fairness/reciprocity toward others, and binding moral foundations can be characterized as in-group/loyalty, authority/respect and purity/sanctity attitudes (Graham et al., 2011).Based on this moral foundation theory, Goddard et al. (2019) studied individual purchasing and voting decisions for livestock products, produced with lower levels of antibiotic use or higher levels of environmental sustainability contingent on degrees of agreement with moral foundation statements. This paper concentrates on the individualizing moral foundation beliefs relevant to harm/care and fairness/reciprocity towards others.

2.4.2 Trust

Trust is defined by Rousseau et al. (1998, p. 395) as "… a psychological state comprising the intention to accept vulnerability based upon positive expectations of the intentions or behavior of another." In case of food products, trust is assumed to influence consumers' behavior (actual or stated) directly and possibly indirectly through perceptions (risk or quality perceptions) (Muringai et al., 2017). Trust has been shown to play an important role in transactions where one party (farmers for example) might have more information about the product as compared to the other (consumers), or that there is information asymmetry (Janssen and Hamm, 2012). Trust in the food system is important since the distance (social, physical and temporal) between production and consumption have increased (Thorsøe and Kjeldsen, 2016) as a result of developments in transportation, other technologies, refrigeration, internationally coordinated food standards and international trade agreements, for example (Muringai and Goddard, 2019). According to Thorsøe and Kjeldsen (2016), although food production is increasingly uncertain (for example, in terms of food safety events, weather and climate changes), trust allows people to continue to support the food system. Trust is also important for the acceptance of novel products such as functional foods (Meijboom, 2007) and the acceptance of the use of new technologies in production or processing (Poortinga and Pidgeon, 2005; Bieberstein et al, 2013). According to Savadori et al. (2007), there are three types of trust including individual trust, system oriented or structural trust (similar to social trust) and relational trust (Savadori et al., 2007). Individual trust focuses on attitudes by an individual towards a product, which leads to the decision to consume the product (Muringai and Goddard, 20197). In the context of food, system-oriented trust focuses on trust in the overall food industry and government institutions in

terms of their ability to provide adequate food safety levels (or other regulatory oversight such as regulation on the use of technologies) (Muringai and Goddard, 2019). Lack of system oriented trust may lead to consumers avoiding a product, political activism or the creation of alternative markets (Savadori et al., 2007). Relational trust relates to trust in other individuals such as other consumers, friends, relatives or sellers and can result from personal interactions. Previous studies say that farmers learn from peers, friends, neighbors, or experts through active or passive learning (Feder and Slade, 1984). This social interaction effect refers to a particular form of externalities where group characteristics (or behavior) influence individuals (or individual behavior) (Becker, 1974; Manski 1993).

Frewer et al. (2005) state that trust in food agents is important for acceptance of animal production systems in situations where consumers are not interested in knowing the details about the systems. Although labels can be used to inform consumers about any production attribute, consumers need to trust that the attribute is present (if it is not verified by someone likely a third party) and use the label information when they make decisions (Lobb and Mazzocchi, 2007; Olynk, 2012). Thus, this paper will analyze how general trust and trust in institutions responsible for food influences customers' preferences when buying dairy products.

Glaeser et al. (2000) measured trust and trustworthiness by conducting experiments with monetary rewards. In that paper, they estimated subjects' attitudes, background characteristics, and social connectedness to identify individual and situational correlates of trust (Glaeser et al., 2000). The empirical literature on trust has focused on responses to the question : "Generally speaking, would you say that most people can be trusted or that you can't be too careful in dealing with people? (Glaeser et al., 2000) This question is taken from

the National Opinion Research Center's General Social Survey (GSS). The survey is the primary source for U. S. evidence on trust and social capital. Since its inception in 1972 the survey has been administered twenty times to a sample of between one and two thousand respondents. The set of questions on the GSS changes from survey to survey, but the GSS trust question has been asked almost continuously. Thus, this study also adopted this trust question to understand generalized trust by respondents.

An alternative approach to trust is less centered on the individual and includes groups as trusting or trusted actors (Roosen et al., 2015). Rotter (1967, p. 651), for example, defines interpersonal trust ''as expectancy held by an individual or a group that the word, promise, verbal or written statement of another individual or group can be relied upon.'' (Nooteboom, 1996). In accordance with Roosen et al. (2015), research on technology acceptance has focused on the impact of social trust on technological risk perception and on the acceptance of a technology. The definition of social trust relates to interpersonal relationships and to relationships between individuals and institutions (Kasperson et al., 1992). Interpersonal trust and institutional trust are often differentiated (Hudson, 2006), the latter is supposed to be important in complex societies such as ours (Luhmann, 1968/2000) and important for understanding the acceptance of modern technologies (Roosen et al., 2015). Institutional trust has also been found to play an important role in explaining perceived risk (Earle and Cvetcovich, 1995; Siegrist et al., 2000; Slovic, 1999) and the acceptance of new food technologies (Costa-Font et al., 2008; Visschers et al., 2007). This paper asked to survey participants concerning how much they trust groups such as farmers or food processors responsible for food production in Canada to grasp differing trust in institutions.

2.4.3 Animal attitudes

Due to the increasing awareness of the importance of animals in human life, researchers have developed a variety of instruments designed to measure aspects of our relationships with other species (Herzog et al., 2015). Many questions related to the psychological underpinnings of animal ethics can be addressed via attitude scales (Herzog et al., 2015). For example, these include the impacts of factors such as education, early experiences with pets or hunting, personality differences, social class and political ideology, beliefs about animal sentience, and the relationship between attitudes and behaviors (e.g., meat eating, involvement in animal protection) (Herzog et al., 2015). The animal attitudes may be one of the components that lead people to stated concerns about 'animal welfare' in food production.

The most widely used definition of animal welfare is one that encompassing the five freedoms (freedom from hunger and thirst, freedom from discomfort, freedom from pain, injury and disease, freedom to express normal behavior, freedom from fear and distress) established by the Farm Animal Welfare Council (FAWC, 1979). It is known that animal welfare has a considerable impact on the food chain (Blokhuis et al., 2008), in which an important part consumers are concerned about the welfare quality of the products they buy. Cerjak et al. (2016)'s survey showed that the vast majority of the respondents in that research stated relatively high concern about animal welfare; nonetheless most of them do not consider it when buying meat. Besides, most of the participants in this survey stated a willingness to pay an additional price for animal friendly meat (Cerjak et al., 2016). Therefore, there is strong evidence of public concern over the moral implications of actual

animal production systems on farm animal welfare (Fernandes et al., 2019; European-Commission, 2007, 2016). Over the last two decades, increasing numbers of consumers and citizens demanded ethical production systems and claimed to refuse to buy products that did not meet their animal welfare concerns (Broom, 2017). In this study, based on the Herzog et al. (2015) animal attitude research, the respondents were questioned whether they agreed or disagreed regarding the use of animals in hunting or being raised for human consumption etc.

2.4.4 Animal husbandry

Animal husbandry practices may be another component of people's individual concerns about 'animal welfare' in food production. Individuals may have little knowledge of livestock production practices and this may drive their concerns particularly if an extreme circumstance of livestock mistreatment is publicized. Recent policy developments in the area of livestock husbandry have suggested that, from the perspective of optimizing animal welfare, new animal husbandry systems should be developed that provide opportunities for livestock animals to be raised in environments where they are permitted to engage in ''natural behavior.'' (Frewer et al., 2005). Also, when it comes to the animal husbandry, there is increased public concern about the welfare of animals used for meat production (Bornett et al., 2003). It is not known whether consumers regard animal husbandry issues as important, and whether they differentiate between animal husbandry and other animal welfare issues (Frewer et al., 2005). According to Frewer et al. (2005), there is less information regarding consumer perceptions of animal husbandry systems in particular, and the influence of these perceptions on potential impact on consumer choice of products

resulting from the application of these systems or otherwise.

Consumers are generally becoming more sensitized to extrinsic quality factors associated with products (Frewer et al., 2005). For example, Pan-Huy and Fawaz (2003) report that meat produced with animal friendly husbandry practices is perceived by Swiss consumers as being of higher quality than that reared intensively. Therefore, the current study uses the animal husbandry scale to figure out how participants believe and satisfy concerning animal husbandry issue. In this research, we used the animal husbandry behavioral attitude which combines the importance of a particular component such as clean environment, healthy living conditions or medical treatment for the animals etc. with how satisfactory the particular component is.

2.4.5 Environmental and Biodiversity Attitudes

The issue of environment degradation was serious during 1970s but concerns toward the environment was confined to the governments of the states. The general public was either not concerned or aware of the issues (Akehurs et al., 2012). The late 1980s witnessed number of environmental disasters which forced people to think again and be aware of environmental issues (Titterington et al., 1996). The decade of 1990 was considered as the 'decade of the environment' or 'the Earth decade', and the social and environment concern got its place in the market and people started collecting more information about the environmental issues (Prothero, 1996). Consequently, people became more sensitive about environmental degradation and started taking initiatives in their individual and collective capacity (Chirag and Neeraj, 2017). Amyx et al., (1994) defined perceived importance with respect to the environment as 'the degree to which one expresses concern about ecological

issues'. This can be understood in the sense that the perceived importance of the product and convenience (in the overall process of product purchase, use and disposal) is very important for the consumers before taking any purchase decision (Chirag and Neeraj, 2017). Cattle produce methane as a by-product of digestion in the rumen (Hosseini, 2014). The livestock industry is responsible for 35-40% of annual methane emissions the result from enteric fermentation in ruminants and farm animal manure (Steinfeld et al., 2006). As cattle are a large source of methane emissions, there has been growing public concern to reduce emissions to achieve environmental sustainability. Therefore, this study asked how consumers think about environmental problems generally first to analyze how this general environmental attitude can give an impact on choosing dairy products.

Secondly, biodiversity describing how much variety an ecosystem has, in terms of resources and species, and also genetically within species, is a key measure of the health of any ecosystem, and of our entire planet (Bolger, 2018). A more diverse ecosystem will have more resources to help it recover from famine, drought, disease or even the extinction of a species (Bolger, 2018). There are several categories of biodiversity, each representing how diverse the genes, species and resources are in a region (Bolger, 2018). Especially, genetic diversity refers to how closely related the members of one species are in a given ecosystem (Bolger, 2018). Simply, if all members have many similar genes, the species has low genetic diversity. Having low genetic diversity can pose a threat to a population if inheritance of undesirable traits or diseases are occurred while, having high genetic diversity is useful for species to adapt to changing environments (Bolger, 2018).

Therefore, these participants' attitudes with regard to biodiversity was considered as well in this paper based on Spash and Hanley (1995)'s paper. Spash and Hanley (1995) took into

account the nature of preferences for the preservation of biodiversity, and the extent to which individuals are well-informed about biodiversity.

2.4.6 Myths of Nature and NHIP (New Human Interdependence Paradigm)

In this paper, two approaches with respect to attitudes towards the environment were addressed by survey respondents, which the first is about the perception of environmental risks and the second is more about environmental belief. First, the perception of environmental risks can be categorized in correspondence with four so-called myths of nature : nature capricious, nature perverse/tolerant, nature benign, and nature ephemeral (Steg and Sievers, 2000). In figure 1, the landscape symbolized the vulnerability of nature; the ball symbolizes environment-risky behavior. Within each landscape, the ball is in equilibrium) (Steg and Sievers, 2000).

Figure. 1 : Myths of Nature

Nature Capricious (Fatalist)
* View on nature: none
* View on resources: lottery
* Needs nor resources controllable
* Environmental risk perception: what you don't know cannot harm you
* Management strategy: cope

Nature Perverse/Tolerant (Hierarchist)
* View on nature: unstable equilibrium
* View on resources: scarce
* Needs are not, but resources are controllable
* Environmental risk perception: acceptable risks, determined by experts
* Management strategy: regulation and control

Nature Benign (Individualist)
* View on nature: stable/global equilibrium
* View on resources: abundant

Nature Ephemeral (Egalitarian)
* View on nature: precarious balance
* View on resources: depleting

Source : Steg and Sievers (2000), pp. 252

Nature benign, the individualists' myth of nature, conveys a robust and resilient system: The ball will always find its way back to the bottom of the basin (see Figure 1). Nature is seen as a stable and global equilibrium, and resources are expected to be abundant (Steg and Sievers, 2000). Steg and Sievers (2000) said nature perverse or tolerant, the hierarchists' myth of nature, conveys a robust system but only up to a point. The ball will find its way to the bottom of the basin but only as long as people respect the limits set by experts (see Figure 1). Nature is seen as an unstable equilibrium with resources being scarce (Steg and Sievers,

2000). Nature ephemeral, the egalitarian myth of nature, represents a precarious and delicate balance; the least jolt may lead to disastrous consequences (see Figure 1). They view nature as a limited equilibrium, and natural resources are supposed to be depleting, and think resources are not controllable, unlike needs) (Steg and Sievers, 2000). The fatalists' myth of nature, nature capricious, represents nature as an unmanageable and inefficacious system: You do not know in which direction the ball will roll or what the consequences will be (see Figure 1) (Steg and Sievers, 2000).

Secondly, it is thought that a dichotomy exists between two apparently contradictory belief systems: the so-called "Human Exception Paradigm" (HEP)—an anthropocentric belief system—and the "New Environmental Paradigm" (NEP), of eco-centric nature (Corral-Verdago et al., 2008). A system focusing on human needs and its dominance as a species, which disregards the intrinsic value of the natural world has been generally labeled as an anthropocentric worldview; on the other hand, an eco-centric worldview has been recognized that conceives humans just as one more component of nature, and claims for limits to human activities to avoid the disruption of ecosystems (Dunlap et al., 2000). Although the mainstream tradition in the conservation psychology domain has considered the elements of this dichotomy as contradictory and incompatible belief systems, findings of other studies might be suggestive of a possible integration between them (Bechtel, Corral-Verdugo, Asai and González, 2006; Bechtel, Corral-Verdugo and Pinheiro, 1999). These findings are, therefore, suggestive of a possible alternative worldview, which sees the potential conciliation and not only the opposition between these two main dimensions (Corral-Verdago et al., 2008). Corral-Verdago et al. (2008) tested the presence of an integrative, nondichotomic, New Human Interdependence Paradiam (NHIP) and its

influence on water conservation practices. This NHIP scales also were employed to comprehend power of the environmental belief systems.

2.4.7 Views towards science and technology

Siegrist et al. (2007a) argue that among all of the applications in nanotechnology, applications in the food and health domain are most likely to become controversial topics. With few exceptions however most studies on attitudes toward nanotechnology have focused on nanotechnology in general (Cobb and Macoubrie, 2004; Gaskell et al., 2004; Lee et al., 2005; Scheufele and Lewenstein, 2005). Vandermoere et al. (2011) aimed to fill this knowledge gap by focusing on nanotechnology applications in the food domain specifically. They discovered people are rather ambiguous and pessimistic about nanotechnology applications in the food domain, in spite of great expectations about the potential of nanotechnology (Vandermoere et al., 2011). In that study, Vandermoere et al. (2011) measured views on science and technology by asking, "would you say that the world is better off, or worse off because of science and technology?" as well as trust or familiarity with nanotechnology itself. The current study adopted this scale to estimate how the general views toward science technology can make an impact on dairy products consumptions.

Furthermore, Dijkstra et al. (2010) created a measurement scale and investigated if public participation existed pertaining to genomics issues. Their questionnaire was consisted of several parts including public participation, interest in genomics issues and perception of genomics etc. (Dijkstra et al., 2010). Especially, in the public participation section was based on five items in which respondents could indicate their participation in genomics research (Dijkstra et al., 2010). Participants could indicate if they had taken part in genomics research

by means of reading about, talking about, or searching for information on genomics research, or by attending public meetings or by involving actively in discussions about genomics (Dijkstra et al., 2010). This approach was employed in this study with focusing on biotechnology instead of genomics.

2.4.8 Health consciousness

Slater and Flora (1989) suggested a new method of audience segmentation called "health lifestyle," which is an analysis that measures health related factors. To identify subgroups, Slater and Flora (1989) collected data about health knowledge, health attitude and cognition, perception of social norms, and health behaviors (e.g., dietary habits, exercise, smoking, and alcohol consumption). The analysis resulted in two major clusters (health-oriented vs. non-health oriented) and seven lifestyle patterns, four of which were included in the health-oriented cluster (i.e., healthful adults, healthful young adults, healthful talkers, and young athletes), and three of which were included in the non-health oriented cluster (i.e., unhealthful adults, unhealthful young adults, and worried older adults).

Hong (2011) proposed the notion of "health consciousness" as a powerful segmentation criterion in diverse health interventions. From this perspective, Slater and Flora's (1989) division of health-oriented vs. non-health oriented audiences is closely related to the notion of health consciousness, and the health lifestyle analysis represents an early attempt to measure one's level of health consciousness. Hong (2011) attempted to directly measure underlying psychological traits of the concept, rather than indirectly measuring the concept using visible behaviors. Therefore, health consciousness is a psychological state predicting a variety of related variables (e.g., health attitudes and behaviors), rather than actual specific

behaviors (Hong, 2011).

2.4.9 Summary

As the table 3 shows, there are explanatory variables which are likely to affect consumer's preferences when purchasing dairy products. Generalized trust in people (Glaeser et al. 2000), trust in groups of institutions (Roosen et al., 2015), animal husbandry scale (Frewer et al., 2005), myths of nature (Steg and Sievers, 2000) and knowledge variables have been found to influence people's behavior in different livestock-product contexts (Goddard et al., 2018). Therefore, these variables including health consciousness and views on genomics will be used to identify the characteristics of individuals who are more or less in favor of one or more attributes. Moreover, the demographic variables like age, income etc. as well as explanatory variables that we discussed in Table 3 will be included for the further analysis to understand which one has an impact on dairy product attribute preferences.

Table 3. Explanatory variables

Variable	Variable description	Reference
Moral foundations	When you decide whether an action taken by someone is right or wrong, to what extent are the following considerations relevant to your thinking? (i) Whether or not the person suffered emotionally (ii) Whether or not the person protected someone weak or defenceless (iii) Whether or not the person was cruel (iv) Whether or not some people were treated differently than others (v) Whether or not the person acted unfairly (vi) Whether or not the person was denied their rights. 1. not at all relevant … 6. extremely relevant.	Graham et al. (2011)
Generalized trust in people	Generally speaking, would you say that most people can be trusted? 1. Most people can be trusted 2. Can't be too careful in dealing with people 3. don't know.	Glaeser et al. (2000)
Trust in institutions responsible for food	How much trust do you have in the following groups or institutions regarding their responsibility for food production in Canada? (scores range from 1 = no trust to 5 = absolute trust) Please randomize items in this question : (i) Farmers (ii) Food processors or manufacturers (iii) Research organizations/universities (iv) Pharmaceutical industry which provides drugs to treat animals (v) Government agencies/public authorities (vi) Advocacy consumer	Roosen et al. (2015)

	organizations (vii) Advocacy environmental organizations (viii) Advocacy organizations for animal welfare (ix) Retailers. (x) Veterinarians	
Animal Attitude Scale(sum)	Please identify whether you agree or disagree with the following statements: (i) It is morally wrong to hunt animals for sport (ii)* There is nothing morally wrong with hunting wild animals for food (iii) *I think it is perfectly acceptable for cattle and hogs to be raised for human consumption (iv) The slaughter of whales and dolphins should be immediately stopped even if it means some people will be put out of work (v) I sometimes get upset when I see wild animals in cages at zoos (vi) One of the worst things someone can do is to hurt a defenseless animal Responses are anchored as follows: 1. strongly disagree … 5. strongly agree.	Herzog et al. (2015)
Animal husbandry scale	1.How important or unimportant are the following to the welfare of dairy cattle that are maintained for dairy production? Please randomize the items in this question. 1 Not important at all … 5. extremely important. 6. Don't know 2. How satisfactory or unsatisfactory are the current conditions under which dairy cattle are being maintained in Canada? Please randomize the items in this question. 1 Not important at all … 5. extremely important. 6. Don't know The issues for both two above questions are (i) Healthy living conditions (ii) Skilled attention (iii) Clean environment (iv) Environment free from disease (v) Medical treatment when the cattle are sick (vi) Comfortable living conditions (vii) Nutrition to strengthen the cattle's immune system (viii) Adaptation of the housing system to the needs of the cattle (ix) Food to satisfy the cattle and to optimize their growth and health (x) Space to allow the cattle to be on their own (xi) Variation or diversity in the living environment (xii) Prevention of stressful situations (xiii) Providing an environment that allows the animals to experience little or no fear. The first question is about respondent's beliefs and the second questions is for satisfaction scores. They are multiplied and summed/averaged.	Frewer et al. (2005)
Myths of nature (dummy variables)	Please indicate which one of the following statements corresponds most with your view on nature. Only one answer is possible (i) Environmental problems can only be controlled by enforcing radical changes in human behaviour in society as a whole (ii) Environmental problems are not entirely out of control, but the government should dictate clear rules about what is and what is not allowed (iii) We do not need to worry about environmental problems because in the end, these problems will always be resolved by technological solutions (iv)We do not know whether environmental problems will magnify or not	Steg and Sievers (2000)
NHIP	Please identify whether you agree or disagree with the following statements: (i) Human beings can progress only by conserving nature's resources (ii) Human beings can enjoy nature only if they make wise use of its resources. (iii) Human progress can be achieved only by maintaining ecological balance. (iv) Preserving nature at the present time means ensuring the future of human beings. (v) We must reduce our consumption levels to ensure well-being of the present and future generations. Responses are anchored as follows: 1. strongly disagree … 5. strongly agree.	Corral-Verdago et al. (2008)

Environmental self assessed knowledge	To what extent do you feel knowledgeable about environmental problems? 1 means that 'you have little knowledge', and 10 means that 'you know a lot	
Biodiversity attitudes	Please identify whether you agree or disagree with the following statements: (i) Biodiversity is a measure of the number of different species of plants and animals in a particular area (birds or trees in Ontario, for example) (ii) Biodiversity is a measure of the extent of genetic variation within a species, for example the number of different types of apple trees, different breeds of cattle. (iii) Biodiversity means the number of different types of ecosystems within a particular region – such as wetlands, coastal areas, forest, prairies. Responses are anchored as follows: 1. strongly disagree … 5. strongly agree 6. Don't know	Spash and Hanley (1995)
Health Consciousness	Please identify your level of agreement with the following statements. (please randomize elements) HC1: I'm very self-conscious about my health. HC2: I'm generally attentive to my inner feelings about my health. HC3: I reflect about my health a lot. HC4 : I'm concerned about my health all the time. H5. I notice how I feel physically as I go through the day. H6.I take responsibility for the state of my health. H7. Good health takes active participation on my part. H8, I only worry about my health when I get sick.h9. Living life without disease and illness is very important to me. H10. My health depends on how well I take care of myself. H11. Living life in the best possible health is very important to me.	Hong (2011)
Views of Genomics	When you hear the word genomics is your reaction : 1. Negative…3. Neutral …5. Positive 6. Don't know	
	How would you describe your familiarity with genomics? : 1. Not at all familiar 2. Not very familiar 3. Somewhat Familiar 4. Very Familiar	
Views and Knowledge of science and technology	In general, to what extent do you feel knowledgeable about scientific and technological developments? 1 means that 'you have little knowledge', and 10 means that 'you know a lot.	
	All things considered, would you say that the world is better off, or worse off, because of science and technology? 1 means that 'the world is a lot worse off,' and 10 means that 'the world is a lot better off.	Vandermoere et al. (2011)
	When you hear the word biotechnology is your reaction : 1. Negative ...3. Neutral …5. Positive 6. Don't know	
	Before you filled out this questionnaire, did you ever…? (i) Read information about biotechnology (ii) Talk to someone about biotechnology (iii) Search for information about biotechnology in a library or on the internet. (iv) Attend a public meeting where biotechnology was discussed. (v) Participate actively in discussions about biotechnology	Dijkstra et al. (2010)

Furthermore, there are many studies that have examined consumer preferences at an individual or household level and the various factors considered have included socio-demographic factors (e.g. gender, age, presence of children in the household, education, income) (Chen et al., 2018;

de-Magistris and Gracia, 2016; Shan et al., 2017). Therefore, based on the previous studies, this study will also include socio-demographic variables such as income, age etc. as well.

2.5 Reliability and Validity

Eliciting quality responses has become an increasingly difficult task (Curtin, Presser, and Singer 2005; Meyer, Mok, and Sullican 2015). Individuals have limited capacities for processing information, making it reasonable for a survey participant to inattentively complete a survey (Malone, 2018). Often, the convention has been to delete these inattentive participants form the sample, as eliminating these observations has been shown to increase statistical power (Oppenheimer, Meyvis, and Davidenko 2009). However, this convention can prove problematic as data collection is costly, and throwing out responses is akin to throwing away money (Malone, 2018). Furthermore, deleting these respondents has the potential to threaten the survey's external validity by biasing the survey sample (Berinsky, Margolis, and Sances 2014; Lancsar and Louviere 2006). Thus, the previous studies said it is the more appropriate approach to "rescue" inattentive respondents as much as possible by taking advantage of divers tools such as trap or certainty questions, and ultimately achieve validity and reliability. Reliability can be defined as reproducibility of result on average, which is related with similar variance across samples (Telser, 2008), while validity refers to the degree to which the method is truly measuring what researchers intended it to.

2.5.1. Trap question

As an effort to identify the most problematic respondents, the trap question was used. In other words, trap questions are intended to identify respondents who are not paying close attention to survey questions, which would mean that they are providing sub-optimal responses to not only the trap question itself but to other questions included in the survey (Oppenheimer, Meyvis, and Davidenko 2009). Malone (2018) found that individuals who miss trap questions and do not correctly revise their responses have significantly different choice patterns as compared to individuals who correctly answer the trap question. Research has shown that inattention can substantively bias policy-relevant estimates, making inattention bias an important issue for survey method (Malone and Lusk, 2018). When it comes to choice experiments, inattentive survey participants have a tendency to pay less attention to price changes, resulting in higher willingness to pay estimates (Malone, 2018). In this study, one trapped question was used to identity inattentive respondents.

2.5.2. Certainty question

Stated preference methods are subject to various biases that lead to differences between actual and hypothetical willingness to pay. After reviewing evidence about the relationship between actual and hypothetical willingness to pay, the previous study concluded that "hypothetical markets tend to overstate willingness to pay for private as well as public goods" (Arrow et al., 1993, p 4610). To avoid or adjust for hypothetical bias, the certainty question, which allows respondents to indicate how sure their choices can be used. For example, Li and Mattsson (1995) used a scale from 0 to 100% in 5% increments where 0% was labelled "absolutely uncertain" and 100% was labelled "absolutely certain", and Champ et al. (1997) used a 10-point rating scale with 1 labelled "very uncertain" and 10 labelled

"very certain". Little and Berrens (2003) in their meta-analysis show that use of follow-up certainty scales can be effective at eliminating the difference between actual and hypothetical mean willingness to pay. For this study, one certainty question which is similar to previous studies' type was included such as "very uncertain", "certain" etc.

2.5.3. Reasons for choices

The objective of a stated preference (SP) survey is to elicit respondents' WTP or WTA for the change in provision of a non-market good described to them in the scenario (Pearce et al. 2002). It is anticipated that respondents will state the amount that they genuinely believe they would be willing to pay or willing to accept in compensation if the change in provision actually occurred (Pearce et al. 2002). This value is called the respondent's formulated value. However, if respondents perceive some strategic advantage in mis-reporting their values then their stated value may not equal their formulated value (Pearce et al. 2002). Thus, the task of the questionnaire is to provide an unbiased and transparent vehicle which gives respondents the best possible chance to deliberate about their preferences and approach as closely as possible to the values that they would affirm in the light of experience (Pearce et al. 2002). The criteria upon which success is judged in the stated preference method can be divided into tests of reliability and tests of validity. Reliability refers to the degree of replicability of a measurement, while validity refers to the degree to which a study succeeds in measuring the intended quantity (Pearce et al. 2002). Generally, validity can be assessed by three criteria : content, construct and criterion. Whether the stated preference survey asked the right questions in a clear, understandable and appropriate manner, which is termed content validity is relevant to consequentiality (Pearce et al. 2002). In other words,

consequentiality is one of the standards to judge the content validity. Under consequentiality, survey participants are explicitly told that their answers to preference questions will influence agency decisions concerning the non-market good presented in the survey (Carson et al., 2014). Carson et al. (2014) suggest that understanding how to ensure consequentiality in stated preference surveys should be a major focus for survey designers. This message is in concert with the long-standing advice (e.g., Mitchell and Carson, 1989) that emphasizes the need for realism in the design of such surveys (Carson et al., 2014). Consequentiality will not in general be as easy as telling respondents that the survey's results may influence some vague policy, and it brings on a set of difficult challenges (Carson et al., 2014). When survey responses represent real economic commitments, respondents care about program details (Carson et al., 2014). In the literature, two types of consequentiality have developed : policy consequentiality and payment consequentiality (Herriges et al., 2010). Policy consequentiality exits when the respondents believes that the results of the survey will give an impact on the corresponding policy. Payment consequentiality occurs when respondents perceive that there is some non-zero probability, which means they will have to pay the bid amount (Groothuis et al., 2015). This study asked agree/disagree questions about the reasons for choosing certain choices to participants related to both policy and payment consequentiality, 'Why did you select the dairy products (or none of the products) you did in the questions above?'. The whole question lists are as follow.

Table 4. Answering Rate for Reasons of choices

Why did you select the dairy products (or none of the products) you did in the questions above?

Number	Reason	Agree that this reason affected my choices	Disagree that this reason affected my choices

1	I think the cost increases are a small amount to pay for the benefits received	1204/1801	597/1801
2	I believe that we should encourage dairy production, with the characteristics identified in the choices.	1327/1801	474/1801
3	I feel it (enhancing the characteristics of dairy production) is the "right" thing to do.	1202/1801	599/1801
4	It is important to invest in breeding dairy cows with higher fertility, higher feed efficiency, lower GHG emissions and higher disease resilience.	1220/1801	581/1801
5	I do not believe that breeding dairy cows with the characteristics above will improve dairy production enough for me to continue to eat dairy products.	648/1801	1153/1801
6	I am worried about what technology might be used in selectively breeding dairy cows	945/1801	856/1801
7	I don't believe the changes can actually be achieved	604/1801	1197/1801

We picked the no. 6 question for the further regression analysis because almost half and half people chose for each agree/disagree option to explore discrepancies between two groups. The full survey is presented in Appendix I.

Chapter 3: Methods, Data collection, and Descriptive Statistics

3.1 Introduction

In the previous chapter, a literature review on survey itself, explanatory variables and several tools to avoid ambiguity in the stated preference method were presented. In this chapter, data sources as to dependent and independent variables including descriptive statistics, factor analysis and correlation analysis are described. In other words, different dependent variables and what the numbers are and the set of explanatory variables is delineated. Furthermore, this chapter represents about a model specification, which how regression models are formed and willingness to pays are calculated.

3.2 Data Sources

To address the objectives of this study, data was collected in September 2020 through a market research company (Asking Canadians Inc.) with a targeted sample size of 1800 Canadian consumers (general population, choice of completing survey in English or French). People aged at least 18 years of age participated in the surveys. Respondents were compensated though the normal procedures for panelists who self-select to join the company's panel, including points towards certain products to be claimed or cash. In total, 12,589 invites were sent to complete the survey. From the 12,589 invites there were 1800 fully completed responses, 64 responses were screened (for respondents being under 18, for example), 604 respondents only partially completed the survey and 423 respondents who attempted to complete the survey when it was already at 1800 complete responses. The

response rate, in total, was, thus, 23%.

3.1.1 Dependent variables

Table 4 summarizes the dependent variables, which how four versions of the survey were assigned and how many participants chose for each choice set. There are two main attributes and price, the first attribute outlines four genomic traits in breeding cows: feed efficiency, methane emissions reduction, enhanced disease resilience, improved fertility, the second one describes antibiotics use or not, and then four prices representing the weekly costs for a bundle of dairy products, $16.10, $24.15, $32.20 and $40.25.With this number of levels of different attributes there are many combinations possible so a fractional factorial design with a D-efficiency of 100 (using SAS) was used to identify the required number of choice sets that would allow identification of the responses to the various individual traits. This resulted in 32 choices (with three products and a status quo option – would not purchase any – to choose from) options.

For example, one product in a choice set is comprised of the improved fertility, no antibiotics used, $40.25 and 52 participants chose this as their best preference among four choice sets in the no.3 question from version 1 of the choice sets. The 32 choices were divided into four sets of responses (with each trait identified in each version of choices) with 8 questions each. There was an almost equal number of respondents completing each version of the choice sets which were distributed randomly across respondents, 432, 433, 440 and 429 out of total 1734 respondents. Some of the 1800 survey respondents were excluded from this analysis since they do not consume dairy products.

Figure 2. An Example of the choice sets

Dairy Products A	Dairy Products B	Dairy Products C	I would not purchase any of the dairy products
In addition, the cows have been selectively bred to have higher levels of fertility, enabling them to get and remain pregnant more easily.	In addition, the cows have been selectively bred to have higher levels of fertility, enabling them to get and remain pregnant more easily.	In addition, the cows have been selectively bred to have reduced methane emissions	
No antibiotics are used on cows in dairy production	Antibiotics are only used in dairy production when prescribed by a veterinarian to treat a disease or infection.	Antibiotics are only used in dairy production when prescribed by a veterinarian to treat a disease or infection.	
$40.25 per week cost for dairy products including milk, cheese, yogurt and ice cream, for example	*$16.10 per week cost for dairy products including milk, cheese, yogurt and ice cream, for example*	*$32.20 per week cost for dairy products including milk, cheese, yogurt and ice cream, for example*	
I would choose the following option:			
OPTION A	**OPTION B**	**OPTION C**	**OPTION D**

Table 5 . Dependent variable Information

Question	Traits			No. of choices for each option	Traits			No. of choices for each option
	Version 1				Version 2			
1	Feed efficiency	No antibiotics	$40.25	134	Feed efficiency	Antibiotics	$32.20	65
	Methane emissions reduction	No antibiotics	$40.25	102	Methane emissions reduction	Antibiotics	$16.10	200
	Improved Fertility	No antibiotics	$40.25	66	Disease resilience	No antibiotics	$24.15	120
	Would not purchase any of the dairy products			130	Would not purchase any of the dairy products			48
2	Disease resilience	Antibiotics	$24.15	142	Disease resilience	Antibiotics	$32.20	36
	Improved Fertility	No antibiotics	$16.10	165	Disease resilience	Antibiotics	$24.15	93
	Improved Fertility	No antibiotics	$24.15	51	Disease resilience	Antibiotics	$16.10	234
	Would not purchase any of the dairy products			74	Would not purchase any of the dairy products			70
3	Improved Fertility	No antibiotics	$40.25	52	Disease resilience	No antibiotics	$40.25	50
	Improved Fertility	Antibiotics	$16.10	149	Feed efficiency	No antibiotics	$40.25	76
	Methane emissions reduction	Antibiotics	$32.20	146	Feed efficiency	Antibiotics	$32.20	216
	Would not purchase any of the dairy products			85	Would not purchase any of the dairy products			91
4	Improved Fertility	Antibiotics	$32.20	88	Methane emissions reduction	No antibiotics	$16.10	168
	Feed efficiency	No antibiotics	$32.20	197	Improved Fertility	No antibiotics	$24.15	72
	Feed efficiency	No antibiotics	$40.25	54	Improved Fertility	Antibiotics	$16.10	140
	Would not purchase any of the dairy products			93	Would not purchase any of the dairy products			53
5	Methane emissions reduction	No antibiotics	$16.10	139	Methane emissions reduction	No antibiotics	$40.25	58
	Disease resilience	No antibiotics	$24.15	117	Disease resilience	Antibiotics	$16.10	244
	Feed efficiency	No antibiotics	$24.15	116	Disease resilience	No antibiotics	$40.25	63
	Would not purchase any of the dairy products			60	Would not purchase any of the dairy products			68
6	Disease resilience	Antibiotics	$40.25	27	Improved Fertility	Antibiotics	$16.10	66
	Disease resilience	Antibiotics	$32.20	170	Feed efficiency	Antibiotics	$16.10	253
	Improved Fertility	No antibiotics	$16.10	159	Improved Fertility	Antibiotics	$40.25	47
	Would not purchase any of the dairy products			76	Would not purchase any of the dairy products			67

7	Feed efficiency	Antibiotics	$32.20	59	Improved Fertility	No antibiotics	$24.15	118
	Disease resilience	No antibiotics	$40.25	97	Disease resilience	No antibiotics	$32.20	130
	Feed efficiency	Antibiotics	$24.15	192	Methane emissions reduction	Antibiotics	$40.25	103
	Would not purchase any of the dairy products			84	Would not purchase any of the dairy products			82
8	Methane emissions reduction	No antibiotics	$24.15	180	Improved Fertility	Antibiotics	$24.15	96
	Improved Fertility	No antibiotics	$32.20	58	Feed efficiency	Antibiotics	$40.25	93
	Disease resilience	No antibiotics	$32.20	120	Disease resilience	No antibiotics	$24.15	165
	Would not purchase any of the dairy products			74	Would not purchase any of the dairy products			79
Total				3456				3464

Note: Price is per week cost for dairy products including milk, cheese, yogurt and ice cream, for example

Question	Traits			No. of choices for each option	Traits			No. of choices for each option
	Version 3				Version 4			
1	Disease resilience	No antibiotics	$32.20	80	Feed efficiency	No antibiotics	$24.15	137
	Feed efficiency	No antibiotics	$16.10	181	Feed efficiency	Antibiotics	$24.15	177
	Methane emissions reduction	No antibiotics	$16.10	115	Improved Fertility	No antibiotics	$32.20	60
	Would not purchase any of the dairy products			64	Would not purchase any of the dairy products			55
2	Improved Fertility	Antibiotics	$32.20	38	Methane emissions reduction	Antibiotics	$16.10	172
	Methane emissions reduction	No antibiotics	$32.20	156	Methane emissions reduction	Antibiotics	$24.15	82
	Improved Fertility	Antibiotics	$24.15	161	Feed efficiency	No antibiotics	$32.20	115
	Would not purchase any of the dairy products			85	Would not purchase any of the dairy products			60
3	Methane emissions reduction	No antibiotics	$32.20	126	Feed efficiency	Antibiotics	$16.10	198
	Disease resilience	Antibiotics	$40.25	84	Disease resilience	No antibiotics	$40.25	74
	Improved Fertility	Antibiotics	$24.15	153	Methane emissions reduction	No antibiotics	$32.20	104
	Would not purchase any of the dairy products			77	Would not purchase any of the dairy products			53
4	Feed efficiency	Antibiotics	$40.25	44	Disease resilience	No antibiotics	$16.10	179
	Improved Fertility	Antibiotics	$32.20	59	Methane emissions reduction	Antibiotics	$32.20	94
	Feed efficiency	Antibiotics	$24.15	244	Methane emissions reduction	No antibiotics	$24.15	112
	Would not purchase any of the dairy products			93	Would not purchase any of the dairy products			44
5	Methane emissions reduction	Antibiotics	$24.15	84	Feed efficiency	No antibiotics	$16.10	161
	Methane emissions reduction	Antibiotics	$40.25	54	Feed efficiency	Antibiotics	$32.30	67
	Methane emissions reduction	Antibiotics	$16.10	227	Disease resilience	Antibiotics	$16.10	154
	Would not purchase any of the dairy products			75	Would not purchase any of the dairy products			47
6	Methane emissions reduction	Antibiotics	$40.25	32	Disease resilience	No antibiotics	$24.15	148
	Feed efficiency	No antibiotics	$24.15	178	Methane emissions reduction	Antibiotics	$24.15	161
	Methane emissions reduction	Antibiotics	$24.15	162	Feed efficiency	Antibiotics	$40.25	61
	Would not purchase any of the dairy products			68	Would not purchase any of the dairy products			59
7	Disease resilience	Antibiotics	$16.10	237	Improved Fertility	Antibiotics	$40.25	56
	Improved Fertility	No antibiotics	$40.25	82	Methane emissions reduction	No antibiotics	$24.15	114
	Disease resilience	Antibiotics	$40.25	65	Disease resilience	No antibiotics	$16.10	196
	Would not purchase any of the dairy products			56	Would not purchase any of the dairy products			63
8	Feed efficiency	Antibiotics	$32.20	125	Improved Fertility	No antibiotics	$32.20	49
	Improved Fertility	Antibiotics	$24.15	143	Improved Fertility	Antibiotics	$40.25	71
	Methane emissions reduction	No antibiotics	$40.25	92	Feed efficiency	No antibiotics	$16.10	253
	Would not purchase any of the dairy products			80	Would not purchase any of the dairy products			56
Total				3520				3432

3.1.2 Descriptive statistics

Table 5 presents the descriptive statistics on mean, standard deviation, frequency (%) for main explanatory variables, and also compares demographic variables with frequencies from Canadian census of 2016 to check whether the sample represent the population well. The survey sample is 50.3% male which is almost consistent with 2016 census data. Regarding age, the sample is composed of the participants who are from 18 to over 65 years old, with an average age of 48.9. Compared to census data, the respondents' age in the sample is older. Also, in the case of survey sample, 86.8% of the respondents stay in an urban area, while 81.3 % of the 2016 census data live in the urban regions. However, when it comes to the household income and household size, the sample's means are almost similar with the census data's ones. For instance, in the survey, participants have just slightly higher income and a bit lower household size than people in the census populations in general, but the numbers don't have wide discrepancies.

With respect to other explanatory variables, Table 5 shows the mean, standard deviation and frequencies as well. The number in parentheses means the range from minimum to maximum for each variable. For example, trust in government variable has the range from 1 to 5, with the average 3.16 and familiarity with genomics has 1 to 6 range, with the 1.84 mean value. In terms of frequencies, the frequency for generalized trust is calculated by taking into account option 1, most people can be trusted. This generalized trust frequency is about 9.2% lower than one of the census data. Moreover, the whole sample was divided by whether the respondents passed or failed trap question and agreed or disagreed with technology use in breeding dairy cows. In the case of the trap question, depending on the results (pass/fail), it could arise difference between two groups because, in the trap question

fail group, the respondents were likely to answer randomly without paying much attention. Therefore, it is necessary to figure out how much the answers have statistically significant discrepancies between the two groups. Around 2/3 people passed the trap question and 1/3 failed. In terms of demographic characteristics, there are no distinguishable differences between two groups except for the household size. However, there are discrepancies as to generalized trust in people and myth of nature variables, which the group passed the trap question has about 10% proportion more who trust people generally and the participants in that group have much higher belief pertaining to 'nature ephemeral' concept.

Concerning the question whether the participants agree or disagree with technology in breeding cows, almost half of people (912) agreed with that, while 822 people opposed with using technology. Thus, it is needed to grasp distinguishable differences between two groups as well. When it come to the group that disagreed with the use of technology in breeding cows, it has slightly higher myth of nature, 'nature benign' which a view on resources is abundant. On top of that, 10% more males showed negative perspective on using technology. In Chapter 4, regression analysis will be presented as to theses trap question groups and agree/disagree with technology use groups.

For the variables, health consciousness and the environmental associated variable, NHIP (New Human Interdependence Paradigm), factor analysis was conducted to simplify the multi part questions.

Table 6. Descriptive statistics

	Survey					2016 Census
	Whole Sample	Trap Pass	Trap Fail	Worry about technology-Agree	Worry about technology-Disagree	
No. of Observations	1734	1279	455	912	822	
Demographic variables				*Frequency (%)*		*Frequency (%)*
Male	50.3	49.3	53.4	45.7	55.5	49.1
Children aged < 18 years live in the household	17.1	16.7	18.2	16.9	17.3	33.4
Live in an urban area	86.8	86.1	88.8	87.3	86.3	81.3
Education						
Elementary school	0.39	0.23	0.88	0.55	0.24	11.5
Secondary (high) school	14.1	13.8	17.1	15.7	13.5	23.7
Technical/business school/community college	27.0	28.3	27.3	29.3	26.6	33.2
University	38.8	39.8	41.5	39.4	41.2	24.8
Post graduate studies (Masters or PhD)	16.0	17.9	13.2	15.1	18.4	6.85
				Mean(SD)		*Mean*
Age (years)	48.9(14.9)	49.1(14.6)	48.8(15.5)	49.6(14.7)	48.4(15.1)	41.0
Household income ($1,000.00)	79.0(32.5)	81.0(32.4)	72.9(32.1)	76.5(32.5)	81.6(32.4)	76.2
Household size	2.30(1.06)	2.29(1.05)	2.32(1.10)	2.27(1.03)	2.33(1.10)	2.40
Other variables				*Frequency (%)*		*Frequency (%)*
Generalized trust in people (0. can't be careful in dealing with people/don't know 1. most people can be trusted)[2]	43.3	46.9	33.2	41.0	45.9	52.5[1]
Myth of nature 1: nature ephemeral (dummy)	43.2	45.8	35.8	45.4	40.8	
Myth of nature2: nature perverse/tolerant (dummy)	42.4	41.2	45.7	42.0	42.8	
Myth of nature 3: nature benign (dummy)	3.29	2.50	5.50	2.08	4.62	
Myths of nature 4: nature capricious (dummy)	11.1	10.5	13.0	10.5	11.8	
				Mean(SD)		
Trust in universities/research organization (1-5)	3.47(0.91)	3.55(0.89)	3.26(0.91)	3.39(0.89)	3.57(0.91)	
Trust in government (1-5)	3.16(0.94)	3.18(0.96)	3.10(0.87)	3.09(0.96)	3.23(0.91)	
Trust in the food industry (1-5)	2.89(1.03)	2.80(1.09)	2.92(0.97)	2.83(1.03)	2.95(1.01)	
Trust in advocacy groups (1-5)	2.89(0.98)	2.89(1.00)	2.90(0.92)	2.96(0.96)	2.82(1.00)	
Animal attitude scale (1-30)	20.5(3.91)	23.2(3.13)	21.7(3.73)	21.1(3.66)	19.9(4.07)	
Animal husbandry scale (0-25)	9.95(7.58)	9.71(7.69)	10.6(7.23)	10.3(7.53)	9.61(7.57)	
Environmental self-assessed knowledge(1-10)	5.70(2.19)	5.73(2.23)	5.62(2.06)	5.61(2.19)	5.80(2.18)	
Moral foundation 1: Harm/care (1-18)	12.4(3.07)	12.7(2.94)	11.6(3.28)	12.6(3.02)	12.2(3.11)	
Moral foundation 2: Fair/reciprocity (1-18)	12.9(3.27)	13.2(3.09)	11.9(3.54)	13.1(3.19)	12.7(3.34)	
Knowledge on science and technical development(1-10)	5.22(2.33)	5.15(2.36)	5.41(2.22)	5.07(2.35)	5.39(2.29)	
Views on science and technology(1-10)	7.03(2.03)	7.15(2.07)	6.70(1.89)	6.70(2.02)	7.40(2.99)	
Familiarity with genomics(1-6)	1.84(0.85)	1.83(0.85)	1.88(0.82)	1.76(0.81)	1.94(0.88)	

[2] Frequency for generalized trust is calculated by taking into account option 1(most people can be trusted).

3.2. Factor Analysis

Factor analysis is a technique that is used to reduce a large number of variables into fewer numbers of factors. In other words, this factor analysis shrinks the mass of dataset into the smaller data with taking into account variables' correlation to find latent variables. To find hidden patterns, all variables in an original data are created into a new set which is called dimension (2021 Statistics How To). Therefore, the factor analysis is one of the main data reduction methods. The factor analysis was employed for two explanatory variables, health consciousness and NHIP (New Human Interdependence Paradigm) for this study.

As Table 6 shows, 11 items were used to conceptualize health consciousness, and each item has a scale of 1 (strongly disagree) to 5 (strongly agree). Item 8 was reverse coded.

Table 7. Description of Questions used to Access Health consciousness

Factor	Item
Self-health awareness	HC1: I'm very self-conscious about my health.
	HC2: I'm generally attentive to my inner feelings about my health.
	HC3: I reflect about my health a lot.
	HC4: I'm concerned about my health all the time.
Personal responsibility	HC5: I notice how I feel physically as I go through the day.
	HC6: I take responsibility for the state of my health.
	HC7: Good health takes active participation on my part.
	HC8: I only worry about my health when I get sick. ®
Health motivation	HC9: Living life without disease and illness is very important to me.
	HC10: My health depends on how well I take care of myself.
	HC11: Living like in the best possible health is very important to me.

Source : Hong (2009)
Note: R means the statement is reverse coded.

Variables with factor loading coefficients below 0.4 were deleted. Table 7 provides a summary for factor loadings for the health consciousness. In light of the factor analysis result, only factor 1 which eigenvalue is above 1 was statistically significant. Also, the result of the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (0.91) exceeded the

recommended acceptance value, which is 0.5 (Kaiser, 1974; Arenna, 2017). Thus, only factor 1 for the health consciousness variable was used for further analysis. Factor loadings presented in the brackets in the Table 7 are the factor loadings obtained by Hong (2009) which is the base study about the health consciousness for this survey. Compared to Hong (2009)'s study, the factor loadings are not identical and, in addition, while all statements in this paper heavily loaded to factor 1, there were three factors in the case of Hong (2009)'s paper.

Table 8. Factor loadings Table for Health consciousness

Variable	Factor1	Factor2	Unique variances
HC1: I'm very self-conscious about my health.	0.6447 (0.816)[1]		0.5843
HC2: I'm generally attentive to my inner feelings about my health.	0.6710 (0.771)[1]		0.5497
HC3: I reflect about my health a lot.	0.6347 (0.748)[1]	0.4298	0.5971
HC4: I'm concerned about my health all the time.	0.4514 (0.709)[1]	0.4695	0.7962
HC5: I notice how I feel physically as I go through the day.	0.6540 (0.888)[2]		0.5722
HC6: I take responsibility for the state of my health.	0.7234 (0.813)[2]		0.4767
HC7: Good health takes active participation on my part.	0.7560 (0.490)[2]		0.4285
HC8: I only worry about my health when I get sick(R).	(0.405)[2]		0.9739
HC9: Living life without disease and illness is very important to me.	0.7048 (0.800)[3]		0.5032
HC10: My health depends on how well I take care of myself.	0.7243 (0.546)[3]		0.4754
HC11: Living life in the best possible health is very important to me.	0.7643 (0.500)[3]		0.4159
Eigenvalue	4.6268	0.8168	
Cumulative proportion	0.9366	1.1020	

Note: R means the statement is reverse coded.
<.4 are suppressed.
1,2,3 means factor1, factor2, and factor3 respectively.
Source : Hong (2009)

In the case of NHIP (New Human Interdependence Paradigm), the factor analysis result is as follow. Like the health consciousness case, only factor 1 was statistically significant,

which the eigenvalue is above 1, 2.8834. Besides, it also exceeded recommended acceptance value (0.87) for KMO measure of sampling adequacy. The numbers in brackets shows Corral-Verdago et al. (2008)'s factor loadings. Even though the factor loadings themselves are not identical, it turned out that only one factor is valid statistically similar to the results in the Corral-Verdago et al. (2008)'s paper.

Table 9. Factor loadings Table for NHIP

Variable	Factor1	Factor2	Unique variances
NHIP1: Human beings can progress only by conserving nature's resources.	0.7753 (0.73)		0.3989
NHIP2: Human beings can enjoy nature only if they make wise use of its resources.	0.7280 (0.60)		0.4700
NHIP3: Human progress can be achieved only by maintaining ecological balance	0.8263 (0.73)		0.3172
NHIP4: Preserving nature at the present time means ensuring the future of human beings.	0.7673 (0.53)		0.4113
NHIP5: We must reduce our consumption levels to ensure well-being of the present and future generations.	0.6933 (0.56)		0.5193
Eigenvalue	2.8834	0.0107	
Cumulative proportion	1.1176	1.1218	

Note: <.4 are suppressed.
Source : Corral-Verdago et al. (2008)

Both the health consciousness and NHIP calculated factors data will be used in the further analysis to compare differences across classes from the latent class analysis.

3.3. Correlation Analysis

Correlation is bivariate analysis that measures the strength of association between two variables and the direction of the relationship. A correlation coefficient is a way to put a value to the relationship. Especially, Pearson correlation is the most widely used correlation statistic to measure the degree of the relationship. The Pearson correlation coefficients have

a value of between -1 and 1. A “0” means there is no relationship between the variables at all, while -1 or 1 means that there is a perfect negative or positive correlation. However, this Pearson correlation analysis has an important pitfall, indicating that the correlation coefficient can be influenced by the range of observations (Janse et al., 2021). Because the variables in this study have widely varying values from dummy variables which are 0 or 1 and another variables which have actual quantities, this correlation analysis also can have this limitation. To check for multicollinearity referring to a phenomenon in which strong correlation among independent variables exists and thus regression may not give valid results about individual predictors, correlation analysis was done.

Table 9 provides a summary of the dependent variable and explanatory variables’ correlation results. If seeing the first row, it is likely to say there is a very low degree of positive or negative correlation between independent variables and dependent variable because the numbers are almost close to 0. Besides, across explanatory variables, it is unlikely to say there are high degree of positive or negative relationships because the numbers are generally almost close to 0 as well.

Table 10. Correlation Table

	1	2	3	4	5	6	7	8	9	10	11	12
1.Dependent Variable	1											
2.Age	-0.129***	1										
3.Male	-0.0405***	0.0807***	1									
4.Household No.	-0.0530***	-0.208***	0.0513***	1								
5.Education Years	-0.0341***	-0.106***	0.00335	-0.0535***	1							
6.Income	-0.0860***	-0.00905	0.0767***	0.243***	0.220***	1						
7.Living	0.0270**	0.135***	-0.0152	-0.0372***	-0.116***	-0.0609***	1					
8.Trust food industry	-0.0771***	0.0637***	0.101***	-0.00522	-0.130***	-0.0505***	0.0146	1				
9.Trust advocacy	0.0281**	-0.0901***	-0.0575***	-0.00288	-0.00159	-0.0527***	-0.0134	0.389***	1			
10.Trust university	-0.0573***	0.0108	0.0829***	-0.0122	0.0724***	0.0972***	-0.0262**	0.411***	0.438***	1		
11.Trust government	-0.0681***	0.0361***	0.0969***	0.0270**	0.0440***	0.0633***	-0.0194*	0.527***	0.358***	0.480***	1	
12.View of Science & Tech.	-0.104***	-0.00757	0.115***	-0.000945	0.171***	0.160***	-0.0171	0.132***	0.0396***	0.299***	0.230***	1
13.View of Genomics	0.00291	-0.0160	-0.0445***	-0.0391***	-0.00559	-0.00503	-0.0524***	0.0748***	0.0489***	0.0433***	0.0776***	0.178***
14.NHIP	-0.0698***	0.124***	-0.0855***	-0.0984***	0.0837***	0.0158	0.0179*	-0.0590***	0.224***	0.206***	0.0795***	0.0815***
15.Animal attitude	0.0467***	0.0474***	-0.226***	-0.0645***	0.0192*	-0.0637***	-0.0254**	-0.145***	0.250***	0.0258**	-0.0652***	-0.0937***
16.General Trust	-0.0906***	0.219***	0.00904	-0.0593***	0.124***	0.104***	0.00487	0.151***	0.0804***	0.149***	0.185***	0.162***
17.Moral foundation(Harm& Care)	-0.0245**	0.146***	-0.105***	-0.0419***	-0.0123	-0.00357	0.00646	0.00837	0.165***	0.136***	0.0570***	0.0324***
18.Moral foundation(Fair & reciprocity)	-0.0360***	0.174***	-0.103***	-0.0600***	0.00602	0.00373	0.0207*	-0.0125	0.120***	0.125***	0.0562***	0.0857***
19.Health consciousness	-0.0264**	0.231***	-0.0497***	-0.0938***	0.0181*	0.0673***	0.0237**	-0.0127	0.0882***	0.132***	0.0576***	0.0681***
20.Animal Husbandry	-0.0775***	0.0969***	0.0831***	-0.0301***	-0.0926***	-0.0294**	0.0504***	0.153***	0.0910***	0.0741***	0.0514***	0.0340***
21.Knowledge about Science & Tech.	-0.0149	-0.0563***	0.215***	0.0128	0.213***	0.102***	-0.0143	0.0515***	0.0563***	0.130***	0.0922***	0.2778***
22.Myth of Nature : ephemeral	-0.0103	0.0273**	0.0176*	-0.0308***	-0.00277	-0.0508***	-0.00540	0.0411***	0.0113	0.00992	0.0462***	-0.0132
23.Myth of Nature : preserve	0.0101	-0.0169	-0.0325***	0.0252**	0.00176	0.0367***	0.00879	-0.0455***	-0.0294**	-0.0213*	-0.0418***	0.0159
24.Myth of Nature : benign	0.000365	-0.0264**	0.0375***	0.0143	0.00254	0.0357***	-0.00856	0.0111	0.0458***	0.0287**	-0.0112	-0.00672

	13	14	15	16	17	18	19	20	21	22	23
13.View of Genomics	1										
14.NHIP	0.0151	1									
15.Animal attitude	-0.0302***	0.385***	1								
16.General Trust	0.00173	0.106***	-0.0830***	1							
17.Moral foundation(Harm& Care)	0.0491***	0.328***	0.246***	0.0876***	1						
18.Moral foundation(Fair & reciprocity)	0.0252**	0.342***	0.218***	0.107***	0.790***	1					
19.Health consciousness	0.0446***	0.432***	0.252***	0.120***	0.329***	0.346***	1				
20.Animal Husbandry	-0.0407***	0.0703***	-0.0295**	0.0387***	0.104***	0.0746***	0.0920***	1			
21.Knowledge about Science & Tech.	0.0414***	0.0332***	-0.0852***	0.0198*	0.00617	-0.0122	0.0174	0.188***	1		
22.Myth of Nature : ephemeral	0.0103	0.00631	0.00503	0.0264**	0.00175	-0.0325***	-0.0101	-0.0252**	0.00921	1	
23.Myth of Nature : preserve	-0.0226*	0.00290	-0.0111	-0.00891	0.000512	0.0412***	0.0124	0.0182*	-0.00291	-0.922***	1
24.Myth of Nature : benign	0.0310***	-0.0233**	0.0154	-0.0443***	-0.00571	-0.0218*	-0.00583	0.0178*	-0.0159	-0.200***	-0.196***

Note: * , ** , * , Significant at 1%, 5%, and 10% level**

3.4. Model specification

In the choice experiment, decision makers choose one option from a set of alternatives. The researcher only observes the choice and a set of systematic factors such as price and attributes. Therefore, there is information that the decision maker has that the research does not, that is captured in the random component of utility. Because utility is random we only describe the probability that an alternative is chosen as a function of observable components. More specifically, in this random utility model, a decision maker n faces a choice among J alternatives (Arenna, 2017). The utility of the decision maker n chooses an alternative j is U_{nj}, j=1,…,J. The decision maker chooses alternative j if and only $U_{nj} > U_{ni}$ $\forall$ j $\neq$ i (Train, 2003). However, as this utility is known to the decision maker but not by the researcher, the utility of the decision maker who chooses alternative j is decomposed as $U_{nj} = V_{nj} + \varepsilon_{nj}$, where V_{nj} is the representative utility, ε_{nj} is a random term and captures the factors that affect utility but not included in V_{nj} (Train, 2003). Representative utility is denoted as $V_{nj} = V(X_{nj}, S_n)$ $\forall$ j, where X_{nj} is the attributes of the alternatives that decision maker faces, S_n is the attributes of the decision maker (Arenna, 2017). Therefore, based on the random utility model, the probability that the decision maker n chooses alternative i is as follow (Arenna, 2017):

$$P_{ni} = \text{Prob}(U_{ni} > U_{nj} \; \forall \; j \neq i)$$

$$= \text{Prob}(V_{ni} + \varepsilon_{ni} > V_{nj} + \varepsilon_{nj} \; \forall \; j \neq i)$$

$$= \text{Prob}(\varepsilon_{nj} - \varepsilon_{ni} < V_{ni} - V_{nj} \; \forall \; j \neq i).$$

A conditional logit model is the most widely used in discrete choice model (Train, 2003). The conditional logit model is obtained by assuming that ε_{ni} is independently and identically

distribute (McFadden, 1974). This conditional logit model was used to analyze a base model with only using main attributes and price. On the basis of McFadden (1974), the conditional logit choice probability that the decision maker n chooses alternative i is :

$$P_{ni} = \frac{exp^{V_{ni}}}{\sum_j exp^{V_{nj}}}$$

Therefore, the base regression model for the conditional logit model is as follow :

$$\begin{aligned} U_{ij} = \beta_p Price + \beta_{Feed} Feed\ efficiency + \beta_{methane} Methane\ emissions\ reduction \\ + \beta_{Ferility} Improved\ Ferility + \beta_{Disease} Enhanced\ disease\ resilience \\ + \beta_{Antibio} Antibiotics\ Use + \beta_{No\ aniti} No\ Antibiotics + \beta_n None + \varepsilon_{ij} \end{aligned}$$

However, the basic RUM assumes all individuals have the same preferences, which means it cannot reflect heterogeneity. Thus, to explore and capture the heterogeneity, a latent class model which has relaxing assumptions was employed as well. The latent class model assumes that respondents belong to different classes (m=1,…,M) that are defined by a small number of segments(M) (Holmes and Adamowicz, 2003). Based on Train (2003), the latent class model choice probability is described as :

$$P_{ni} = \sum_{m=1}^{m} S_m \left(\frac{exp^{b'_m X_{ni}}}{\sum_j exp^{b'_m X_{nj}}}\right)$$

where S_m is the share of the population in segment m and can be estimated within the model along with the b'_m which is the coefficient for person n representing his/her tastes in each segment m. This latent class model is useful if there are M segments in the population, each

of which has its own choice behavior or preferences (Train, 2003). Therefore, to explore the heterogeneity depending on segments(memberships), the latent class model was conducted with including additional explanatory variables in this paper. On the basis of the base model, other independent variables such as general trust and health consciousness etc., demographic variables and certainty, agree/disagree question on worrying about technology use are included.

Besides, this study calculated the willingness to pay to address the research objective. The willingness to pay can be estimated for each attribute using coefficients obtained from the conditional logit and latent class models (Arenna, 2017). The willingness to pay for each attribute is calculated using following formula (Ndunda and Mungatana, 2013) :

$$WTP_j = -1 * (\frac{\beta_{attribute\ j}}{\beta_{price}})$$

To understand how much Canadian consumers are willing to pay for particular genomic t/antibiotic traits in purchasing the dairy products, the WTPs were estimated with this formula and reported in Chapter 4.

3.5. Summary

In short, this chapter covered how regression models would be estimated as well as how the data was collected and set up through descriptive statistics and factor analysis. This study will analyze a base conditional logit model with four main genomic traits, antibiotics use levels and prices for the whole sample first. The base conditional logit model will be used for the trap question pass/fail groups and technology agree/disagree groups in breeding cows

to figure out significant differences as well. Secondly, to explore and capture the sample heterogeneity, the latent class model will be estimated including other independent and socio-demographic variables. This latent class model will be conducted for the whole sample first with using with using agree/disagree question on technology in breeding cows, the certainty (how certain are you about your answers to stated choice questions) question, other explanatory and demographic variables as the membership criteria. Then, it will be estimated for both trap question pass and fail groups, respectively as the figure 2 shows.

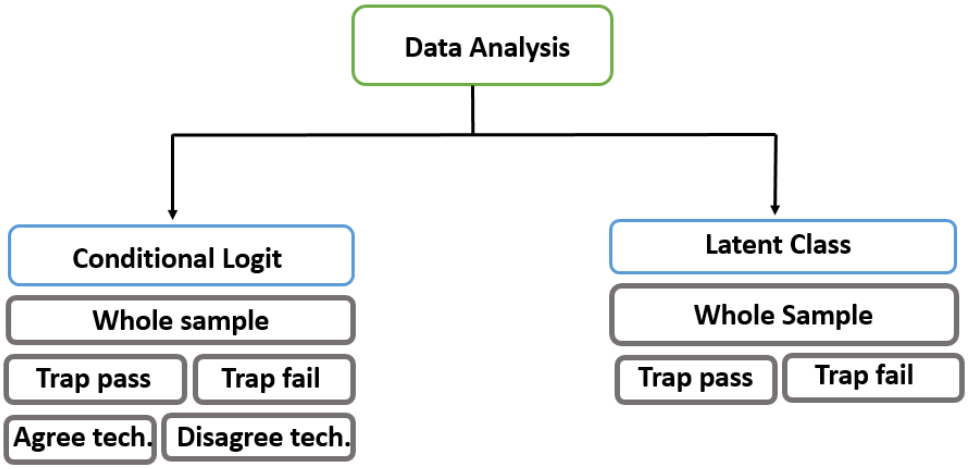

Figure 2. Summary for data analysis

Chapter 4: Regression Results and Welfare Measures

4.1. Introduction

This chapter delineates the results of the regression analysis of the data from the national survey. Conditional logit (CL), Latent class models (LCM) were conducted to analyze the stated preference data and explore heterogeneity. First of all, the result of a base model about main four traits and antibiotic use for 1. the whole sample, 2. trap pass/fail groups and 3. worry about using technology in breeding cows agree/disagree groups will be presented in turn. For this, conditional logit model was employed and willingness to pay (WTP) for the main four genomic attributes and antibiotic status was calculated. Secondly, the latent class model was used to confirm and reflect the heterogeneity across the sample of respondents. After estimating the latent class model, the levels of other influencing variables such as general trust in people, environmental attitude, health consciousness and demographics etc. were calculated for each class of respondents to identify how they differ across classes.

4.2. Regression results

4.2.1 Conditional logit model for a base model (Whole sample)

Firstly, a base model that included only the main four genomic technology traits and antibiotic use status was employed to comprehend consumers' preferences for the use of genomic selection in breeding dairy cows and antibiotic use in production without considering the influence of other explanatory and demographic variables. To estimate the

conditional logit model, one of the four genomic traits (and one of the antibiotic variables) had to be dropped because of a collinearity issue which stems from the fact that adding up the four traits total 1 in the dataset. Appendix A presents the results of conditional logit model for a base model depending on each dropped variable showing that the preferences rankings are the same in each case.

As one of the four traits was dropped for the estimation, when it comes to the interpretation, relative comparisons are calculated. As this model is based on the Random Utility Model (RUM), the coefficients are interpreted as marginal utilities. From the sign and significance of the coefficients, Canadian consumers relatively prefer the feed efficiency trait to the methane emissions reduction, improved fertility and enhanced disease resilience traits. Because the therapeutic use of antibiotic's coefficient is not significant, the use of antibiotics does not affect the marginal utility of decision makers in this model. This relative comparison as to preferences among the four traits is more apparent in willingness to pay calculations from the base model. Table 10 provides a summary of the willingness to pay premium calculation for the base model. When respondents have a negative willingness to pay, this represents that a discount is required to make people purchase the products as compared to the product with the genomic trait of feed efficiency and/or the non use of antibiotics. However, in this study, for the four main genomic traits, if it is negative, it will be interpreted as a relative discount amount as compared to the feed efficiency trait and, for antibiotics, a relative premium/discount as compared to the non use of antibiotics. In light of the results, compared to the feed efficiency trait, respondents have a requirement to be compensated (discount) $2.65 for the methane emissions reduction, $10.94 for the improved fertility and $2.17 for the enhanced disease resilience for them to consume dairy products

with those particular traits. From this point, it clear that the feed efficiency trait is the most preferred among four genomic traits. Given the third column, the decision makers have willingness to pay $10.94 more for cows from the feed efficiency trait, $8.28 more for the methane emissions reduction, and $8.77 more for the enhanced disease resilience in comparison to products from cows with the improved fertility trait. As the Table 10 shows, regardless of the dropped variable, the sizes of differences are consistent among four traits. For further analysis, the feed efficiency trait will be dropped consistently, given it is the preferred trait. Lastly, the negative values of the None variable suggest that to purchase dairy products with particular traits is preferred to the status quo across the sample.

Table 11. Willingness to pay premium ($) calculation for a base model

	Dropped variable			
	1.Feed efficiency	**2. Methane emissions reduction**	**3.Improved Fertility**	**4.Enhanced Disease resilience**
1	-	2.65***	10.94***	2.17***
2	-2.65***	-	8.28***	-0.49
3	-10.94***	-8.28***	-	-8.77***
4	-2.17***	0.49	8.77***	-
Therapeutic use of antibiotics	0.33	0.33	0.33	0.33
None	-2.20***	-2.06***	-1.61***	-2.08***
# of observations	55488	55488	55488	55488

Note : ***,**,*, Significant at 1%, 5%, and 10% level

4.2.2 Conditional logit model for a base model (Trap question Pass/Fail groups)

In this section, the base model regression results for the trap question pass/fail groups using the conditional logit model is presented in Appendix B. Between the two groups, the directions of sign are different with respect to the enhanced disease resilience and therapeutic antibiotic use. In the case of trap question pass group, the respondents like the enhanced disease resilience less than the feed efficiency trait, while the people in the trap question fail group expressed indifferent preference between them. When it comes to the therapeutic use of antibiotics, both the trap question pass and fail groups do not care the use of antibiotics because the coefficients are not statistically significant. In terms of the discount, the trap fail group prefer the methane emissions reduction attribute less than the trap pass group in that the trap fail group have a lager discount of $3.14, which is the difference between $5.38 and $2.24 for the methane emissions reduction trait in comparison to the feed efficiency trait, to purchase dairy products from cows produced with the methane emission trait. As to the improved fertility, the result is reversed. The trap pass group wants to be compensated $2.67 for the improved fertility trait as compared to the feed efficiency trait than the trap fail group, which means the trap pass group dislike the improved fertility trait more than the trap fail group.

Table 12. Willingness to pay premium ($) for a base model (Trap question pass/Fail groups)

	Trap Pass	Trap Fail
Feed efficiency	-	-
Methane emissions reduction	-2.24***	-5.38**
Improved Fertility	-11.43***	-8.76***

Enhanced Disease resilience	-2.60***	0.065
Therapeutic use of antibiotics	-0.007	1.99
None	-2.513***	-1.427***
# of observations	40928	14560

Note: ***,**,*, Significant at 1%, 5%, and 10% level

4.2.3 Conditional logit model for a base model (Agree/Disagree on worrying about using of Tech. in breeding cows)

This part describes the base model results for two groups that agree or disagree with using technologies in breeding cows based on the conditional logit model. In the Appendix C, it is clear that the technology agree and disagree groups have different perspectives as to therapeutic use of antibiotics. The therapeutic use of antibiotics is negative and significant, indicating that respondents do not prefer the use of antibiotics relative to a baseline of no use of antibiotics. On the other hand, for the disagree group, the therapeutic use of antibiotics affects positive marginal utility because the coefficient is positive and significant.

Except for that, both of groups have the same directions in valuation for other methane emission reduction and improved fertility traits. Given the willingness to pay premium Table 12, the technology agree group has a requirement to be discounted $2.80, while the disagree group has a willingness to pay $2.96 more for the therapeutic use of antibiotics relative to the non-use of antibiotics. In that the agree group or the disagree group which have concerns about technology use in breeding cows, this result aligns with expectations because agree group wants to be compensated for higher antibiotic use, while disagree group is willing to pay positive amounts for the therapeutic antibiotics use.

Table 13. Willingness to pay premium ($) calculation for a base model (Agree/Disagree groups)

	Worry about tech.- Agree	Worry about tech.- Disagree
Feed efficiency	-	-
Methane emissions reduction	-3.96***	-1.60**
Improved Fertility	-11.92***	-10.21***
Enhanced Disease resilience	-1.25	-3.04***
Therapeutic use of antibiotics	-2.80***	2.96***
None	-1.992***	-2.445***
# of observations	29184	26304

Note: ***,**,*, Significant at 1%, 5%, and 10% level

In the case of methane emissions reduction and improved fertility, the agree group has a higher demand for compensation (larger discounts) for them to purchase the dairy products than the disagree group.

4.2.4 Conditional logit model for a latent class analysis (Whole sample)

In this part, the conditional logit model result will be summarized for a further analysis to explore heterogeneity. In other words, to check which variables may contribute to heterogeneity among survey participants' preferences, the conditional logit model with demographic variables, the certainty question and technology agree/disagree question was conducted. The interaction terms between these variables and price, genomic and antibiotic use attributes were included in the base model. The results are summarized in the Appendix D. According to the results, we concluded the certainty question, male, age, household size, and general trust variables are statistically significant, which means these five variables

could be contributing to some heterogeneity among respondents. In other words, the certainty question, male, age, household size, and general trust will be included as membership criteria representing the variables that cause heterogeneity in the following latent class analysis. Given that some other attitude responses may be endogenous to the choice decisions made by respondents, they are not included as explanatory variables but will be examined later in terms of variation across the probability that respondents fall into particular latent classes.

4.2.5 Latent Class model (Whole sample)

A latent class model is used to capture heterogeneity in participants' responses. As a latent class model assumes that respondents belong to different classes (m=1,…,M), it is critical to decide the optimal number of classes based on several guidelines. First guidelines are information criteria such as the Bayesian Information Criterion (BIC), the Akaike Information Criterion (AIC) or the Consistent Akaike Information Criterion (CAIC). The AIC is calculated as [-2(LS+KS)], where LS is the log likelihood and KS is the number of free parameters, for a model with S latent segments (Ben-Akiva and Swait, 1986). The BIC is calculated as [-2LS+KS*ln(N)] (Schwarz, 1987) and the CAIC is calculated as [-2LS+KS*(ln(N)+1)] (Bozdogan, 1987). For example, in a data analysis setting, we would compare the values of the BIC across the set of fitted models and would pick the model that has the lowest value of the BIC. That is, the model preferred by the BIC is the model with the lowest value among the set being considered (Nylund-Gibson and Young Choi, 2018). Second are two indices, one is the Bayes Factor (BF) and the other is the correct model probability (cmP). The Bayes Factor is used as a pairwise comparison of fit between two

neighboring class models (Nylund-Gibson and Young Choi, 2018). The BF represents the ratio of the probability that each model being compared is true. More specifically, 1 < BF < 3 suggests "weak" support for the model with less classes, 3 < BF < 10 suggests "moderate" support, and BF > 10 suggests "strong" support (Wagenmakers, 2007; Wasserman, 1997). The cmP provides an estimate of each model being "correct" out of all models considered, assuming that the "true" model is indeed among them, the model with the largest value is selected (Nylund-Gibson and Young Choi, 2018). When it comes to the information criteria, the 9-class model (for the whole sample with identified membership criteria) seems to be the best fit because the BIC and CAIC provide the lowest values in Table 13.

Table 14. Information Criteria for selecting the Optimal Number of Classes

Classes	LLF	AIC	CAIC	BIC
2	-15511.8	31059.59	31175.84	31157.84
3	-14806.2	29672.4	29866.15	29836.15
4	-14369.34	28822.68	29093.92	29051.92
5	-14110.87	28329.73	28678.47	28624.47
6	-13946.61	28025.21	28451.45	28385.45
7	-13768.72	27693.43	28197.17	28119.17
8	-13644.08	27469.16	28049.4	27959.4
9	-13553.63	27311.25	27969.99	27867.99
10	-13511.06	27250.11	27986.34	27872.34

We also calculated the Bayes Factor (BF) and correct model Probability (cmP) to confirm the optimal number of classes. As Table 14 shows, the 9-class model has the largest value in the cmP. Therefore, on the basis of two results, the 9-class model was selected as the best model for the latent class analysis.

Table 15. Relative Fit indices for selecting the Optimal Number of Classes

Classes		Bayes Factor	Classes	Correct Model Probability	
$\boldsymbol{BF_{2,3}}$	0.0000	The BF comparing Model	cmP_2	0.0000	We calculate a cmP for each
$\boldsymbol{BF_{3,4}}$	0.0000		cmP_3	0.0000	

$\boldsymbol{BF_{4,5}}$	0.0000	A (model K) and Model B (model K+1) is $BF_{A,B} = \exp[SIC_A - SIC_B]$ where SIC, the Schwartz Information Criterion, is defined as $SIC = -.05(BIC)$; (e.g., BF of 5 provides moderate evidence for a 3-class model compared to the 4-class model)	cmP_4	0.0000	model in a set of J models specified by the user. We compute it as follows, $cmP_A = \frac{\exp[SIC_A - SIC_{max}]}{\sum_{j=1}^{J} \exp[SIC_A - SIC_{max}]}$ Where SIC_{max} is the maximum SIC score of the J models that were considered in the given application.
$\boldsymbol{BF_{5,6}}$	0.0000		cmP_5	0.0000	
$\boldsymbol{BF_{6,7}}$	0.0000		cmP_6	0.0000	
$\boldsymbol{BF_{7,8}}$	0.0003		cmP_7	0.0000	
$\boldsymbol{BF_{8,9}}$	0.0104		cmP_8	0.0057	
$\boldsymbol{BF_{9,10}}$	1.2430		cmP_9	0.5510	
			cmP_{10}	0.4433	

Source : Nylund-Gibson and Young Choi, 2018

Considering the latent class regression results in the Appendix E, we can interpret that people in class 7 and 9 are sensitive to the price but people in class 4 don't care about the price, indicating that this group is somewhat irrational. Besides, while respondents in the conditional logit model which doesn't reflect the respondent heterogeneity relatively prefer the feed efficiency trait the most and the fertility the least, people in the latent class model have different preferences depending on classes. For instance, participants in class 2 consisting of 13.2% of respondents like the enhanced disease resilience trait relative to the feed efficiency trait but dislike the methane emissions reduction and improved fertility traits as compared to the feed efficiency trait. People in class 8 comprised of 9.2% of respondents prefer the methane emissions reduction trait compared to the feed efficiency trait and do not prefer the improved fertility and enhanced disease resilience traits relative to the feed efficiency trait. Whereas, the enhanced disease resilience is preferred compared with the feed efficiency and the methane emissions reduction and improved fertility traits are less preferred as compared to the feed efficiency for class 6 composed of 6.1% of respondents. For the class 3 group, they are indifferent among the feed efficiency, reduced methane emissions, improved fertility and enhanced disease resilience traits because all coefficients in the Appendix E are not statistically significant. When it comes to the therapeutic use of

antibiotics, respondents in class 2, 3, 4, 5, 6 dislike to therapeutic use of antibiotics relative to the baseline, no antibiotics use, on the other hand, people with a probability of being in class 1, 7, 8 like the therapeutic use antibiotics more than no use. Participants in class 3 prefer the status quo, which means "I would not purchase any of the dairy products" in that the coefficient of the corresponding group is a positive and statistically significant for the None variable in the Appendix E. This relative comparison of the willingness to pay (or discount) for the whole sample is summarized in Table 15.

Table 16. Willingness to pay (or premium/discount) for Whole sample and Trap question pass group ($)

Class	Variables	Class Share (Whole sample)	Willingness to pay $ (Whole Sample)	Class share (Trap question pass group)	Willingness to pay $ (Trap question pass group)
Class1	Feed efficiency	0.095	-	0.136	-
	Methane emissions reduction		-10.49***		9.28
	Improved Fertility		-19.41***		6.18
	Enhanced Disease resilience		4.86		27.62**
	use of antibiotics		75.99***		-3.81
Class2	Feed efficiency	0.132	-	0.138	-
	Methane emissions reduction		-5.97***		-7.78***
	Improved Fertility		-20.43***		-22.14***
	Enhanced Disease resilience		11.79***		13.92***
	use of antibiotics		-4.69**		-6.86***
Class3	Feed efficiency	0.092	-	0.124	-
	Methane emissions reduction		0.63		3.08*
	Improved Fertility		-11.32		-29.35***
	Enhanced Disease resilience		-7.04		-16.09***
	use of antibiotics		-15.27**		5.94***
Class4	Feed efficiency	0.197	-	0.051	-
	Methane emissions reduction		11.86		-29.85**
	Improved Fertility		4.22		-23.46**
	Enhanced Disease resilience		20.40**		21.51**
	use of antibiotics		13.12*		-28.57***
Class5	Feed efficiency	0.085	-	0.097	-
	Methane emissions reduction		-0.24		0.41
	Improved Fertility		-14.33***		-4.71***
	Enhanced Disease resilience		-7.19**		-1.62**
	use of antibiotics		-62.06***		1.47*
Class6	Feed efficiency	0.061	-	0.170	-
	Methane emissions reduction		-30.85*		-2.29***
	Improved Fertility		-20.91*		-3.49***
	Enhanced Disease resilience		19.69*		-0.48
	use of antibiotics		-26.34**		1.53***
Class7	Feed efficiency	0.169	-	0.104	-
	Methane emissions reduction		-2.22***		-3.92
	Improved Fertility		-3.22***		-19.87***
	Enhanced Disease resilience		-0.51		-15.96***

	use of antibiotics		1.96***		-71.79***
Class8	Feed efficiency	0.092	-	0.093	-
	Methane emissions reduction		3.56*		-9.09***
	Improved Fertility		-33.64***		-13.77***
	Enhanced Disease resilience		-20.02***		0.08
	use of antibiotics		5.81***		53.52***
Class9	Feed efficiency	0.078	-	0.085	-
	Methane emissions reduction		0.39		5.42
	Improved Fertility		-4.19***		-7.31
	Enhanced Disease resilience		-1.45**		-13.38
	use of antibiotics		1.07		-22.93

Note: ***,**,*, Significant at 1%, 5%, and 10% level

For people with a probability of being in class 1, in comparison with the feed efficiency trait, respondents require larger discounts for example, $10.49, $19.41, to purchase the products from cows with reduced methane emissions reduction and improved fertility, respectively. In the case of people with probabilities in classes 2, 4 and 6, they have willingness to pay $11.79, $20.40 and $19.69 more each for the enhanced disease resilience trait relative to the feed efficiency trait. Furthermore, respondents with a probability of being in class 8 are willing to pay $3.56 more for the methane emissions reduction trait relative to the feed efficiency trait. People with a probability of being in class 5 need prices discounted by $14.33 and $7.19 to purchase dairy products made from cows with improved fertility and enhanced disease resilience traits.

In terms of the antibiotics attribute, people with probabilities of being in class 2,3,5 and 6 need discounts, $4.69, $15.27, $62.06 and $26.34 separately to buy dairy products produced from cows with therapeutic antibiotic use. Especially people with a probability of being in class 5 dislike therapeutic use of antibiotics the most because they require the biggest discount. That is, we can explain that there is clear heterogeneity with respect to trait preferences and willingness to pay (or discount) among each group.

4.2.6 Latent Class model (Trap question Pass group)

To compare the latent class analysis results between the whole sample and trap pass group, a latent class analysis for the trap pass group was conducted with the same membership criteria variables (Certainty question, Age, Male, Household number, General Trust) and the same number of classes, 9. Given the latent class regression results in the Appendix F, we can say that people with a probability of being in class 1 are not sensitive to price, while respondents with probabilities of being in classes 5 and 6 have relatively high sensitivity to price.

Furthermore, people in class 2 like the enhanced disease resilience genomic trait relative to the feed efficiency but dislike the methane emissions reduction and improved fertility traits compared with the feed efficiency. In the case of respondents with a probability of being in class 5 which has 9.7 % portion of the sample, they have indifferent preferences between the feed efficiency and reduced methane emissions genomic traits and like enhanced disease resilience and improved fertility as compared to the feed efficiency genomic trait. People with a probability of being in class 3 like the reduced methane emission trait, while people with a probability of being in class 4 prefer the enhanced disease resilience genomic trait as compared to the feed efficiency. When it comes to the respondents with probabilities of being in classes 6 and 8, they like the methane emissions reduction and improved fertility traits less than the feed efficiency genomic trait but are indifferent between the feed efficiency and enhanced disease resilience genomic traits. People with a probability of being in class 7 like the improved fertility and enhanced disease resilience traits in comparison to the feed efficiency trait and have indifferent preferences between the reduced methane emission and feed efficiency traits. Regarding people with a probability of being in class 9,

they have the same preferences for the feed efficiency, methane emission reduction, improved fertility and enhanced disease resilience traits.

In that class 9 has a positive and significant coefficient for the N (None) variable, we can interpret that people with a probability of being in class 9 like the status quo, 'I would not purchase any of the dairy products.' more than any of the identified products. As to the therapeutic use of antibiotics, participants with probabilities of being in classes 2, 4 and 7 dislike the therapeutic use of antibiotics relative to the no use of antibiotics. However, respondents with probabilities of being in classes 5, 6 and 8 like the therapeutic use of antibiotics. If comparing these results with the whole sample results, these results seem to be different.

These differences between the whole sample and trap pass group can be described in terms of the willingness to pay (premium/ discounts). As Table 16 shows, if we see the class 2 which has a probability of being about 13.8% of the entire sample, people in this corresponding group require the dairy products to be discounted by $7.78 for the methane emissions reduction trait compared to the feed efficiency trait. Moreover, they have a willingness to pay of $13.92 more for the enhanced disease resilience trait in comparison to the feed efficiency trait. Respondents with a probability of being in class 1 of the whole sample need to be discounted $10.49, $19.41 for the methane emission reduction trait and improved fertility trait as compared to the feed efficiency. While, people with a probability of being in class 1 of the trap pass group have indifferent preferences across the feed efficiency, methane emission reduction and improved fertility traits. On the contrary, people with a probability of being in class 3 of the whole sample, they regard the feed efficiency, reduced methane emission, improved fertility and enhanced disease resilience traits with the

same preferences. However, respondents with a probability of being in class 3 of the trap question pass group have different preferences for each trait in that they have willingness to pay $3.08 more for the methane emissions reduction trait relative to the feed efficiency trait and need to have discounts of $29.35 and $16.09 respectively to buy dairy products produced from cows with improved fertility and enhanced disease resilience traits. People with a probability of being in class 4 of the trap question pass group need to have discounts of $29.85 and $23.46 each to purchase the dairy products from cows with the methane emissions reduction and improved fertility traits, while people with a probability of being in class 4 of the whole sample have no preferences among the feed efficiency, reduced methane emission and improved fertility traits. Concerning people with a probability of being in class 5 of both the whole sample and trap pass group, they have indifference preferences between the feed efficiency and methane emissions reduction trait, but need to be discounted for the improved fertility and enhanced disease resilience traits as compared to the feed efficiency trait. People with a probability of being in class 6 of the trap question pass group want discounts of $2.29 and $3.49 separately to consume the dairy products from cows with reduced methane emissions and improved fertility traits. People with a probability of being in class 7 of the trap question pass group show the similar pattern to genomic traits such as class 5 of the trap question pass group. They require $19.87 and $15.96 price discounts each to purchase the dairy items produced from cows with improved fertility and enhanced disease resilience traits. Similarly, people with a probability of being in class 8 consisting 9.3% of the trap pass group need to get discounts of $9.09, $13.77 individually for the methane emissions reduction and improved fertility traits. As to the therapeutic antibiotics use, people with probabilities in classes 2, 4 and 7 of the trap question pass group do not like

the therapeutic use of antibiotics, indicating they need to be discounted of $6.86, $28.57 and $71.79 to buy the dairy products made from cows with the therapeutic use of antibiotics. On the other hand, respondents with probabilities in classes 3, 5, 6, and 8 are willing to pay $5.94, $1.47, $1.53 and $53.52 per week more when purchasing the dairy products from cows with the therapeutic use of antibiotics trait than the dairy product without antibiotics. As a reference, we also conducted a latent class model with four membership criteria variables (Certainty question, Age, Male, General Trust) since these four interaction terms with main attributes are statistically significant in the conditional logit model. Besides, on the basis of cmP which is one of the criteria to choose the optimal number of classes, 10 classes were picked as the optimal number of the classes for the trap pass group. These regression results and willingness to pay (or premiums /discounts) are explained in Appendix G and Appendix H.

4.2.7 Descriptive statistics comparison for other explanatory variables across 9 classes (Whole Sample)

In the previous section, we found that there were 9 groups with heterogeneous preferences in the whole sample using latent class modeling. However, beyond the variables used in determining the latent classes, we do not know if there are any other unique characteristics on the basis of attitudes, knowledge or beliefs associated with class membership. In Chapter 2, we presented many other variables which have been shown to be related to individual's preferences for different livestock products. In this section, we will look at the values of those variables for each of the 9 classes in our latent classes to identify descriptively if there are differences across groups. The descriptive statistics for the attitudes which were not

included in the regression analysis (due to potential endogeneity with choices) such as views on technology, animal attitudes, moral foundations, environmental attitudes as well as demographic characteristics are summarized to compare and identify significant differences across the 9 latent class groups. To identify who is in which class across 9 groups, we calculated each person's posterior probabilities of being in 9 different classes. Then, we sorted out the maximum probabilities out of 9 probabilities for each person to figure out which class a person is most likely to be in.

The results in Table 17 show that people with probabilities of being in classes 3, 5 and 8 have nature perverse/tolerant myths of nature beliefs the most, while respondents in the rest of the groups have nature ephemeral beliefs towards nature the most. When it comes to the environmental self-assessed knowledge, people with a probability of being in class 8 have the highest average score, which aligns with the regression results since we found they prefer the methane emissions reduction trait the most among four main attributes. Moreover, this group has the highest average rate of general trust in people. Concerning the animal attitude score, moral foundation 1 (Harm/Care) and moral foundation 2 (Fair/Reciprocity) variables, there are no distinguishable variations across the 9 classes. On the other hand, respondents have diverse beliefs pertaining to the animal husbandry assessment. Respondents with a probability of being in class 3 have the lowest average score, 6.98 in the animal husbandry assessment and they prefer the status quo, 'I would not purchase any of the dairy products' option, while people with probabilities of being in classes 1 and 4 have the highest ones, 11.3 and 11.8 respectively and they do not prefer the reduced methane emission trait relative to the feed efficiency.

Also, people with probabilities of being in classes 1, 7 and 8 who prefer the therapeutic use

of antibiotics in the regression analysis have comparatively a higher average score for a variable representing views on science and technology. The bigger number for this variable means people's affirmative perspective on the science and technology, 'the world is a lot better off because science and technology.' Generally, respondents that have more trust in universities and research organizations compared to in government, food industry or advocacy groups. Furthermore, in terms of the general trust variable, there are distinguishable differences across 9 groups. People with probabilities of being in classes 4 and 6 have lower general trust towards people and they have a tendency to prefer the enhanced disease resilience trait than the improved fertility and reduced methane emission traits. Respondents with a probability of being in class 8 have the highest score for views on science and technology meaning they think the world is better off because of science and technology. At the same time, they have highest score for familiarity with genomics and high score for science and technology development. These people who are favor and knowledgeable about science and technology show that they like the methane emissions reduction trait the most. In terms of the demographic variables, the rate of female is higher in class 2 and 3 than the rest of groups. Especially people with a probability of being in class 2 prefer the enhanced disease resilience trait the most. Besides, there are variations about the number of children under age 18 years live in the household by classes. Respondent with a probability of being in classes 4 and 6 have the higher rate of having children under 18 and they like the enhanced disease resilience trait the most. The rate of living in urban area is low for class 1 and high for class 8 and 9. The classes 8 and 9 which have the highest rate of urban people show that people in these corresponding groups do not prefer the improved fertility and enhanced disease resilience traits.

Table 17. Descriptive statistics for 9 classes (Whole sample)

	Latent class model								
	Class1	Class2	Class3	Class4	Class5	Class6	Class7	Class8	Class9
No. of Observations	166	215	162	342	153	98	313	156	137
Demographic variables					*Frequency (%)*				
Male	54.2	36.3	33.3	64.3	46.4	43.8	54.6	55.7	43.0
Children aged < 18 years live in the household	15.7	7.96	12.9	23.6	12.4	24.4	14.3	21.7	13.8
Live in an urban area	74.7	89.3	88.8	88.8	86.9	82.6	84.9	91.6	91.9
Education									
Elementary school	2.41	0.47	0.62	1.17	0.65	0.00	0.96	1.28	0.00
Secondary (high) school	18.7	15.4	19.1	15.2	9.80	23.5	15.0	6.41	8.76
Technical/business school/community college	27.7	27.4	27.1	28.1	23.5	31.6	31.3	21.2	30.7
University	31.9	42.3	34.6	44.2	44.4	32.7	35.8	49.4	44.5
Post graduate studies (Masters or PhD)	19.3	14.4	18.5	11.4	21.6	12.2	16.9	21.8	16.1
					Mean(SD)				
Age (years)	54.5(13.2)	54.7(12.5)	43.6(13.7)	46.9(15.4)	49.6(14.2)	48.1(14.3)	49.9(15.0)	46.8(15.3)	45.8(14.9)
Household income ($1,000.00)	79.2(31.9)	77.9(32.3)	71.3(32.2)	78.0(32.4)	82.2(30.0)	75.9(32.4)	81.4(33.2)	88.5(30.5)	72.4(31.8)
Household size	2.37(1.07)	2.13(0.94)	2.06(1.10)	2.51(1.14)	2.25(1.05)	2.45(1.10)	2.27(1.07)	2.60(1.08)	2.06(0.88)
Other variables					*Frequency (%)*				
Generalized trust in people (0. can't be careful in dealing with people/don't know 1. most people can be trusted)[3]	53.6	47.9	24.6	29.2	49.0	32.6	42.4	57.6	46.7
Myth of nature 1: nature ephemeral (dummy)	54.2	50.7	46.3	49.4	44.4	54.1	50.5	42.3	48.9
Myth of nature2: nature perverse/tolerant (dummy)	39.2	46.5	47.5	46.5	51.6	38.8	44.7	50.6	47.4
Myth of nature 3: nature benign (dummy)	3.61	1.86	4.32	3.22	3.27	6.12	3.19	7.05	2.19
Myths of nature 4: nature capricious (dummy)	3.01	1.40	1.85	0.88	0.65	1.02	1.60	0.00	1.46
					Mean(SD)				
Trust in universities/research organization (1-5)	3.60(0.85)	3.53(0.86)	3.10(0.98)	3.37(0.91)	3.50(0.92)	3.19(0.93)	3.59(0.90)	3.71(0.76)	3.48(0.91)
Trust in government (1-5)	3.33(0.97)	3.17(0.90)	2.73(0.99)	3.11(0.93)	2.95(0.92)	2.91(0.95)	3.35(0.88)	3.37(0.84)	3.21(0.94)
Trust in the food industry (1-5)	3.11(0.71)	2.89(0.75)	2.57(0.80)	2.94(0.76)	2.66(0.73)	2.71(0.71)	3.07(0.71)	2.87(0.66)	2.84(0.72)
Trust in advocacy groups (1-5)	2.84(0.88)	2.97(0.81)	2.87(0.89)	2.92(0.85)	2.97(0.79)	2.90(0.70)	2.80(0.86)	3.01(0.75)	2.75(0.85)
Animal attitude scale (1-30)	20.4(3.45)	21.1(3.62)	22.3(4.52)	19.9(3.78)	21.2(4.02)	21.0(3.93)	19.5(3.74)	20.5(3.57)	19.6(3.99)
Animal husbandry scale (0-25)	11.3(7.44)	10.4(7.56)	6.98(7.50)	11.8(7.27)	9.91(7.51)	8.29(7.28)	9.58(7.71)	9.96(7.35)	7.83(7.14)
Environmental self-assessed knowledge (1-10)	5.76(2.06)	5.56(2.16)	5.24(2.33)	5.82(2.20)	6.02(2.19)	5.16(2.28)	5.55(2.06)	6.47(1.90)	5.58(2.32)
Moral foundation 1: Harm/care (1-18)	13.0(2.69)	12.6(3.38)	12.1(3.62)	12.0(2.76)	12.7(2.88)	12.3(3.52)	12.3(2.99)	12.6(3.16)	12.4(2.69)
Moral foundation 2: Fair/reciprocity (1-18)	13.5(2.90)	13.0(3.40)	12.4(3.70)	12.4(3.08)	13.3(2.95)	12.7(3.77)	12.6(3.30)	13.4(3.26)	13.0(2.81)
Knowledge on science and technical development (1-10)	5.27(2.33)	4.94(2.30)	4.83(2.38)	5.57(2.351)	5.33(2.25)	4.74(2.34)	5.13(2.32)	5.56(2.17)	5.12(2.41)
Views on science and technology (1-10)	7.17(2.02)	6.94(1.96)	6.02(2.20)	6.88(1.99)	6.92(2.14)	6.40(2.08)	7.37(1.91)	7.85(1.87)	7.23(1.85)

[3] Frequency for generalized trust is calculated by taking into account option 1(most people can be trusted).

Familiarity with genomics (1-6)	1.85(0.84)	1.79(0.81)	1.63(0.78)	1.93(0.86)	1.94(0.80)	1.61(0.78)	1.83(0.88)	2.04(0.84)	1.82(0.84)
NHIP[4]	0.05(0.79)	0.06(0.93)	-0.18(1.06)	-0.25(0.94)	0.29(0.84)	-0.19(0.91)	0.07(0.87)	-0.18(1.06)	-0.02(0.92)
Health consciousness[5]	0.06(0.81)	0.11(0.91)	-0.07(1.08)	-0.19(1.05)	0.22(0.87)	-0.12(1.13)	0.03(0.91)	0.34(0.87)	-0.06(0.83)

4 Factor score average
5 Factor score average

4.3 Summary

In this chapter, we discussed the regression and willingness to pay (or premium/discount) of both conditional and latent class models. Given all the results of the conditional logit models, whole sample, trap question pass and worry about technology agree/disagree groups, we can say that the feed efficiency trait is preferred the most whereas, the improved fertility trait is preferred the least on the basis of the willingness to pay results. For the latent class models, we can conclude that there is obvious respondent heterogeneity across 9 classes which were chosen by the information criteria for the optimal number of classes. Unlike the conditional logit models, large portion of the people with a probability of being in a specific class of the latent class model like the enhanced disease resilience trait the most. Concerning the therapeutic use of antibiotics, around half of people in the latent class model do not prefer the therapeutic use of antibiotics relative to non-use of antibiotics, indicating they need to be compensated for the therapeutic use of antibiotics. In case of the other explanatory variables which were not included in the regression because of endogeneity issue with choices, by the descriptive statistics, we can notice that there is a relationship between environmental self-assessed knowledge, views towards science and technology and reduced methane emission trait. The higher average score on environmental self-assessed knowledge, the higher preference on the methane emission reduction trait. Besides, there was a tendency of which people who are in favor of and knowledgeable about science and technology like the methane emission reduction trait the most.

Moreover, the higher average score on the views toward science and technology, the more preference on therapeutic use of antibiotics. On the other hand, the lower average score about general trust towards people, the more preference on enhanced disease resilience trait.

When it comes to the socio-demographic variables, people in the groups having large portion of female and higher rate of having children under 18 prefer the enhanced disease resilience trait the most. More detailed interpretation about regression and willingness to pay (or premium/discount) will be done in Chapter 5.

Chapter 5: Conclusion

5.1. Introduction

This study provides Canadian public preferences for the use of genomic selection in breeding dairy cows for particular traits. We identified Canadian people's preferences for four selective breeding traits- feed efficiency, methane emission reduction, enhanced disease resilience and improved cow fertility as well as preferences for the use of antibiotics in production through conditional logit and latent class models for the whole sample and other sorted groups. Furthermore, to understand and compare the characteristics of individuals who more or less like one or more traits, descriptive statistics comparison pertaining to the variables such as beliefs about technology, trust and animal attitudes as well as demographic characteristics etc. was also employed. Therefore, this chapter will suggest effective guidelines that dairy farmers are able to adopt as the better options which can lead to positive influences on animals, environment and themselves based on the elicited people's willingness to pay (premium/discount).

5.2. Conclusions and Implications

On the basis of the empirical results, we draw the conclusion that the feed efficiency trait is preferred the most and the improved fertility is preferred the least in the conditional logit model for the whole sample, trap question pass group and both technology agree/disagree groups. However, in the latent class models which can reflect respondents' heterogeneity, respondents were divided into 9 groups. People with probabilities of being in classes 2,4 and

6 (whole sample) or 1,2 and 4 (trap question pass group) who consist of 39%, 32.5% of survey respondents without considering indifferent preferences with other traits respectively like the enhanced disease resilience trait the most. Besides, as these people from the whole sample have relatively higher average scores for the animal husbandry scale, it seems that attitudes about satisfaction with current animal husbandry may the choice of the enhanced disease resilience trait. With respect to the respondents with a probability of being in class 8 (whole sample) and class 3 (trap question pass group) who are comprised of 9.2%, 12.4% of the entire sample, they prefer the methane emissions reduction trait the most and have the highest rate of nature preserve/tolerant beliefs from the myths of nature environmental scale and highest rate of general trust in people. The nature preserve/tolerant concept represents the belief that resources are scarce, so regulations and controls are needed as a management strategy for nature. From this point, it is likely that myths of nature beliefs and general trust in people play a role for people to select the methane emissions trait. Seeing that the coefficients for the main genomic traits are not statistically significant in the regression estimates in the Appendix E, we can know that people with probabilities of being in classes 3 (whole sample) and 9 (trap question pass group) are indifferent to the genomic traits when purchasing dairy products. One commonality between the conditional logit and latent class models, the improved fertility trait is preferred the least in all estimates.

Assuming the sample is representative of the general population, the market share for dairy products produced with genomic selective breeding for each of the four traits can be calculated. That is, we can extrapolate the market share from the regression results showing what percentage of the sample prefers each trait to the population in terms of purchasing dairy products. Given the summary in Table 19 and Table 20, the whole sample and trap

question pass group's results from the latent class models are picked to deduce the market share because these contain the heterogeneity across respondents. Therefore, it can be inferred that there are around 67.3~74.6% largest predicted shares about the dairy products produced from cows with the enhanced disease resilience trait if taking into account the indifferent preferences with other traits. For example, people with probabilities of being in class 2 (13.2%)[6], 4 (19.7%) and 6 (6.1%) of the whole sample prefer the enhanced disease resilience trait relative to the base case, feed efficiency. People with probabilities of being class 1 (9.5%) and 7 (16.9%) of the whole sample have indifferent preferences between the enhanced disease resilience and feed efficiency and people with a probability of being class 3 (9.3%) of the whole sample have indifferent preferences across four genomic traits. In short, if summing these class shares, it can be expected the market share for the enhanced disease resilience trait of the whole sample.

With the same approach, there is around 51.9~54.9% predicted market shares for the dairy products made from cows bred with the feed efficiency trait given indifferent preference with other traits. For instance, people with probabilities of being in class 1 (9.5%)[7] and 7 (16.9%) of the whole sample have indifferent preferences between the feed efficiency and enhanced disease resilience. People with probabilities of being in class 5 (8.5%) and 9 (7.8%) of the whole sample have prefer indifferently between the feed efficiency and methane emission reduction and people with a probability of being in class 3 (9.2%) of the whole sample prefer indifferently across four genomic traits. Provided summing these class shares, it is the expected market share for the feed efficiency trait of the whole sample. To sum up, in the whole sample, the feed efficiency and enhanced disease resilience are

[6] The numbers in brackets mean class shares for each class
[7] The numbers in brackets mean class shares for each class

preferred the same in class 1, 3 and 7 and the feed efficiency and methane emission reduction are indifferent in class 5 and 9. This is the reason why the total expected market shares is beyond 100 percent because we considered these indifferent preferences as well. For example, the class 1' share 9.5% was included in both the feed efficiency and enhanced disease resilience traits share calculations. Moreover, the enhanced disease resilience is preferred to the feed efficiency in class 2, 4 and 6 and the methane emissions reduction is preferred to the feed efficiency in class 8.

Also, there is about 34.7~41 % market demand for the dairy products which have the methane emission reduction trait.

Table 18. Preference Order of conditional logit models

Model	Group	Preference Order			
Conditional logit model	**Whole sample**	1.Feed efficiency	2.Enhanced disease resilience	3.Methane emissions reduction	4.Improved fertility
	Trap question pass group	1.Feed efficiency	2.Methane emissions reduction	3.Enhanced disease resilience	4.Improved fertility
	Worry about technology-Agree	1.Feed efficiency = Enhanced disease resilience		3.Methane emissions reduction	4.Improved fertility
	Worry about technology-Disagree	1.Feed efficiency	2.Methene emissions reduction	3.Enhance disease resilience	4.Improved fertility

Table 19. Expected Market demand (%) for each four genomic traits (Indifferent preferences are considered)

Genomic traits	Whole sample	Trap question pass group
Feed efficiency	51.9	54.9
Methane emissions reduction	34.7	41
Improved Fertility	9.2	8.5
Enhanced Disease resilience	74.6 (54.9)	67.3 (53.7)

Note: The brackets mean Class 4 (Whole sample), Class 1 (Trap question pass group) which showed irrational price responses were excluded respectively
Because of indifferent preference across traits, the total is beyond 100 %

Last but not least, considering all results that we have garnered, it is recommended that dairy product farmers focus on the enhanced disease resilience and feed efficiency traits more to appeal to consumers since customers have a great interest in those traits when buying the items. As to the therapeutic use of antibiotics, around half of the people who are 48.4% in the trap question pass group and 55.3% in the whole sample of the latent class models like therapeutic antibiotics use as compared to no use of antibiotics. Also, 50.5%[8] people of the whole sample who prefer the enhanced disease resilience trait the most like the therapeutic use of antibiotics. This result gives insight, which is that the farmers need to choose enhanced disease resilience and therapeutic antibiotics use breeding options to target the largest market demand in terms of the dairy products sales. However, in case of the trap question pass group, 58.2%[9] of people who like the enhanced disease resilience attribute the most do not like the therapeutic use of

[8] 50.7% was calculated as follow: 39(the class 4 share which like the use of antibiotics and at the same time, like the enhanced disease resilience trait the most) was divided by 39(sum of the class 2,4,6 shares which like the enhanced disease resilience trait the most)

[9] 58.2% was calculated as follow: (sum of the class 2 and 4 shares which like the use of antibiotics and simultaneously, like the enhanced disease resilience trait the most) was divided by 32.5(sum of the class 1,2 and 4 shares which like the enhanced disease resilience trait the most)

antibiotics and 41.8% do not care about the antibiotics use.

In conclusion, this research suggests for Canadian dairy products farmers need to choose and concentrate on two genomic traits, enhanced disease resilience and feed efficiency when breeding cows. This approach can entice more customers to increase dairy products purchases and ultimately, cause benefits to animals and environment as well. Other traits such as increased fertility may be important for farm profits and animal welfare but may not need to be the focus of consumer marketing since they are not preferred by consumers. Possibly more education with respect to the issues around certain traits could improve the public perception about the importance of the traits. When it comes to the therapeutic use of antibiotics, it is controversial based on this research results because there are almost half and half people regarding the antibiotic use preference. Since around half of the customers are concerned about the use of antibiotics and, simultaneously, public health crisis arising from antibiotic resistant bacteria is arising (World Health Organization, 2017), farmers should approach carefully and transparently the therapeutic use of antibiotics.

Table 20. Preference and Preference rate for the therapeutic use of antibiotics

Model	Group	Preference for the therapeutic use of Antibiotics(Prefer/Non-prefer/Don't care)
Conditional logit model	**Whole sample**	Don't care
	Trap question pass group	Don't care
	Worry about technology-Agree	Non-prefer
	Worry about technology-Disagree	Prefer
		Preference rate about the therapeutic use of

		Antibiotics(%)
Latent class model	**Whole sample**	55.3
	Trap question pass group	48.4

Note: Don't care means the coefficient of the therapeutic use of antibiotics is not statistically significant.

5.3. Limitations

As mentioned in the previous chapter, one of the online survey's negative parts is to use maintained panels of respondents. Since this research used the maintained panel, it might for respondents of this survey not to say the authentic answers despite of efforts such as trap question or reasons for choosing options etc. which can alleviate the ambiguity and biased answer issues. Therefore, the further study can complement this part by using non-maintained panels to get more consequentiality. Furthermore, the future research can cover the antibiotic trait more deeply in terms of consumer marketing since almost half and half respondents on the basis of this study have different perspective on the use of antibiotics. For instance, we have limited understanding with regard to other factors on which people choose use or non-use of antibiotics traits. Exploring this issue will fill the gap and shed light on research of this field both relevant in theory and practice.

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Appendix A: Estimates of Conditional logit for a Base model

	Drop Feed efficiency		Drop Methane emissions reduction		Drop Improved Fertility		Drop Enhanced Disease resilience	
	Coefficient	**SE**	**Coefficient**	**SE**	**Coefficient**	**SE**	**Coefficient**	**SE**
Price	-0.54***	0.001	-0.54***	0.001	-0.54***	0.001	-0.54***	0.001
Feed efficiency	-	-	0.14***	0.031	0.59***	0.033	0.12***	0.032
Methane emissions reduction	-0.14***	0.031	-	-	0.45***	0.033	-0.03	0.031
Improved Fertility	-0.59***	0.033	-0.45***	0.033	-	-	-0.47***	0.033
Enhanced Disease resilience	-0.12***	0.032	0.03	0.031	0.47***	0.033	-	-
therapeutic Use of antibiotics	0.02	0.023	0.02	0.023	0.02	0.023	0.02	0.023
None	-2.20***	0.048	-2.06***	0.049	-1.61***	0.049	-2.08***	0.049

Model Statistics	
Log-likelihood	-17850.585
Pseudo R-squared	0.0718
# of Observations	55488

Note : *,**,*, Significant at 1%, 5%, and 10% level**

Appendix B: Estimates of Conditional logit for a base model (Trap question Pass/Fail)

	Trap question success group		Trap question fail group	
	Coefficient	**SE**	**Coefficient**	**SE**
Price	-0.064***	0.002	-0.030***	0.002
Feed efficiency	-	-	-	-
Methane emissions reduction	-0.143***	0.037	-0.161***	0.061
Improved Fertility	-0.729***	0.039	-0.262***	0.061
Enhanced Disease resilience	-0.165***	0.038	0.002	0.061
therapeutic use of antibiotics	-0.000	0.027	0.059	0.044
None	-2.513***	0.057	-1.427***	0.09
Model Statistics				
Log-likelihood	-12885.357		-4874.0883	
Pseudo R-squared	0.0916		0.0341	
# of Observations	40928		14560	

Note : ***,**,*, Significant at 1%, 5%, and 10% level

Appendix C: Estimates of Conditional logit for a base model (Agree/Disagree on worrying about Tech. use in breeding cows)

	Worry about technology- Agree		Worry about technology- Disagree	
	Coefficient	**SE**	**Coefficient**	**SE**
Price	-0.046***	0.002	-0.063***	0.002
Feed efficiency	-	-	-	-
Methane emissions reduction	-0.184***	0.043	-0.101**	0.0457
Improved Fertility	-0.554***	0.045	-0.64***	0.0477
Enhanced Disease resilience	-0.058	0.043	-0.19***	0.048
therapeutic use of antibiotics	-0.13***	0.032	0.186***	0.034
None	-1.992***	0.065	-2.445***	0.071
Model Statistics				
Log-likelihood	-9545.5884		-8247.2507	
Pseudo R-squared	0.0562		0.0953	
# of Observations	29184		26304	

Note : ***,**,*, Significant at 1%, 5%, and 10% level

Appendix D : Estimated of Conditional logit model with Interaction terms (Whole sample)

Variables	Coefficients	Std. Err.	z	P>z	[95% Conf.	Interval]
Price	-0.0525***	0.0015	-34.96	0	-0.05545	-0.04956
2.Methane emissions reduction	-1.344***	0.3427	-3.92	0	-2.01557	-0.67234
3.Improved Fertility 3	-0.801*	0.3638	-2.2	0.028	-1.51428	-0.08837
4.Enhanced Disease resilience	-0.776*	0.3478	-2.23	0.026	-1.45817	-0.09463
therapeutic use of antibiotics	-0.480	0.2654	-1.81	0.07	-1.00052	0.039893
None	-2.296***	0.0550	-41.75	0	-2.40399	-2.18839
Interaction Age2	-0.000276	0.0023	-0.12	0.905	-0.0048	0.004245
Interaction Age3	0.00422	0.0025	1.69	0.092	-0.00069	0.009134
Interaction Age4	0.0123***	0.0024	5.16	0	0.007659	0.017039
Interaction AgeAntib	0.00619***	0.0018	3.41	0.001	0.002628	0.009756
Interaction GeneralTrust2	0.203**	0.0653	3.11	0.002	0.075398	0.331519
Interaction GeneralTrust3	0.0331	0.0699	0.47	0.636	-0.10398	0.170104
Interaction GeneralTrust4	-0.0488	0.0674	-0.66	0.506	-0.17681	0.087248
Interaction GeneralTrustAntib	0.308***	0.0509	6.05	0	0.20812	0.407793
Interaction Worrying about Tech. question2	0.0701	0.0632	1.1	0.27	-0.05439	0.194603
Interaction Worrying about Tech. question3	-0.0430	0.0677	-0.64	0.525	-0.17573	0.08965
Interaction Worrying about Tech. question4	-0.102	0.0646	-1.58	0.114	-0.22872	0.02452
Interaction Worrying about Tech. questionAntib	0.405***	0.0492	8.22	0	0.308275	0.501286
Interaction Certainty question 2	-0.0765	0.0439	-1.74	0.081	-0.16264	0.009569
Interaction Certainty question 3	-0.128**	0.0467	-2.73	0.006	-0.21943	-0.0362
Interaction Certainty question 4	-0.0637	0.0450	-1.42	0.157	-0.15183	0.024501
Interaction CertaintyAntib	-0.144***	0.0343	-4.19	0	-0.21127	-0.07671
Interaction Eduyear2	0.0498**	0.0166	3	0.003	0.01725	0.082261
Interaction Eduyear3	0.00117	0.0175	0.07	0.947	-0.03311	0.035446
Interaction Eduyear4	0.00796	0.0170	0.47	0.638	-0.02521	0.041129
Interaction EduyearAntib	-0.0195	0.0129	-1.51	0.13	-0.04479	0.005747
Interaction Children2	-0.140*	0.0580	-2.42	0.016	-0.25426	-0.02662
Interaction Children3	-0.0138	0.0614	-0.22	0.822	-0.13413	0.106517
Interaction Children4	-0.0433	0.0604	-0.72	0.473	-0.16167	0.074985
Interaction ChildrenAntib	-0.0117	0.0455	-0.26	0.797	-0.10089	0.077533
Interaction Male2	0.242***	0.0638	3.8	0	0.117384	0.367511
Interaction Male3	0.366***	0.0690	5.31	0	0.230906	0.501253
Interaction Male 4	0.131*	0.0652	2	0.045	0.002822	0.258269
Inteactionr MaleAntib	0.162**	0.0496	3.27	0.001	0.065177	0.259632

Interaction Income2	0.000000702	0.000000104	0.67	0.501	-1.34E-06	2.75E-06
Interaction Income3	-0.000000971	0.000000110	-0.88	0.379	-3.13E-06	1.19E-06
Interaction Income4	0.000000609	0.000000105	0.58	0.563	-1.45E-06	2.67E-06
Interaction Income2	0.000000868	0.000000807	1.08	0.282	-7.14E-07	2.45E-06
Interaction Householdno.2	0.118**	0.0450	2.63	0.009	0.030157	0.206556
Interaction Householdno.3	0.0875	0.0479	1.83	0.068	-0.00641	0.181428
Interaction Householdno.4	0.0579	0.0466	1.24	0.214	-0.03338	0.149249
Interaction Householdno.Antib	0.00197	0.0353	0.06	0.956	-0.06731	0.071252
Log likelihood			-13782.823			
Pseudo R-squared			0.0882			
# of observations[10]			43616			

Note: * p < 0.05, ** p < 0.01, *** p < 0.001

[10] Because of the missing data for two variables (Children under 18 and Male), the number of observations for the interaction term analysis is 43616.

Appendix E: Estimates of Latent Class model (Whole Sample)

	Variables	Coefficient	SE	z	P>|z|	[95% Conf. Interval]	
Class1	Price	-0.04419	0.009713	-4.55	0	-0.06323	-0.02515
	Methane emissions reduction	-0.46364	0.167854	-2.76	0.006	-0.79262	-0.13465
	Improved Fertility	-0.85793	0.166715	-5.15	0	-1.18468	-0.53117
	Enhanced Disease resilience	0.214667	0.209716	1.02	0.306	-0.19637	0.625704
	therapeutic use of antibiotics	3.357826	0.233353	14.39	0	2.900463	3.815189
	None	-1.30271	0.375036	-3.47	0.001	-2.03777	-0.56765
Class2	Price	-0.06779	0.009238	-7.34	0	-0.0859	-0.04969
	Methane emissions reduction	-0.40492	0.142169	-2.85	0.004	-0.68356	-0.12627
	Improved Fertility	-1.38528	0.25108	-5.52	0	-1.87739	-0.89317
	Enhanced Disease resilience	0.799373	0.151636	5.27	0	0.502172	1.096575
	therapeutic use of antibiotics	-0.31827	0.142509	-2.23	0.026	-0.59759	-0.03896
	None	-6.20424	0.632873	-9.8	0	-7.44465	-4.96383
Class3	Price	-0.10573	0.031796	-3.33	0.001	-0.16805	-0.04341
	Methane emissions reduction	0.066533	0.515547	0.13	0.897	-0.94392	1.076987
	Improved Fertility	-1.19724	0.778053	-1.54	0.124	-2.72219	0.327719
	Enhanced Disease resilience	-0.74429	0.654938	-1.14	0.256	-2.02794	0.539368
	therapeutic use of antibiotics	-1.61404	0.626642	-2.58	0.01	-2.84224	-0.38584
	None	1.403466	0.79109	1.77	0.076	-0.14704	2.953974
Class4	Price	0.012189	0.004296	2.84	0.005	0.003769	0.020609
	Methane emissions reduction	-0.14458	0.081107	-1.78	0.075	-0.30354	0.014391
	Improved Fertility	-0.05147	0.087075	-0.59	0.554	-0.22213	0.119198
	Enhanced Disease resilience	-0.24864	0.098264	-2.53	0.011	-0.44124	-0.05605
	therapeutic use of antibiotics	-0.15997	0.077102	-2.07	0.038	-0.31109	-0.00886
	None	-2.36519	0.360249	-6.57	0	-3.07126	-1.65911
Class5	Price	-0.0638	0.01052	-6.06	0	-0.08441	-0.04318
	Methane emissions reduction	-0.01533	0.168269	-0.09	0.927	-0.34513	0.314475
	Improved Fertility	-0.91439	0.192231	-4.76	0	-1.29116	-0.53763
	Enhanced Disease resilience	-0.45863	0.20126	-2.28	0.023	-0.85309	-0.06417
	therapeutic use of antibiotics	-3.95909	0.264259	-14.98	0	-4.47702	-3.44115
	None	-5.28496	0.394109	-13.41	0	-6.05739	-4.51252
Class6	Price	-0.02347	0.009955	-2.36	0.018	-0.04298	-0.00396

	Methane emissions reduction	-0.72393	0.240565	-3.01	0.003	-1.19543	-0.25243
	Improved Fertility	-0.49068	0.216584	-2.27	0.023	-0.91518	-0.06619
	Enhanced Disease resilience	0.462059	0.186959	2.47	0.013	0.095625	0.828492
	therapeutic use of antibiotics	-0.61818	0.210276	-2.94	0.003	-1.03032	-0.20605
	None	-0.28206	0.327298	-0.86	0.389	-0.92355	0.359431
Class7	Price	-0.26998	0.017695	-15.26	0	-0.30466	-0.2353
	Methane emissions reduction	-0.59854	0.12892	-4.64	0	-0.85122	-0.34587
	Improved Fertility	-0.86977	0.136274	-6.38	0	-1.13686	-0.60267
	Enhanced Disease resilience	-0.13716	0.151511	-0.91	0.365	-0.43411	0.1598
	therapeutic use of antibiotics	0.530391	0.122342	4.34	0	0.290605	0.770177
	None	-11.4112	0.74683	-15.28	0	-12.875	-9.94748
Class8	Price	-0.09365	0.010181	-9.2	0	-0.11361	-0.0737
	Methane emissions reduction	0.333322	0.182515	1.83	0.068	-0.0244	0.691044
	Improved Fertility	-3.15043	0.536909	-5.87	0	-4.20275	-2.09811
	Enhanced Disease resilience	-1.87506	0.338573	-5.54	0	-2.53865	-1.21147
	therapeutic use of antibiotics	0.543827	0.18122	3	0.003	0.188642	0.899011
	None	-6.53547	0.650275	-10.05	0	-7.80999	-5.26096
Class9	Price	-0.29733	0.023355	-12.73	0	-0.3431	-0.25155
	Methane emissions reduction	0.116442	0.208342	0.56	0.576	-0.2919	0.524785
	Improved Fertility	-1.24538	0.199451	-6.24	0	-1.6363	-0.85446
	Enhanced Disease resilience	-0.43166	0.213407	-2.02	0.043	-0.84993	-0.01339
	therapeutic use of antibiotics	0.318601	0.25464	1.25	0.211	-0.18048	0.817686
	None	-6.88878	0.627578	-10.98	0	-8.11881	-5.65875
Share1	Certainty	0.179976	0.186007	0.97	0.333	-0.18459	0.544544
	Age	0.048136	0.01115	4.32	0	0.026282	0.06999
	Male	0.225876	0.272573	0.83	0.407	-0.30836	0.760108
	Household number	0.504024	0.143509	3.51	0	0.222751	0.785297
	General Trust	0.067978	0.278854	0.24	0.807	-0.47857	0.614522
	_cons	-3.96522	0.844734	-4.69	0	-5.62087	-2.30957

Share2	Certainty	0.051936	0.182435	0.28	0.776	-0.30563	0.409501
	Age	0.042521	0.01094	3.89	0	0.021079	0.063964
	Male	-0.31706	0.299863	-1.06	0.29	-0.90478	0.270659
	Household number	0.294613	0.150548	1.96	0.05	-0.00045	0.589681
	General Trust	-0.21335	0.281907	-0.76	0.449	-0.76588	0.339174
	_cons	-2.11708	0.862167	-2.46	0.014	-3.8069	-0.42727
Share3	Certainty	0.622225	0.175009	3.56	0	0.279215	0.965236
	Age	-0.00414	0.008486	-0.49	0.626	-0.02077	0.012493
	Male	-0.46218	0.261997	-1.76	0.078	-0.97569	0.051321
	Household number	0.003425	0.137721	0.02	0.98	-0.2665	0.273354
	General Trust	-0.96416	0.275632	-3.5	0	-1.50439	-0.42393
	_cons	-0.8115	0.690203	-1.18	0.24	-2.16428	0.541271
Share4	Certainty	0.19578	0.161334	1.21	0.225	-0.12043	0.51199
	Age	0.014947	0.008233	1.82	0.069	-0.00119	0.031083
	Male	0.720395	0.242615	2.97	0.003	0.244879	1.195911
	Household number	0.490739	0.123616	3.97	0	0.248457	0.733022
	General Trust	-0.72663	0.250514	-2.9	0.004	-1.21763	-0.23563
	_cons	-1.49242	0.669006	-2.23	0.026	-2.80364	-0.18119
Share5	Certainty	0.41458	0.185734	2.23	0.026	0.050548	0.778612
	Age	0.018492	0.009204	2.01	0.045	0.000453	0.036531
	Male	-0.00884	0.271958	-0.03	0.974	-0.54187	0.524183
	Household number	0.315206	0.14074	2.24	0.025	0.039362	0.59105
	General Trust	-0.04878	0.274877	-0.18	0.859	-0.58753	0.489965
	_cons	-2.54289	0.763093	-3.33	0.001	-4.03852	-1.04725
Share6	Certainty	0.074248	0.212101	0.35	0.726	-0.34146	0.48996
	Age	0.016484	0.012243	1.35	0.178	-0.00751	0.04048
	Male	-0.13533	0.329904	-0.41	0.682	-0.78193	0.511267
	Household number	0.461347	0.15644	2.95	0.003	0.154731	0.767963
	General Trust	-0.72767	0.332758	-2.19	0.029	-1.37986	-0.07548
	_cons	-1.9178	0.965155	-1.99	0.047	-3.80947	-0.02613
Share7	Certainty	0.055458	0.165336	0.34	0.737	-0.26859	0.379509
	Age	0.017767	0.008258	2.15	0.031	0.001581	0.033953
	Male	0.300855	0.247219	1.22	0.224	-0.18368	0.785396
	Household number	0.331111	0.12685	2.61	0.009	0.082491	0.579732
	General Trust	0.094231	0.248787	0.38	0.705	-0.39338	0.581845
	_cons	-1.13185	0.659769	-1.72	0.086	-2.42497	0.161276

Share8	Certainty	0.233841	0.189563	1.23	0.217	-0.1377	0.605376
	Age	0.005328	0.009635	0.55	0.58	-0.01356	0.024213
	Male	0.385166	0.280188	1.37	0.169	-0.16399	0.934325
	Household number	0.480848	0.138903	3.46	0.001	0.208604	0.753093
	General Trust	0.408264	0.287288	1.42	0.155	-0.15481	0.971338
	_cons	-2.18954	0.813043	-2.69	0.007	-3.78307	-0.596

Log likelihood	-13553.607
BIC	27867.93

Appendix F: Estimates of Latent Class model (Trap Pass group- 9 classes, 5 membership criteria)

	Variables	Coefficient	SE	z	P>|z|	[95% Conf. Interval]	
Class1	Price	0.01631	0.005674	2.87	0.004	0.00519	0.027431
	Methane emissions reduction	-0.1513	0.115555	-1.31	0.19	-0.37778	0.075184
	Improved Fertility	-0.10072	0.127691	-0.79	0.43	-0.35099	0.149548
	Enhanced Disease resilience	-0.4505	0.142379	-3.16	0.002	-0.72955	-0.17144
	therapeutic use of antibiotics	0.062203	0.110855	0.56	0.575	-0.15507	0.279475
	None	-1.89937	0.358171	-5.3	0	-2.60137	-1.19737
Class2	Price	-0.06442	0.009282	-6.94	0	-0.08261	-0.04623
	Methane emissions reduction	-0.50088	0.156322	-3.2	0.001	-0.80726	-0.19449
	Improved Fertility	-1.42607	0.207811	-6.86	0	-1.83337	-1.01877
	Enhanced Disease resilience	0.89692	0.158795	5.65	0	0.585689	1.208151
	therapeutic use of antibiotics	-0.44182	0.151601	-2.91	0.004	-0.73896	-0.14469
	None	-5.60126	0.532506	-10.52	0	-6.64495	-4.55757
Class3	Price	-0.09848	0.01052	-9.36	0	-0.1191	-0.07786
	Methane emissions reduction	0.303699	0.170653	1.78	0.075	-0.03078	0.638172
	Improved Fertility	-2.89021	0.377162	-7.66	0	-3.62943	-2.15098
	Enhanced Disease resilience	-1.58499	0.271286	-5.84	0	-2.1167	-1.05328
	therapeutic use of antibiotics	0.584866	0.152416	3.84	0	0.286137	0.883595
	None	-6.95202	0.586364	-11.86	0	-8.10127	-5.80277
Class4	Price	-0.03555	0.013825	-2.57	0.01	-0.06265	-0.00846
	Methane emissions reduction	-1.06136	0.311722	-3.4	0.001	-1.67233	-0.4504
	Improved Fertility	-0.83392	0.281771	-2.96	0.003	-1.38618	-0.28166
	Enhanced Disease resilience	0.764785	0.213071	3.59	0	0.347173	1.182397
	therapeutic use of antibiotics	-1.01558	0.243413	-4.17	0	-1.49266	-0.5385
	None	-0.58408	0.451363	-1.29	0.196	-1.46874	0.300572
Class5	Price	-0.27997	0.017285	-16.2	0	-0.31385	-0.24609
	Methane emissions reduction	0.114245	0.205669	0.56	0.579	-0.28886	0.517349
	Improved Fertility	-1.31991	0.200135	-6.6	0	-1.71216	-0.92765
	Enhanced Disease resilience	-0.45385	0.21695	-2.09	0.036	-0.87906	-0.02863
	therapeutic use of antibiotics	0.411379	0.230519	1.78	0.074	-0.04043	0.863188
	None	-6.54588	0.484298	-13.52	0	-7.49509	-5.59668
Class6	Price	-0.31585	0.024484	-12.9	0	-0.36383	-0.26786
	Methane emissions reduction	-0.72261	0.151304	-4.78	0	-1.01916	-0.42606
	Improved Fertility	-1.10198	0.182734	-6.03	0	-1.46013	-0.74383
	Enhanced Disease resilience	-0.15024	0.181354	-0.83	0.407	-0.50569	0.205202

	therapeutic use of antibiotics	0.483254	0.138527	3.49	0	0.211746	0.754763
	None	-12.9945	1.04996	-12.38	0	-15.0524	-10.9366
Class7	Price	-0.05424	0.010753	-5.04	0	-0.07532	-0.03317
	Methane emissions reduction	-0.2127	0.166539	-1.28	0.202	-0.53911	0.113711
	Improved Fertility	-1.07797	0.196231	-5.49	0	-1.46257	-0.69336
	Enhanced Disease resilience	-0.8656	0.202831	-4.27	0	-1.26315	-0.46806
	therapeutic use of antibiotics	-3.89401	0.254133	-15.32	0	-4.3921	-3.39592
	None	-5.11079	0.392804	-13.01	0	-5.88067	-4.3409
Class8	Price	-0.0706	0.011877	-5.94	0	-0.09388	-0.04732
	Methane emissions reduction	-0.64179	0.196366	-3.27	0.001	-1.02666	-0.25692
	Improved Fertility	-0.97222	0.205976	-4.72	0	-1.37593	-0.56852
	Enhanced Disease resilience	0.005864	0.247723	0.02	0.981	-0.47966	0.491391
	therapeutic use of antibiotics	3.77887	0.31041	12.17	0	3.170478	4.387262
	None	-2.10231	0.470109	-4.47	0	-3.02371	-1.18092
Class9	Price	-0.08241	0.041741	-1.97	0.048	-0.16423	-0.0006
	Methane emissions reduction	0.446303	0.728798	0.61	0.54	-0.98212	1.874721
	Improved Fertility	-0.60267	0.903733	-0.67	0.505	-2.37395	1.168616
	Enhanced Disease resilience	-1.10303	1.050661	-1.05	0.294	-3.16229	0.956229
	therapeutic use of antibiotics	-0.98327	0.720393	-1.36	0.172	-2.39522	0.428671
	None	2.43399	1.162508	2.09	0.036	0.155515	4.712464
Share1	Certainty	-0.74033	0.190143	-3.89	0	-1.113	-0.36766
	Age	0.024354	0.00987	2.47	0.014	0.00501	0.043698
	Male	1.504118	0.299775	5.02	0	0.916571	2.091665
	Household number	0.50881	0.146722	3.47	0.001	0.22124	0.796379
	General Trust	0.464168	0.30112	1.54	0.123	-0.12602	1.054352
	_cons	-0.57535	0.834154	-0.69	0.49	-2.21026	1.059564
Share2	Certainty	-0.71631	0.193329	-3.71	0	-1.09523	-0.33739
	Age	0.058668	0.011536	5.09	0	0.036058	0.081278
	Male	0.27664	0.311086	0.89	0.374	-0.33308	0.886357
	Household number	0.376302	0.160056	2.35	0.019	0.062598	0.690005
	General Trust	0.378235	0.30743	1.23	0.219	-0.22432	0.980788
	_cons	-1.41765	0.928241	-1.53	0.127	-3.23697	0.40167

Share3	Certainty	-0.6417	0.190988	-3.36	0.001	-1.01603	-0.26737
	Age	0.009824	0.009711	1.01	0.312	-0.00921	0.028858
	Male	1.037522	0.294389	3.52	0	0.46053	1.614514
	Household number	0.508519	0.14503	3.51	0	0.224265	0.792772
	General Trust	1.081372	0.298896	3.62	0	0.495546	1.667198
	_cons	-0.26549	0.820828	-0.32	0.746	-1.87428	1.343305
Share4	Certainty	-0.70979	0.244763	-2.9	0.004	-1.18952	-0.23006
	Age	0.030598	0.012943	2.36	0.018	0.005231	0.055965
	Male	0.365313	0.378147	0.97	0.334	-0.37584	1.106467
	Household number	0.587066	0.1829	3.21	0.001	0.228588	0.945543
	General Trust	-0.09431	0.393047	-0.24	0.81	-0.86466	0.676053
	_cons	-1.3383	1.128737	-1.19	0.236	-3.55059	0.873982
Share5	Certainty	-0.86412	0.194187	-4.45	0	-1.24472	-0.48352
	Age	0.008019	0.009595	0.84	0.403	-0.01079	0.026826
	Male	0.608657	0.300474	2.03	0.043	0.019739	1.197574
	Household number	0.046912	0.161242	0.29	0.771	-0.26912	0.36294
	General Trust	0.817388	0.304331	2.69	0.007	0.22091	1.413867
	_cons	1.545219	0.797402	1.94	0.053	-0.01766	3.108098
Share6	Certainty	-0.87615	0.176932	-4.95	0	-1.22294	-0.52937
	Age	0.021147	0.008842	2.39	0.017	0.003817	0.038477
	Male	1.057824	0.272629	3.88	0	0.523481	1.592167
	Household number	0.385283	0.138442	2.78	0.005	0.113941	0.656624
	General Trust	0.966387	0.276284	3.5	0	0.42488	1.507895
	_cons	0.478177	0.743221	0.64	0.52	-0.97851	1.934864
Share7	Certainty	-0.50543	0.18983	-2.66	0.008	-0.87749	-0.13337
	Age	0.027282	0.009587	2.85	0.004	0.008492	0.046072
	Male	0.725118	0.292206	2.48	0.013	0.152404	1.297831
	Household number	0.348512	0.149462	2.33	0.02	0.055573	0.641452
	General Trust	0.61267	0.295055	2.08	0.038	0.034372	1.190968
	_cons	-0.85691	0.821431	-1.04	0.297	-2.46689	0.753061
Share8	Certainty	-0.56433	0.20386	-2.77	0.006	-0.96389	-0.16477
	Age	0.049084	0.011936	4.11	0	0.025691	0.072478
	Male	1.089151	0.310528	3.51	0	0.480527	1.697776
	Household number	0.463628	0.160151	2.89	0.004	0.149738	0.777517
	General Trust	0.790508	0.31481	2.51	0.012	0.173492	1.407525
	_cons	-2.48173	0.954201	-2.6	0.009	-4.35193	-0.61153

Log likelihood	-9573.3357
BIC	19876.37

Appendix G: Estimates of Latent Class model (Trap Pass group- 10 classes, 4 membership criteria)

	Variables	Coefficient	SE	z	P>|z|	[95% Conf. Interval]	
Class1	Price	0.011688	0.005719	2.04	0.041	0.000479	0.022897
	Methane emissions reduction	-0.15845	0.115746	-1.37	0.171	-0.3853	0.068413
	Improved Fertility	-0.07388	0.129257	-0.57	0.568	-0.32721	0.179463
	Enhanced Disease resilience	-0.46185	0.141791	-3.26	0.001	-0.73976	-0.18394
	therapeutic use of antibiotics	0.014344	0.113835	0.13	0.9	-0.20877	0.237456
	None	-2.20222	0.36755	-5.99	0	-2.9226	-1.48184
Class2	Price	-0.06351	0.009603	-6.61	0	-0.08234	-0.04469
	Methane emissions reduction	-0.50669	0.158891	-3.19	0.001	-0.81811	-0.19527
	Improved Fertility	-1.48181	0.213398	-6.94	0	-1.90006	-1.06355
	Enhanced Disease resilience	0.895181	0.162263	5.52	0	0.577151	1.213211
	therapeutic use of antibiotics	-0.44889	0.146569	-3.06	0.002	-0.73616	-0.16162
	None	-5.58081	0.542477	-10.29	0	-6.64405	-4.51757
Class3	Price	-0.03742	0.013426	-2.79	0.005	-0.06373	-0.0111
	Methane emissions reduction	-1.01247	0.305619	-3.31	0.001	-1.61147	-0.41347
	Improved Fertility	-0.837	0.280895	-2.98	0.003	-1.38754	-0.28645
	Enhanced Disease resilience	0.807684	0.214318	3.77	0	0.387629	1.227739
	therapeutic use of antibiotics	-1.03211	0.249112	-4.14	0	-1.52036	-0.54386
	None	-0.6406	0.431586	-1.48	0.138	-1.4865	0.205292
Class4	Price	-0.05495	0.011008	-4.99	0	-0.07653	-0.03338
	Methane emissions reduction	-0.21875	0.168638	-1.3	0.195	-0.54927	0.111778
	Improved Fertility	-1.07376	0.197464	-5.44	0	-1.46078	-0.68673
	Enhanced Disease resilience	-0.85545	0.205048	-4.17	0	-1.25734	-0.45356
	therapeutic use of antibiotics	-3.91741	0.26127	-14.99	0	-4.42949	-3.40533
	None	-5.12807	0.405287	-12.65	0	-5.92241	-4.33372
Class5	Price	-0.2769	0.016712	-16.57	0	-0.30966	-0.24415
	Methane emissions reduction	0.113186	0.196568	0.58	0.565	-0.27208	0.498452
	Improved Fertility	-1.28529	0.19557	-6.57	0	-1.6686	-0.90198
	Enhanced Disease resilience	-0.49543	0.212519	-2.33	0.02	-0.91196	-0.0789
	therapeutic use of antibiotics	0.490021	0.178401	2.75	0.006	0.140362	0.83968
	None	-6.47712	0.446187	-14.52	0	-7.35163	-5.60261
Class6	Price	-0.2488	0.038998	-6.38	0	-0.32524	-0.17237

	Methane emissions reduction	-1.41921	0.378504	-3.75	0	-2.16107	-0.67736
	Improved Fertility	-0.5634	0.279076	-2.02	0.044	-1.11038	-0.01642
	Enhanced Disease resilience	0.847915	0.364554	2.33	0.02	0.133403	1.562427
	therapeutic use of antibiotics	4.804162	0.994152	4.83	0	2.855661	6.752664
	None	-9.81649	1.958622	-5.01	0	-13.6553	-5.97766
Class7	Price	-0.0984	0.010675	-9.22	0	-0.11932	-0.07748
	Methane emissions reduction	0.322691	0.172647	1.87	0.062	-0.01569	0.661074
	Improved Fertility	-2.8737	0.372601	-7.71	0	-3.60399	-2.14342
	Enhanced Disease resilience	-1.60049	0.267954	-5.97	0	-2.12567	-1.07531
	therapeutic use of antibiotics	0.605036	0.148895	4.06	0	0.313208	0.896864
	None	-6.94307	0.596129	-11.65	0	-8.11147	-5.77468
Class8	Price	-0.02413	0.01383	-1.74	0.081	-0.05123	0.00298
	Methane emissions reduction	-0.31222	0.262767	-1.19	0.235	-0.82723	0.202793
	Improved Fertility	-1.47186	0.329887	-4.46	0	-2.11843	-0.8253
	Enhanced Disease resilience	-0.00657	0.310692	-0.02	0.983	-0.61552	0.602374
	therapeutic use of antibiotics	3.918317	0.393151	9.97	0	3.147756	4.688877
	None	-0.15256	0.479141	-0.32	0.75	-1.09166	0.786538
Class9	Price	-0.33024	0.03441	-9.6	0	-0.39768	-0.2628
	Methane emissions reduction	-0.83711	0.20546	-4.07	0	-1.2398	-0.43441
	Improved Fertility	-1.28379	0.237742	-5.4	0	-1.74976	-0.81782
	Enhanced Disease resilience	-0.21457	0.228869	-0.94	0.348	-0.66314	0.234009
	therapeutic use of antibiotics	0.016877	0.173901	0.1	0.923	-0.32396	0.357715
	None	-13.633	1.402662	-9.72	0	-16.3822	-10.8838
Class10	Price	-0.07746	0.039554	-1.96	0.05	-0.15499	5.96E-05
	Methane emissions reduction	0.407946	0.674644	0.6	0.545	-0.91433	1.730223
	Improved Fertility	-0.57073	0.800481	-0.71	0.476	-2.13964	0.998185
	Enhanced Disease resilience	-1.27167	1.054846	-1.21	0.228	-3.33913	0.795789
	therapeutic use of antibiotics	-0.98667	0.634593	-1.55	0.12	-2.23045	0.257107
	None	2.388225	1.124228	2.12	0.034	0.184778	4.591671
Share1	Certainty	-0.7891	0.187576	-4.21	0	-1.15674	-0.42146
	Age	0.018075	0.009649	1.87	0.061	-0.00084	0.036986
	Male	1.516801	0.29775	5.09	0	0.933223	2.100379
	General Trust	0.49291	0.296211	1.66	0.096	-0.08765	1.073474
	_cons	0.962818	0.708812	1.36	0.174	-0.42643	2.352064

Share2	Certainty	-0.75622	0.193376	-3.91	0	-1.13523	-0.37721
	Age	0.05556	0.011286	4.92	0	0.033441	0.07768
	Male	0.311824	0.311906	1	0.317	-0.2995	0.923149
	General Trust	0.368507	0.307767	1.2	0.231	-0.23471	0.97172
	_cons	-0.41729	0.794387	-0.53	0.599	-1.97426	1.139683
Share3	Certainty	-0.81226	0.238471	-3.41	0.001	-1.27966	-0.34487
	Age	0.022343	0.012195	1.83	0.067	-0.00156	0.046244
	Male	0.436063	0.372272	1.17	0.241	-0.29358	1.165701
	General Trust	-0.14488	0.383489	-0.38	0.706	-0.89651	0.606741
	_cons	0.628067	0.893584	0.7	0.482	-1.12333	2.37946
Share4	Certainty	-0.53538	0.18901	-2.83	0.005	-0.90583	-0.16492
	Age	0.023812	0.009465	2.52	0.012	0.005261	0.042362
	Male	0.723447	0.290849	2.49	0.013	0.153394	1.293499
	General Trust	0.586515	0.292129	2.01	0.045	0.013953	1.159076
	_cons	0.123612	0.714647	0.17	0.863	-1.27707	1.524294
Share5	Certainty	-0.88	0.192237	-4.58	0	-1.25678	-0.50322
	Age	0.009183	0.009625	0.95	0.34	-0.00968	0.028048
	Male	0.578142	0.297929	1.94	0.052	-0.00579	1.162072
	General Trust	0.788022	0.299562	2.63	0.009	0.200892	1.375152
	_cons	1.662305	0.698349	2.38	0.017	0.293566	3.031044
Share6	Certainty	-0.76021	0.233108	-3.26	0.001	-1.21709	-0.30332
	Age	0.028209	0.012048	2.34	0.019	0.004595	0.051822
	Male	1.150847	0.35326	3.26	0.001	0.458471	1.843224
	General Trust	0.794582	0.352401	2.25	0.024	0.103888	1.485276
	_cons	-0.24666	0.864226	-0.29	0.775	-1.94051	1.447194
Share7	Certainty	-0.67141	0.18909	-3.55	0	-1.04202	-0.3008
	Age	0.004296	0.00947	0.45	0.65	-0.01426	0.022857
	Male	1.064103	0.291647	3.65	0	0.492485	1.635721
	General Trust	1.083599	0.294738	3.68	0	0.505924	1.661274
	_cons	1.163207	0.702014	1.66	0.098	-0.21272	2.53913
Share8	Certainty	-0.70245	0.229835	-3.06	0.002	-1.15292	-0.25199
	Age	0.05245	0.014264	3.68	0	0.024493	0.080407
	Male	1.174113	0.351316	3.34	0.001	0.485547	1.86268
	General Trust	0.745916	0.352313	2.12	0.034	0.055395	1.436436
	_cons	-1.78262	0.982545	-1.81	0.07	-3.70837	0.143134

Share9	Certainty	-0.85093	0.187662	-4.53	0	-1.21874	-0.48312
	Age	0.015307	0.009374	1.63	0.102	-0.00307	0.033679
	Male	0.980709	0.290086	3.38	0.001	0.412151	1.549268
	General Trust	0.919028	0.291869	3.15	0.002	0.346975	1.491082
	_cons	1.352457	0.679433	1.99	0.047	0.020793	2.684121

Log likelihood	-9546.4695
BIC	19844.12

Appendix H : Willingness to pay (or premium) for Trap question pass group ($) with 10 classes

Class	Variables	Class Share	Coefficient
Class1	Feed efficiency	0.138	-
	Methane emissions reduction		13.56
	Improved Fertility		6.32
	Enhanced Disease resilience		39.52*
	Therapeutic use of antibiotics		-1.23
Class2	Feed efficiency	0.135	-
	Methane emissions reduction		-7.98***
	Improved Fertility		-23.33***
	Enhanced Disease resilience		14.09***
	Therapeutic use of antibiotics		-7.07***
Class3	Feed efficiency	0.051	-
	Methane emissions reduction		-27.06**
	Improved Fertility		-22.37**
	Enhanced Disease resilience		21.59**
	Therapeutic use of antibiotics		-27.58***
Class4	Feed efficiency	0.104	-
	Methane emissions reduction		-3.98
	Improved Fertility		-19.54***
	Enhanced Disease resilience		-15.57***
	Therapeutic use of antibiotics		-71.29***
Class5	Feed efficiency	0.099	-
	Methane emissions reduction		0.41
	Improved Fertility		-4.64***
	Enhanced Disease resilience		-1.79**
	Therapeutic use of antibiotics		1.77***
Class6	Feed efficiency	0.069	-
	Methane emissions reduction		-5.70***
	Improved Fertility		-2.26**
	Enhanced Disease resilience		3.41**
	Therapeutic use of antibiotics		19.31***
Class7	Feed efficiency	0.122	-
	Methane emissions reduction		3.28*
	Improved Fertility		-29.20***
	Enhanced Disease resilience		-16.27***
	Therapeutic use of antibiotics		6.15***
Class8	Feed efficiency	0.060	-
	Methane emissions reduction		-12.94
	Improved Fertility		-61.01
	Enhanced Disease resilience		-0.27*
	Therapeutic use of antibiotics		162.41
Class9	Feed efficiency	0.134	-
	Methane emissions reduction		-2.53***
	Improved Fertility		-3.89***
	Enhanced Disease resilience		-0.65
	Therapeutic use of antibiotics		0.05
Class10	Feed efficiency	0.086	-
	Methane emissions reduction		5.27
	Improved Fertility		-7.37
	Enhanced Disease resilience		-16.42
	Therapeutic use of antibiotics		-12.74

Note: ***,**,*, Significant at 1%, 5%, and 10% level

Appendix I : Survey

Dairy Survey Instrument

Food and everyday life

1.

How often are you involved in the regular grocery shopping for your household?

never	once in a while	occasionally	frequently	always
1	2	3	4	5
❒	❒	❒	❒	❒

2.

	Not confident	Some confidence	Confident	Very confident	Don't know
To what extent are you confident that the foods you buy are not harmful for yourself or your family?					

3.

How often do you buy organic foods?

never	infrequently	occasionally	frequently	Every time I buy food
1	2	3	4	5
❒	❒	❒	❒	❒

4.

Which of the following do you eat (please check all that apply): **note if they select none of the above they cannot select any other answer**

1	❒	I eat meat from most animals
2	❒	I eat seafood and fish
3	❒	I eat dairy products (milk, cheese, butter or yogurt)
4	❒	I eat eggs
5	❒	I eat none of the above

.

5. 1. How frequently do you eat dairy products (from cattle, sheep or other animals)?

0 ○ never

1 ○ Less than once per month

2 ○ One to three times per month

3 ○ One to two days per week

4 ○ Three to four days per week

5 ○ Five to six days per week

6 ○ Daily

5. 2.

How frequently do you eat dairy substitute products (for example, milk beverage or yogurt product from soy, almonds, coconut, cashew or other plant bases)?

0 ○ never

1 ○ Less than once per month

2 ○ One to three times per month

3 ○ One to two days per week

4 ○ Three to four days per week

5 ○ Five to six days per week

6 ○ Daily

5.3. How frequently do you eat meat (from cattle, sheep or other animals)?

0 ○ never

1 ○ Less than once per month

2 ○ One to three times per month

3 ○ One to two days per week

4 ○ Three to four days per week

5 ○ Five to six days per week

6 ○ Daily

5. 4.

How frequently do you eat plant based meat (for example, plant based burgers or sausages)?

0 ○ never

1 ○ Less than once per month

2 ○ One to three times per month

3 ○ One to two days per week

4 ○ Three to four days per week

5 ○ Five to six days per week

6 ○ Daily

6.

Have you ever chosen not to purchase a particular food product for any reasons listed below:

	Yes	***No***
1.You were concerned that the food was unsafe to eat	❒	❒
2. You heard about environmental damage caused through production of the food	❒	❒
3. You were concerned about the treatment of animals in production of the product	❒	❒
4. For religious reasons	❒	❒
5. You were concerned that it was a genetically engineered food	❒	❒
6. You were concerned that the food had been found to cause health problems related to diet (chronic disease)	❒	❒

7. Other – please describe_____	❒	❒

Food safety

7. How much trust do you have in the following groups or institutions regarding their responsibility for food production in Canada? (scores range from 1 = no trust to 5 = absolute trust) **Please randomize items in this question**

	No trust	Some trust	Moderate Trust	Trust	Absolute Trust
Farmers					
Food processors or manufacturers					
Research organizations/universities					
Pharmaceutical industry which provides drugs to treat animals					
Government agencies/public authorities					
Advocacy consumer organizations					
Advocacy environmental organizations					
Advocacy organizations for animal welfare					
Retailers					
Veterinarians					

8. How do you rate the health risks of regular consumption of the following?

Please randomize items in this question

	Very low risk	Low risk	Moderate risk	High risk	Very high risk	Don't Know
Vitamin and/or mineral food supplements						
Foods enriched with vitamins or minerals						

Foods with pesticide or other chemical residues						
Genetically modified food (GMOs)						
Preservatives and/or artificial colouring						
Meat/fish/dairy products with hormone residues						
Foods made with ingredients that are produced with nanotechnology						
Meat/fish/dairy products with antibiotic residues						

9. Please respond to the following statements**: Split into three groups but do not randomize groups or statements within groups**

	Strongly disagree	*Disagree*	*Neither agree nor disagree*	*Agree*	*Strongly Agree*
Natural product interest					
1. I try to eat foods that do not contain additives					
2.R I do not care about additives in my daily diet.					
3. I do not eat processed foods, because I do not know what they contain					
4. I would like to eat only organically grown vegetables					
5.R In my opinion, artificially flavoured foods are not harmful for my health.					
6.R In my opinion, organically grown foods are no better for my health than those grown conventionally					
7. The more familiar a food is the more natural it is					
8. The more authentic a food is the more natural it is					

9. Natural food does not contain added colours or artificial flavours					
General health interest					
1.R The healthiness of food has little impact on my food choices					
2. I am very particular about the healthiness of food I eat.					
3.R I eat what I like and I do not worry much about the healthiness of food.					
4. It is important for me that my diet is low in fat.					
5. I always follow a healthy and balanced diet.					
6. It is important for me that my daily diet contains a lot of vitamins and minerals.					
7.R The healthiness of snacks makes no difference to me.					
8.R I do not avoid foods, even if they may raise my cholesterol.					
Pleasure					
1.R I do not believe that food should always be source of pleasure					
2.R The appearance of food makes no difference to me.					
3. When I eat, I concentrate on enjoying the taste of food.					
4. It is important for me to eat delicious food on weekdays as well as weekends.					
5. An essential part of my weekend is eating delicious food.					
6.R I finish my meal even when I do not like the taste of a food.					

10. Please indicate to what extent you agree with each statement.

	Strongly disagree	Disagree	Neither agree, nor disagree	Agree	Strongly agree
	1	2	3	4	5
Food prices paid by consumers are fair	❒	❒	❒	❒	❒
Food prices paid by consumers are reasonable	❒	❒	❒	❒	❒
Food prices paid by consumers are acceptable	❒	❒	❒	❒	❒
Many of my acquaintances regularly purchase meat/dairy products	❒	❒	❒❒	❒	❒ ❒ ❒
I feel guilty about my food choices that impact on greenhouse gas emissions	❒	❒	❒❒	❒	❒ ❒ ❒
I am proud of my food choices that impact on greenhouse gas emissions	❒	❒	❒❒	❒	❒ ❒ ❒
Most of my friends and peers are reducing their purchases of meat/dairy products over time	❒	❒	❒❒	❒	❒ ❒ ❒
I am content with my food choices that impact on greenhouse gas emissions	❒	❒	❒❒	❒	❒ ❒ ❒
I feel remorseful about my food choices that impact on greenhouse gas emissions	❒	❒	❒❒	❒	❒ ❒ ❒

Martin et al. 2004

11. Please indicate to what extent you agree with each statement

	Strongly disagree	Disagree	Neither agree, nor disagree	Agree	Strongly agree
	1	2	3	4	5
Food prices paid to farmers are fair	❒	❒	❒	❒	❒
Food prices paid to farmers are reasonable	❒	❒	❒	❒	❒
Food prices paid to farmers are acceptable	❒	❒	❒	❒	❒

Martin et al. 2004

Science and Technological Development

12. In general, to what extent do you feel knowledgeable about scientific and technological developments? 1 means that "you have little knowledge", and 10 means that "you know a lot."

1	2	3	4	5	6	7	8	9	10

13. All things considered, would you say that the world is better off, or worse off, because of science and technology? 1 means that "the world is a lot worse off," and 10 means that "the world is a lot better off."

1	2	3	4	5	6	7	8	9	10

14. When you hear the word technology is your reaction :

Negative		Neutral		Positive	Don't Know
1	2	3	4	5	6
☐	☐	☐	☐	☐	☐

15. When you hear the word biotechnology is your reaction:

Negative		Neutral		Positive	Don't Know
1	2	3	4	5	6

☐	☐	☐	☐	☐	☐

16. Over the last three months, have you read or heard any news stories involving biotechnology?

No	Yes
1	2
☐	☐

17. How would you describe your familiarity with biotechnology?

Not at all Familiar	Not Very Familiar	Somewhat Familiar	Very Familiar
1	2	3	4
☐	☐	☐	☐

18. In general, to what extent do you support or oppose the use of products and processes that involve biotechnology?

Strongly Oppose	Somewhat Oppose	Somewhat Support	Strongly Support
1	2	3	4
☐	☐	☐	☐

19. Would you buy fruit or vegetables that you know are genetically modified?

Definitely Not	Probably not	Neutral	Probably	Definitely

1	2	3	4	5
☐	☐	☐	☐	☐

20. Recently an apple that has been genetically modified so that the flesh does not brown when exposed to air has been approved to be sold for consumption. The apple is called the Arctic® Apple . When it becomes available for sale in Canada would you consider buying it?

Definitely Not	Probably not	Neutral	Probably	Definitely
1	2	3	4	5
☐	☐	☐	☐	☐

21. Would you buy a food product with a genetically modified ingredient, for example, margarine, made with genetically modified canola oil?

Definitely Not	Probably not	Neutral	Probably	Definitely
1	2	3	4	5
☐	☐	☐	☐	☐

22. Before you filled out this questionnaire, did you ever….?

	No, never	Once or twice	On a few occasions	Yes, often
Read information about biotechnology				
Talk to someone about biotechnology				

Search for information about biotechnology in a library or on the internet				
Attend a public meeting where biotechnology was discussed				
Participate actively in discussions about biotechnology				

(Dijkstra et al 2010)

23. Please identify your level of agreement with the following statements: **Please randomize items in this question**

	Strongly Disagree	Disagree	Neither agree or disagree	Agree	Strongly Agree	Don't know
	1	2	3	4	5	6
The government is doing a good job with respect to regulation of biotechnology	☐	☐	☐	☐	☐	☐
The government is competent enough to deal with regulation of biotechnology	☐	☐	☐	☐	☐	☐
The government is acting in the public interest with regard to regulation of biotechnology	☐	☐	☐	☐	☐	☐
The government is too influenced by industry regarding biotechnology regulation	☐	☐	☐	☐	☐	☐
The government provides all relevant information about biotechnology and its regulation to the public	☐	☐	☐	☐	☐	☐
I feel confident that the Canadian government adequately regulates the use of biotechnology	☐	☐	☐	☐	☐	☐
The government is committed to impartial processes for making decisions	☐	☐	☐	☐	☐	☐
The government makes a good faith effort to treat everyone even-handedly in general	☐	☐	☐	☐	☐	☐

24. When it comes to using new technologies in agriculture and food production: **Randomize the options in this question**

	Strongly disagree	Disagree	Neither agree, nor disagree	Agree	Strongly agree
	1	2	3	4	5
The benefits will all go to food processors, not regular farmers	❒	❒	❒	❒	❒
It's fair spending my tax dollars on developing these new technologies	❒	❒	❒	❒	❒
All the benefits of new technologies will go to consumers	❒	❒	❒	❒	❒
Consumers will experience an unfair amount of risk from the use of new technologies	❒	❒	❒	❒	❒

McCommas et al. 2014

Genomics is the study of the genes and genetic characteristics of organisms like plants, animals, and humans. Genes carry information that determines many of the features and characteristics of organisms. A genome is all of the genes in an organism. The Human Genome Project and the sequencing of the SARS virus are examples of research in Genomics related to people. Similar research is identifying genes and traits in crops and livestock, to better understand things such as susceptibility to disease or drought.

25. Have you ever heard about genomics?

1. _____ Yes
2. _____ No

26. When you hear the word genomics is your reaction:

Negative		Neutral		Positive	Don't Know
1	2	3	4	5	6
☐	☐	☐	☐	☐	☐

27. How would you describe your familiarity with genomics?

Not at All Familiar	Not Very Familiar	Somewhat Familiar	Very Familiar

1	2	3	4
☐	☐	☐	☐

28. Please rate your attitude towards the study of *genomics* for each seven point scale item.

		1	2	3	4	5	6	7	
1	Important								Unimportant*
2	Boring								Interesting
3	Relevant								Irrelevant*
4	Exciting								Unexciting*
5	Means nothing								Means a lot to me
6	Appealing								Unappealing*
7	Fascinating								Uninteresting*
8	Worthless								Valuable
10	Not necessary								Necessary

(* indicates item is reverse scored).

Environment

29. In a few words what does biodiversity mean to you?

30. Please identify whether you agree or disagree with the following statements:

Statement	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree	Don't Know
	1	2	3	4	5	6

Biodiversity is a measure of the number of different species of plants and animals in a particular area (birds or trees in Ontario, for example)						
Biodiversity is a measure of the extent of genetic variation within a species, for example the number of different types of apple trees, different breeds of cattle.						
Biodiversity means the number of different types of ecosystems within a particular region – such as wetlands, coastal areas, forest, prairies.						

(Spash and Hanley)

31. Please identify whether you agree or disagree with the following statements: **Please randomize the items in this question**

Statement	Strongly Disagree	Disagree	Neither agree nor disagree	agree	Strongly Agree
	1	2	3	4	5
I worry about changes to the countryside such as the loss of native plants and animals					
There is nothing I can personally do to help stop the losses in the world's biodiversity					
We can afford to lose some of the world's biodiversity					
Biodiversity losses in animals domesticated for food production are less serious than similar losses in wildlife					
Reduced genetic diversity in cattle can make the cattle population vulnerable to disease and climate threats in the future					

(UK survey with some attitudes towards biodiversity)

32. To what extent do you feel knowledgeable about environmental problems? 1 means that "you have little knowledge", and 10 means that "you know a lot."

1	2	3	4	5	6	7	8	9	10

33. Please identify whether you agree or disagree with the following statements:

	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
Human beings can progress only by conserving nature's resources					
Human beings can enjoy nature only if they make wise use of its resources.					
Human progress can be achieved only by maintaining ecological balance.					
Preserving nature at the present time means ensuring the future of human beings					
We must reduce our consumption levels to ensure well-being of the present and future generations					

34. Please indicate which one of the following statements corresponds most with your view on nature: **only one answer is possible (programming note)**

_____ Environmental problems can only be controlled by enforcing radical changes in human behaviour in society as a whole.

_____ Environmental problems are not entirely out of control, but the government should dictate clear rules about what is and what is not allowed.

_____ We do not need to worry about environmental problems because in the end, these problems will always be resolved by technological solutions.

_____ We do not know whether environmental problems will magnify or not.

(the above two are from scales in papers by Corral-Verdago et al and by Steg and Sievers)

35. How big a part, if any, do you think each of the following activities play in the human contribution to climate change? **Please randomize the statements**

	Nothing at all	A Little	A moderate amount	A Lot	I don't know
Exhaust emissions from planes, trains, cars, trucks and ships	○	○	○	○	○
Farming the meat and dairy products that we eat and drink	○	○	○	○	○
Burning coal, oil and gas in power stations to produce electricity	○	○	○	○	○
Heating and cooling our homes and offices	○	○	○	○	○
Disposal and treatment of waste such as rubbish in landfill and sewage treatment	○	○	○	○	○
Industry and manufacturing, the production of goods	○	○	○	○	○
Cutting down of trees and forests	○	○	○	○	○

36. Thinking about things you might do in order to limit your own contribution to climate change, how likely or unlikely would you be to make the following changes during the next year? **Please randomize the statements**

	Certain not to	Very unlikely to	Fairly unlikely to	Fairly likely to	Very likely to	Certain to	I am doing this as much as I possibly can	Not applicable
Walking, cycling or using public transport instead of driving a car or motorbike	○	○	○	○	○	○	○	○
No flying or replacing some flights with train or bus journeys	○	○	○	○	○	○	○	○
Eating less meat or replacing the meat in some meals with alternatives such as beans/pulses	○	○	○	○	○	○	○	○
Eating fewer dairy products or replacing some dairy products with alternatives such as soy milk	○	○	○	○	○	○	○	○
Saving energy at home, for example, by installing	○	○	○	○	○	○	○	○

insulation or switching off lights								
Recycling materials such as glass, paper or plastic	○	○	○	○	○	○	○	○
Avoiding products that have a lot of packaging	○	○	○	○	○	○	○	○
Avoiding buying new things by, for example, mending what you have or buying used products instead	○	○	○	○	○	○	○	○

Animal Attitudes, Anthropomorphism

37. Please identify whether you agree or disagree with the following statements:

Statement	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
It is morally wrong to hunt animals for sport					
There is nothing morally wrong with hunting wild animals for food					
I think it is perfectly acceptable for cattle and hogs to be raised for human consumption					
The slaughter of whales and dolphins should be immediately stopped even if it means some people will be put out of work					
I sometimes get upset when I see wild animals in cages at zoos.					
One of the worst things someone can do is to hurt a defenceless animal					

(animal attitudes Scale – Herzog, 2015, moral foundations question)

38. Please answer the following questions:

	No	Yes
Are you a member of an animal welfare organization?		

Do you raise livestock for all or part of your livelihood?		
Did you donate any money in the past year to animal rights or animal welfare causes?		
Did you donate any money in the past year to any causes opposing animal rights?		
Do you hunt animals for food or sport?		
Have you owned pets in the past?		
Do you currently own a pet?		
If yes, then is your pet purebred?		
Were you raised on a farm or ranch?		

(taken from Armstrong and Hutchens)

39. How important or unimportant are the following to the welfare of dairy cattle that are maintained for dairy production? **Please randomize the items in this question**

Item	Not Important At All		Important		Extremely Important	Don't Know
	1	2	3	4	5	6
Healthy living conditions						
Skilled attention						
Clean environment						
Environment free from disease						
Medical treatment when the cattle are sick						
Comfortable living conditions						
Nutrition to strengthen the cattle's immune systems						
Adaptation of the housing system to the needs of the cattle						

Food to satisfy the cattle and to optimize their growth and health						
Space to allow the cattle to be on their own						
Variation or diversity in the living environment						
Prevention of stressful situations						
Providing an environment that allows the animals to experience little or no fear						

(Frewer et al 2005)

40. How satisfactory or unsatisfactory are the current conditions under which dairy cattle are being maintained in Canada? **Please randomize the items in this question**

Item	Extremely Unsatisfactory		Neutral		Highly Satisfactory	Don't Know
	1	2	3	4	5	6
Healthy living conditions						
Skilled attention						
Clean environment						
Environment free from disease						
Medical treatment when the cattle are is sick						
Comfortable living conditions						
Nutrition to strengthen the cattle's immune systems						

Adaptation of the housing system to the needs of the cattle						
Food to satisfy the cattle and to optimize their growth and health						
Space to allow the cattle to be on their own						
Variation or diversity in the living environment						
Prevention of stressful situations						
Providing an environment that allows the animals to experience little or no fear						

If you do not eat dairy products then please go to question 45.

41. Approximately how much do you spend on dairy products in an average week? $_____

Selective Breeding Analysis

Farmers have made choices to selectively breed dairy cows and bulls for years. By selecting certain animals they hope that the calves will have characteristics that improve the quality or quantity of milk produced or improve animal characteristics (feet, legs,

fertility). Genomics is the study of the genes and genetic characteristics of organisms like plants, animals, and humans. The study of genomics in dairy cattle can allow for: the identification of specific genes that are linked to disease susceptibility (there are a number of current diseases within the dairy industry, such as Johnes disease, for example),

the identification of specific genes that could be linked to enhanced feed efficiency,

the identification of specific genes that could be linked to reduced greenhouse gas emissions (methane) or

the identification of genes linked to fertility in dairy cows.

With knowledge of the presence (absence) of any of these genes, selective breeding (selecting particular bull semen and particular cows that genetics suggest would produce progeny with the desired traits) could produce dairy cows with significantly lower probabilities of contracting disease, higher probabilities of reduced methane emissions, higher probabilities of increased feed efficiency or higher probabilities of increased fertility.

Dairy Disease

Johne's disease is a contagious chronic progressive bacterial infection of the digestive tracts of cattle. The disease causes abnormal thickening of the lining of the intestinal tract in infected animals restricting the absorption of nutrients. Clinical signs of animals infected with JD are long lasting diarrhea and extreme weight loss despite maintaining appetite. The disease has serious health implications for individual cows and cows in the rest of the herd. Economic costs can be very high for dairy producers.

Feed Efficiency

Feed is one of the largest inputs (biggest costs) in any livestock operation. Producing dairy cows with higher levels of feed efficiency would reduce the feed required per pound (KG) of animal being fed. With knowledge of the presence (absence) of feed efficiency genes, selective breeding can produce cows that are more efficient converters of feed into milk, indirectly reducing greenhouse gases (reduced methane emissions per unit of milk produced) and improving farm profitability.

Methane Emissions

Methane emissions from cows are seen to be a major contributor to global greenhouse gas emissions. By measuring the natural animal variation in methane emissions, selective breeding of animals with lower methane emissions could result in reduced GHG emissions for the entire dairy herd.

Enhanced Fertility

Dairy cow fertility, the ability to conceive and maintain a pregnancy to term, is critical to the sustainable operation of dairy farms. Although fertility is a complex trait, it is possible through selective breeding to improve the fertility of the cows within a farmer's herd. Indirectly, this will also improve the environmental footprint of the dairy industry.

In what follows we will present you with information about dairy products produced from cows selected for different traits. Please select the type of dairy products you are most likely to choose to satisfy your household's needs for a week. Please make the choice as if you were actually doing your grocery shopping, recognizing that any spending on dairy products reduces your spending on other things for the week. According to Statistics Canada, the average household in Canada spends around $16.00 per week on dairy products.

Only one answer is possible *(control by the computer) (each scenario on one page (8 per respondent)*

42:1 Please choose the type of dairy products you would select (as if these were the only products in the grocery store) for your household for a week or choose none of the dairy products.

All dairy products in this choice set have the following characteristics: These dairy products are made from milk produced on a Canadian family dairy farm. Through ***proAction*** (national industry standard) all Canadian dairy farmers collectively demonstrate responsible stewardship of their animals and the environment, sustainably producing high-quality, safe, and nutritious food for consumers. All cows are grass fed as defined by the Dairy Farmers of Canada National Standard for the Production of Milk from Grass-Fed Cows	

Dairy Products A	Dairy Products B	Dairy Products C	I would not purchase any of the dairy products
In addition, the cows have been selectively bred to have higher feed efficiency (reducing cost and indirectly reducing methane emissions)	In addition, the cows have been selectively bred to produce reduced methane (GHG) emissions.	In addition, the cows have been selectively bred to have higher levels of fertility, enabling them to get and remain pregnant more easily.	
No antibiotics are used on cows in dairy production	No antibiotics are used on cows in dairy production	No antibiotics are used on cows in dairy production	
$40.25 per week cost for dairy products including milk, cheese, yogurt and ice cream, for example	*$40.25 per week cost for dairy products including milk, cheese, yogurt and ice cream, for example*	*$40.25 per week cost for dairy products including milk, cheese, yogurt and ice cream, for example*	
I would choose the following option:			
OPTION A	**OPTION B**	**OPTION C**	**OPTION D**

42.2 Please choose the type of dairy products you would select (as if these were the only products in the grocery store) for your household for a week or choose none of the dairy products.

All dairy products in this choice set have the following characteristics: These dairy products are made from milk produced on a Canadian family dairy farm. Through ***proAction*** (national industry standard) all Canadian dairy farmers collectively demonstrate responsible stewardship of their animals and the environment, sustainably producing high-quality, safe, and nutritious food for consumers.	

All cows are grass fed as defined by the Dairy Farmers of Canada National Standard for the Production of Milk from Grass-Fed Cows			
Dairy Products A	**Dairy Products B**	**Dairy Products C**	I would not purchase any of the dairy products
In addition, the cows have been selectively bred to have higher disease resilience (reducing Johne's disease incidence)	In addition, the cows have been selectively bred to have higher levels of fertility, enabling them to get and remain pregnant more easily.	In addition, the cows have been selectively bred to have higher levels of fertility, enabling them to get and remain pregnant more easily.	
Antibiotics are only used in dairy production when prescribed by a veterinarian to treat a disease or infection.	No antibiotics are used on cows in dairy production	No antibiotics are used on cows in dairy production	
$24.15 per week cost for dairy products including milk, cheese, yogurt and ice cream, for example	*$16.10 per week cost for dairy products including milk, cheese, yogurt and ice cream, for example*	*$24.15 per week cost for dairy products including milk, cheese, yogurt and ice cream, for example*	
I would choose the following option:			
OPTION A	**OPTION B**	**OPTION C**	**OPTION D**

42.3 Please choose the type of dairy products you would select (as if these were the only products in the grocery store) for your household for a week or choose none of the dairy products.

All dairy products in this choice set have the following characteristics: These dairy products are made from milk produced on a Canadian family dairy farm. Through ***proAction*** (national industry standard) all Canadian dairy farmers collectively demonstrate responsible stewardship of their animals and the environment, sustainably producing high-quality, safe, and nutritious food for consumers. All cows are grass fed as defined by the Dairy Farmers of Canada National Standard for the Production of Milk from Grass-Fed Cows			
Dairy Products A	**Dairy Products B**	**Dairy Products C**	I would not purchase any of the dairy products
In addition, the cows have been selectively bred to have higher levels of fertility, enabling them to get and remain pregnant more easily.	In addition, the cows have been selectively bred to have higher levels of fertility, enabling them to get and remain pregnant more easily.	In addition, the cows have been selectively bred to have reduced methane emissions	
No antibiotics are used on cows in dairy production	Antibiotics are only used in dairy production when prescribed by a veterinarian to treat a disease or infection.	Antibiotics are only used in dairy production when prescribed by a veterinarian to treat a disease or infection.	
$40.25 per week cost for dairy products including milk, cheese, yogurt and ice cream, for example	*$16.10 per week cost for dairy products including milk, cheese, yogurt and ice cream, for example*	*$32.20 per week cost for dairy products including milk, cheese, yogurt and ice cream, for example*	
I would choose the following option:			
OPTION A	**OPTION B**	**OPTION C**	**OPTION D**

42.4 Please choose the type of dairy products you would select (as if these were the only products in the grocery store) for your household for a week or choose none of the dairy products.

<table>
<tr><td colspan="3">All dairy products in this choice set have the following characteristics:

These dairy products are made from milk produced on a Canadian family dairy farm.

Through proAction (national industry standard) all Canadian dairy farmers collectively demonstrate responsible stewardship of their animals and the environment, sustainably producing high-quality, safe, and nutritious food for consumers.

All cows are grass fed as defined by the Dairy Farmers of Canada National Standard for the Production of Milk from Grass-Fed Cows</td><td></td></tr>
<tr><td>Dairy Products A</td><td>Dairy Products B</td><td>Dairy Products C</td><td rowspan="3">I would not purchase any of the dairy products</td></tr>
<tr><td>In addition, the cows have been selectively bred to have higher levels of fertility, enabling them to get and remain pregnant more easily.</td><td>In addition, the cows have been selectively bred to have higher feed efficiency (reducing cost and indirectly reducing methane emissions)</td><td>In addition, the cows have been selectively bred to have higher feed efficiency (reducing cost and indirectly reducing methane emissions)</td></tr>
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</table>

veterinarian to treat a disease or infection.			
$32.20 per week cost for dairy products including milk, cheese, yogurt and ice cream, for example	*$32.20 per week cost for dairy products including milk, cheese, yogurt and ice cream, for example*	*$40.25 per week cost for dairy products including milk, cheese, yogurt and ice cream, for example*	
I would choose the following option:			
OPTION A	**OPTION B**	**OPTION C**	**OPTION D**

42.5 Please choose the type of dairy products you would select (as if these were the only products in the grocery store) for your household for a week or choose none of the dairy products.

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Dairy Products A	**Dairy Products B**	**Dairy Products C**	I would not purchase any of the dairy products
In addition, the cows have been selectively bred to have reduced methane emissions	In addition, the cows have been selectively bred to have higher disease resilience (reducing Johne's disease incidence)	In addition, the cows have been selectively bred to have higher feed efficiency (reducing cost and indirectly reducing methane emissions)	
No antibiotics are used on cows in dairy production	No antibiotics are used on cows in dairy production	No antibiotics are used on cows in dairy production	
$16.10 per week cost for dairy products including milk, cheese, yogurt and ice cream, for example	*$24.15 per week cost for dairy products including milk, cheese, yogurt and ice cream, for example*	*$24.15 per week cost for dairy products including milk, cheese, yogurt and ice cream, for example*	
I would choose the following option:			
OPTION A	**OPTION B**	**OPTION C**	**OPTION D**

42.6 Please choose the type of dairy products you would select (as if these were the only products in the grocery store) for your household for a week or choose none of the dairy products.

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<tr><td>$40.25 per week cost for dairy products including milk, cheese, yogurt and ice cream, for example</td><td>$32.20 per week cost for dairy products including milk, cheese, yogurt and ice cream, for example</td><td>$16.10 per week cost for dairy products including milk, cheese, yogurt and ice cream, for example</td></tr>
<tr><td colspan="4">I would choose the following option:</td></tr>
<tr><td>OPTION A</td><td>OPTION B</td><td>OPTION C</td><td>OPTION D</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
</table>

42.7 Please choose the type of dairy products you would select (as if these were the only products in the grocery store) for your household for a week or choose none of the dairy products.

<table>
<tr><td colspan="3">All dairy products in this choice set have the following characteristics:

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<tr><td>In addition, the cows have been selectively bred to have higher feed efficiency (reducing cost and indirectly reducing methane emissions)</td><td>In addition, the cows have been selectively bred to have higher disease resilience (reducing Johne’s disease incidence)</td><td>In addition, the cows have been selectively bred to have higher feed efficiency (reducing cost and indirectly reducing methane emissions)</td></tr>
<tr><td>Antibiotics are only used in dairy production when prescribed by a veterinarian to treat a disease or infection.</td><td>No antibiotics are used on cows in dairy production</td><td>Antibiotics are only used in dairy production when prescribed by a veterinarian to treat a disease or infection.</td></tr>
</table>

$32.20 per week cost for dairy products including milk, cheese, yogurt and ice cream, for example	*$40.25 per week cost for dairy products including milk, cheese, yogurt and ice cream, for example*	*$24.15 per week cost for dairy products including milk, cheese, yogurt and ice cream, for example*	
I would choose the following option:			
OPTION A	**OPTION B**	**OPTION C**	**OPTION D**

42.8 Please choose the type of dairy products you would select (as if these were the only products in the grocery store) for your household for a week or choose none of the dairy products.

All dairy products in this choice set have the following characteristics: These dairy products are made from milk produced on a Canadian family dairy farm. Through ***proAction*** (national industry standard) all Canadian dairy farmers collectively demonstrate responsible stewardship of their animals and the environment, sustainably producing high-quality, safe, and nutritious food for consumers. All cows are grass fed as defined by the Dairy Farmers of Canada National Standard for the Production of Milk from Grass-Fed Cows	

Dairy Products A	Dairy Products B	Dairy Products C	I would not purchase any of the dairy products
In addition, the cows have been selectively bred to have reduced methane emissions	In addition, the cows have been selectively bred to have higher levels of fertility, enabling them to get and remain pregnant more easily.	In addition, the cows have been selectively bred to have higher disease resilience (reducing Johne's disease incidence)	
No antibiotics are used on cows in dairy production	No antibiotics are used on cows in dairy production	No antibiotics are used on cows in dairy production	
$24.15 per week cost for dairy products including milk, cheese, yogurt and ice cream, for example	*$32.20 per week cost for dairy products including milk, cheese, yogurt and ice cream, for example*	*$32.20 per week cost for dairy products including milk, cheese, yogurt and ice cream, for example*	
I would choose the following option:			
OPTION A	**OPTION B**	**OPTION C**	**OPTION D**

43. How certain are you that you would make the choices above, if the products were identified in the grocery store, every time you purchase dairy products?

Very uncertain	Uncertain	Certain	Very Certain
1	2	3	4

44. Why did you select the dairy products (or none of the products) you did in the questions above?

Number	Reason	Agree that this reason affected my choices	Disagree that this reason affected my choices

1	I think the cost increases are a small amount to pay for the benefits received		
2	I believe that we should encourage dairy production, with the characteristics identified in the choices.		
3	I feel it (enhancing the characteristics of dairy production) is the "right" thing to do.		
4	It is important to invest in breeding dairy cows with higher fertility, higher feed efficiency, lower GHG emissions and higher disease resilience.		
5	I do not believe that breeding dairy cows with the characteristics above will improve dairy production enough for me to continue to eat dairy products.		
6	I am worried about what technology might be used in selectively breeding dairy cows		
7	I don't believe the changes can actually be achieved		

Please randomize the order of question 45 and question 46

45. How risky do you consider the use of genomic information, to undertake selective breeding for increased feed efficiency, reduced methane emissions, increased disease resilience or increased fertilityof dairy cattle , to be for your health?

Not at All Risky	Some Risk	Moderate Risk	Risky	Very Risky

46. How beneficial do you consider the use of genomic information, to undertake selective breeding for increased feed efficiency, reduced methane emissions, increased disease resilience or increased fertility of dairy cattle, to be for your health?

Not at All Beneficial	Some Benefits	Moderate Benefits	Beneficial	Very Beneficial

47. For you, the use of *genomic information to undertake selective breeding to increase feed efficiency,* reduce methane emissions, increase disease resilience or increase fertility in cattle is :

		1	2	3	4	5	6	7	
1	Useless								Useful
2	Worthless								Valuable
3	Harmful								Beneficial
4	Foolish								Wise
5	Awful								Nice
6	Disagreeable								Agreeable
7	Unpleasant								Pleasant

Sometimes the government provides the opportunity for input to public policies through the use of a referendum (vote). We would now like to ask you how you would vote on two policies were you given the opportunity to do so. When answering each question, please assume that the particular policy in question is the only one on the ballot. That is, please answer each of the next three questions individually assuming only one policy option is under consideration.

(Please randomize the order of Question 48, Question 49 and Question 50)

48.

Suppose the next time you went to vote, there was a referendum on the ballot that would require the Canadian government to implement a policy that required tracking of all livestock and their products, from farm to grocery store, *if they were produced using genomic information in selective breeding*. Would you vote in favour of this policy if the policy would increase the price you would pay for your weekly food by $**X** (assuming a Canadian average household weekly food expenditure of $125.00) due to the added enforcement and oversight required by the policy?

1=I would vote in favor of the mandatory tracking system and a $**X** increase in the price of food;

2=I would vote against the mandatory tracking system and the $**X** increase in the price of food]

[PROGRAMMING NOTE: THE PERCENTAGE PRICE INCREASE, **X** IS TO BE RANDOMLY CHOSEN FOR EACH INDIVIDUAL AMONG THE VALUES OF $1.25, $6.25, $12.50, $31.25, $62.50, $125.00.]

49.

Suppose the next time you went to vote, there was a referendum on the ballot that would require the Canadian government to implement a policy that required grocery stores to label all livestock and their products from *farm animals produced using genomic information in selective breeding*. Would you vote in favor of this policy if the policy would increase the price you would pay for your weekly food by $**Y** (assuming a Canadian average household weekly food expenditure of $125.00) due to the added enforcement and oversight required by the policy?

1=I would vote in favor of the mandatory labeling policy on livestock and meat and a $**Y** increase in the price of food;

2=I would vote against the mandatory labeling policy and the $**Y** increase in the price of food]

[PROGRAMMING NOTE: THE PERCENTAGE PRICE INCREASE, **Y** IS TO BE RANDOMLY CHOSEN FOR EACH INDIVIDUAL AMONG THE VALUES OF $1.25, $6.25, $12.50, $31.25, $62.50, $125.00]

50. Suppose the next time you went to vote, there was a referendum on the ballot that would require the Canadian government to invest more heavily in research to improve genomic information to be used in selective breeding, for feed efficiency, reduced GHG emissions, disease resilience or increased fertility, for dairy cows. Would you vote in favor of this policy if the policy would increase the price you would pay for your weekly food by $1.25 (assuming a Canadian average household weekly food expenditure of $125.00) due to the added research costs?

1=I would vote in favor of more research on the use of genomic information to be used in selective breeding, in dairy cattle and a $**Z** increase in the price of weekly food;

2=I would vote against more research on the use of genomic information to be used in selective breeding, in dairy cattle and the $**Z** increase in the price of food]

[PROGRAMMING NOTE: THE DOLLAR PRICE INCREASE, **Z** IS TO BE RANDOMLY CHOSEN FOR EACH INDIVIDUAL AMONG THE VALUES OF $1.25, $6.25, $12.50, $31.25, $62.50, $125.00.]

51. Please identify whether you agree or disagree with the following statements. (Please randomize items in this question)

Statement	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
	1	2	3	4	5
Animal antibiotic use cannot be seriously harmful; otherwise, authorities would ban them					
There is a good reason why certain animal antibiotics are recommended					
Overall, animal antibiotic use delivers more benefits than harm					
We live in such a hygienic environment that animal antibiotics are redundant					
For serious animal diseases, requirements for farmers to use antibiotics should be in place					
Use of antibiotics is a better strategy than destroying the affected animals					
Animal antibiotics used are another important factor that is threatening the environment					
The process of developing and testing antibiotics for use in livestock production proves their effectiveness and safety					

Consuming meat from vaccinated animals can result in my becoming immune to the illness					

52. For quality assurance purposes, select strongly agree.

	Strongly disagree	Disagree	Neither Disagree or Agree	Agree	Strongly Agree
	☐	☐	☐	☐	☐

Section 3: Background Questions

53. Over the past week, how many days did you……?

	Not at all	**Once**	**Twice**	**Three times**	**More than three times**
	1	**2**	**3**	**4**	**5**
Watch the national news on television					
Watch the local news on television					
Listen to talk radio about news issues					
Read the front section of a national newspaper such as the Globe and Mail, National Post					
Read the front section of a local newspaper?					
Read a newsmagazine					
Read the news on the Internet					
Use the internet to search for information on a topic related to food, agriculture, science or technology.					
Use Facebook to search for information on a topic related to food, agriculture, science or technology					
Use Twitter to search for information on a topic related to food, agriculture, science or technology					
Use any other social media site to search for information on a topic related to food, agriculture, science or technology					
Use the internet to search for recipes					

54. In the past year, how often have you attended a regular service at a place of worship?

Never	Once in a while	Occasionally	Frequently (more than once per month)	Regularly (once per week)	Prefer not to say
1	2	3	4	5	6
❒	❒	❒	❒	❒	❒

55. Do you, or someone you are related to, own or work on a ranch or farm?

1. ❒ Yes
2. ❒ No

56. 1. Approximately how often do you purchase the following foods to eat at home?

Food	Never	A Few Times a Year	About once per month	About once per week	Every day
	1	2	3	4	5
Dairy products: milk					
Dairy products : yogurt					
Meat (beef, pork or poultry etc.)					
Plant based meat products					
Plant (soy almond cashew coconut or other) based beverage					
Plant (soy almond cashew coconut or other) based yogurt					

56.2 How often do you purchase the following foods to eat away from home ? (in restaurants, cafeterias or as a snack)

Food	Never	A Few Times a Year	About once per month	About once per week	Every day
	1	2	3	4	5
Dairy products: milk					
Dairy products : yogurt					
Meat (beef, pork or poultry etc.)					
Plant based meat products					
Plant (soy almond cashew coconut or other) based beverage					
Plant (soy almond cashew coconut or other) based yogurt					

57. Over the past two years, have you lowered your consumption of dairy products?	No	Yes
	1	**2**
	❒	❒

If yes, reduced by roughly what _____% (please give your best estimate)?

If you answered Yes to Question 56 then please do Question 57, otherwise proceed to Question 56 (programming note)

58. Please rate the importance of the following factors on your decision. *(Please check (√) the appropriate number,* 1= Not At All Important to 5= Very Important or 6 Not Applicable.) **Please randomize items in this question**

Factors	1	2	3	4	5	N/A

	(Not at all important)				(Very Important)	
Cost of dairy products	□	□	□	□	□	□
Health concerns	□	□	□	□	□	□
Concerns about the environmental footprint of dairy production	□	□	□	□	□	□
Availability of substitute dairy products (made from plants such as soy, almond)	□	□	□	□	□	□
Concerns about animal welfare	□	□	□	□	□	□
My friends and relations are all reducing their dairy product consumption	□	□	□	□	□	□
Fat Content	□	□	□	□	□	□
Use of antibiotics in livestock production	□	□	□	□	□	□
Use of hormones in livestock production	□	□	□	□	□	□

59. In which of the following age groups do you fall?

1. ❒ 18-20
2. ❒ 21-24
3. ❒ 25-29
4. ❒ 30-36
5. ❒ 37-45
6. ❒ 46-55
7. ❒ 56-65
8. ❒ 65+

60. Generally speaking, would you say that most people can be trusted?

Most people can be trusted	Can't be too careful in dealing with people	Don't know
1	2	3
❒	❒	❒

61. Would you say that most people would try to take advantage of you if they got the chance or would they try to be fair?

Most people would try to take advantage of me	Most people would be fair	Don't know
1	2	3
❒	❒	❒

62. Would you say that most of the time people try to be helpful or that they are mostly looking out for themselves?

People mostly look out for themselves	People mostly try to be helpful	Don't know
1	2	3
❒	❒	❒

63. When you decide whether an action taken by someone is right or wrong, to what extent are the following considerations relevant to your thinking?

	Not at all relevant	Not very relevant	Slightly relevant	Somewhat relevant	Very relevant	Extremely relevant
Whether or not the person suffered emotionally						
Whether or not the person protected someone weak or defenceless						
Whether or not the person was cruel						
Whether or not some people were treated differently than others						
Whether or not the person acted unfairly						
Whether or not the person was denied their rights						

(Graham et al)

64. Please identify your level of agreement with the following statements. (please randomize elements)

	Strongly	Disagree	Neutral	Agree	Strongly
HC1: I'm very self-conscious about my health.					
HC2: I'm generally attentive to my inner feelings about my health.					
HC3: I reflect about my health a lot.					
HC4: I'm concerned about my health all the time.					
HC5: I notice how I feel physically as I go through the day.					
HC6: I take responsibility for the state of my health.					
HC7: Good health takes active participation on my part.					
HC8: I only worry about my health when I get sick. (R)					

HC9: Living life without disease and illness is very important to me.					
HC10: My health depends on how well I take care of myself.					
HC11: Living life in the best possible health is very important to me.					

65. Please indicate if you are:

1. ❒ Male
2. ❒ Female
3. ❒ Other _____

66. Including yourself, how many people live in your household?

1. ❒ 1
2. ❒ 2
3. ❒ 3
4. ❒ 4
5. ❒ 5 or more

67. How many children younger than 18 live in your house?

1. ❒ No children < 18 years live in my house
2. ❒ 1
3. ❒ 2
4. ❒ 3
5. ❒ 4
6. ❒ More than 4

68. What is the highest level of education you've achieved? **ONLY ONE ANSWER POSSIBLE**

1. ❒ Elementary school

2. ❒ Secondary (high) school

3. ❒ Technical/ business school/Community college

4. ❒ University

5. ❒ Post graduate studies (Masters or PhD)

69. Which region do you live in? **ONLY ONE ANSWER POSSIBLE**

1. ❒ Maritimes

2. ❒ Quebec

3. ❒ Ontario

4. ❒ Manitoba

5. ❒ Saskatchewan

6. ❒ Alberta

7. ❒ British Columbia

8. ❒ Yukon, Northwest Territories, Nunavut

70. Do you live in a city, in a town or in the countryside? **ONLY ONE ANSWER POSSIBLE**

1. ❒ In a city (>100.000 inhabitants)

2. ❒ In a town (> 10.000 inhabitants)

3. ❒ In the countryside/rural district

71. What is the approximate range of your total household income? **ONLY ONE ANSWER POSSIBLE**

1. ❒ $ 24,999 or under

2. ❒ Between $ 25,000 and $ 39,999

3. ❒ Between $ 40,000 and $ 54,999

4. ❒ Between $55,000 and $ 64,999

4. ❒ Between $ 65,000 and $ 79,999

5. ❒ Between $ 80,000 and $ 99,999

6. ❒ Between $ 100,000 and $ 119,999

7. ❒ $ 120,000 or more