Canadian Consumer Preference and Willingness to Pay for Beef Raised under Different Antimicrobial Use Practices

by

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ABSTRACT

In recent years, there have been rising public concerns regarding production practices related to antimicrobial use (AMU) in food-animal production (FAP). Many FAP practices have requirements that consumers are not fully aware of. The raised without antibiotics (RWA) requires that no antibiotic be given at any FAP stage. Otherwise, products cannot be labelled as RWA. Consumers are unaware of the negative implications of limiting AMU on animal welfare. This lack of awareness, if unaddressed, may compromise the welfare of FAP. Likewise, the animal welfare-approved (AWA) label has AMU and no-added hormone (NAH) requirements, while the organic label has AMU and animal welfare requirements. Since these practices have related requirements, we want to know if providing consumers with information on the requirements of these practices influences consumer perception and willingness to pay (WTP) for these labels. We conducted a survey using a choice experiment to estimate Canadian consumer preferences and WTP for steak and ground beef with different AMU and animal welfare practices. We estimated consumer WTP for AWA, grass-fed, RWA, raised without medically important antimicrobials (RWMIA), responsible antimicrobial use (RAU), organic, and NAH. We assessed the impact of demographic variables on consumer WTP for these two beef products. Finally, we looked into the effect of information provision about the labelling requirements of these FAP practices on consumer WTP for these beef products. We found that consumers are willing to pay positive premiums for all steak and ground beef labels except RAU. Several demographic variables such as age, income, household size, living in rural areas, farming background, and presence of children under 12 years of age have a negative impact on consumer WTP for labels such as AWA, grass-fed, RWMIA, and organic. The effect of information was generally negative when consumers were provided with labelling requirements of the FAP practices.

PREFACE

This thesis is an original work by Michael Olufemi. This research was conducted as part of the "Genomic ASSETS (Antimicrobial Stewardship Systems from Evidence-based Treatment Strategies) for Livestock" project funded by Genome Canada with support from Genome Prairie and Genome Alberta. This project got research ethics approval from the University of Alberta research ethics board on the 17th of April, 2023, with ID: Pro00129707.

DEDICATION

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CHAPTER 1 INTRODUCTION

1.1 BACKGROUND TO THE STUDY

Antimicrobial use (AMU) in agriculture has contributed to the expansion of intensive animal production and contributed to meeting the rising global demand for animal protein (Mulchandani et al. 2023; Tiseo et al. 2020). AMU in human and veterinary medicine has contributed to the spread of antimicrobial resistance (AMR), potentially impacting both animal and human well-being (Mulchandani et al. 2023). Statistics reveal that in 2020, approximately 99,502 tons of antimicrobials were administered in food-animal production (FAP) globally, a figure projected to increase by 8 percent to 107,472 tons by 2030 based on current trends (Mulchandani et al. 2023).

About 57 percent of medically important antimicrobials (MIA) drugs in the US were used in food-producing animals (FPA)[1] in 2020 (United States Food and Drug Administration 2021). In Canada, the quantity of MIAs sold for animal use increased slightly from approximately 0.98 million to 1.05 million kilograms from 2019 to 2020 (Public Health Agency of Canada 2022). Specifically, sales of antimicrobials for animal use represented 82 percent of all MIAs dispensed for use in humans, crops, and animals. Since 2018, the sales of MIAs (after adjusting for animal biomass) have declined by 11 percent (Public Health Agency of Canada 2024).

The total number of AMR-related deaths globally is roughly 700,000 deaths per year, making it a critical public health issue worldwide (Pokharel, Shrestha, and Adhikari 2020). In Canada specifically, approximately 15 people per day were estimated to have lost their lives to

[1] Includes antimicrobial drug applications that are approved and labeled for use in both food-producing animals (e.g., cattle and swine) and nonfood-producing animals (e.g., dogs and horses).

infections resistant to antimicrobial treatments in 2018, making AMR challenges an important one for Canada (Finlay et al. 2019).

In North America, beef production is generally in three stages. These are the cow-calf, backgrounding, and feedlot stages. Antimicrobials are mostly used in the beef feedlot sector to maintain feedlot cattle health (Brault et al. 2019; Cameron and McAllister 2016). However, Canadian government data reveals that pig production generally uses higher antimicrobial levels than beef cattle production. Specifically, data shows that from 2018 to 2020, pig production used at least 490,000kg of MIAs on average (Public Health Agency of Canada 2022). This data also reports that the quantity of MIAs sold for use in beef cattle from 2018 to 2020 is an average of 266,000kg. The quantity of MIAs sold for use in poultry is even lower with an average of 138,020kg from 2018 to 2020 as the 2022 Canadian Antimicrobial Resistance Surveillance System (CARSS) report indicates (Public Health Agency of Canada 2022). The number of MIAs sold for use in horses, small ruminants, cats and dogs between 2018 and 2020 are 1,417kg, 68kg and 7,110kg, respectively (Public Health Agency of Canada 2022). This suggests that the usage level of antimicrobials, especially MIAs, is lower in beef cattle production than in pig production but usage in beef is higher when compared to poultry production as the figures from the 2022 CARSS report show (Public Health Agency of Canada 2022). Also, consumers tend to have a misconception about AMU in poultry production which is largely based on perception rather than scientific facts (Barrett et al. 2021; Karavolias et al. 2018). They do not realize that most poultry meat, for instance, contains AMU levels considered safe for humans (Cervantes 2015). The 2022 CARSS report reveals that the quantity of AMU in poultry decreased by about 2 percent between 2019 and 2020 (Public Health Agency of Canada 2022). Antimicrobials in beef cattle production are important for preventing diseases, treating sick animals, and promoting growth. Two common

diseases for which antimicrobials are used in the beef cattle industry are bovine respiratory disease (BRD) and liver abscess. The BRD is a critical health issue for beef cattle producers and can lead to significant economic and animal welfare losses if not handled well. This challenge explains the importance of antimicrobials for the beef cattle industry. However, the overuse and misuse of antibiotics in animals and humans contribute to the rising threat of AMR bacteria. Addressing the issue of the development and spread of AMR has become an important priority (Brault et al. 2019).

1.2 PROBLEM STATEMENT

The rise of AMR is now seen as a global threat to humans and animals (Barrett et al. 2021). This problem of AMR has negative economic and human health consequences (Finlay et al. 2019). Consumers are becoming increasingly concerned about how their food is made (Anders, Malzoni, and An 2023; CFDAS and DIAL Ventures 2023). One such concern is regarding the production practices related to the various AMU and animal welfare practices in FAP (Yang and Raper 2024). One example of this type of practice is feed content, whether it is grass-fed or pasture-raised. The AMU type, such as raised without antibiotics (RWA), raised without medically important antibiotics (RWMIA), and responsible antibiotic use (RAU), is also a concern to consumers, putting actors in the beef feedlot industry under pressure to adjust to its AMU practices.

Specific consumer concerns regarding AMU in FAP are documented in Barrett et al. (2021), and the reasons for these concerns are mixed. It is argued that consumers are confused about modern production practices in FAP. Consumers have shown inadequate awareness of antibiotics and antibiotic practices in FAP (Bradford et al. 2022). Some consumers purchase RWA FPA products because they are concerned about animal welfare and personal health (Goddard, Hartmann, and Klink-Lehmann 2017; Karavolias et al. 2018). However, these consumers may not understand that limiting AMU in FAP may negatively impact the welfare of these animals, contrary

to what they believed originally. Consumers may not understand that AMU is vital for disease prevention and treatment in FAP, and the restriction of AMU may lead to increased animal welfare loss and suffering, particularly in cases of clinical infections (Karavolias et al. 2018; Singer et al. 2019).

Some consumers are worried about the use of hormones in FAP. They are concerned that their meat might contain hormone residue and that there might be health implications for them (Barrett et al. 2021). Specifically, the public thinks hormonal growth promoter compounds may be cancer-causing and could negatively impact their health (Health Canada 2012). Scientific research has indicated no health risk from food originating from FPA treated with these hormonal growth promoters (Health Canada 2012).

Consumer concerns and confusion about AMU in FAP are found to be driving animal husbandry practices across the FAP commodity chain (Barrett et al. 2021). Many FAP practices have requirements consumers are not completely knowledgeable about. For instance, the RWA requires that no antibiotic be given at any FAP stage. Otherwise, products cannot be labelled as RWA. Limiting AMU in FAP may negatively impact the welfare of these animals (Goddard, Hartmann, and Klink-Lehmann 2017). If unaddressed, this lack of awareness and misperception may compromise the welfare of FPAs.

Similarly, the requirements for the animal welfare-approved (AWA) labels have AMU, grass-fed, and no-added hormone (NAH) requirements. The grass-fed label also has all the requirements of the AWA labels. In addition, grass-fed labels require that FPAs be fed a 100 percent grass and forage diet. Likewise, the organic label also has AMU and animal welfare protection requirements. However, consumers are not aware of these related production requirements. This lack of awareness may mean consumers' current price expectations are not their true willingness

to pay (WTP) for those product attributes. Their valuation for these practices may change when they are informed about the requirements of these production practices.

Consumers often associate AMU in FAP with harmful degrees of antibiotic residue, even when federal laws do not allow the sale of such meats (Ritter 2021). For example, in Canada, the Canadian Food Inspection Agency (CFIA) has a National Chemical Residue Monitoring Program and Chemistry Food Safety Oversight Program (NCRMP-FSO), which annually verifies food compliance to Canadian standards and guidelines for chemical residues and contaminants. A recent CFIA (2018) annual NCRMP-FSO report reveals that the beef industry has a compliance rate of 98.1 percent for veterinary drug residues, pesticide residues, and contaminants. Consumers may think the accepted levels should be higher, so compliance would still be considered a problem.

The identified consumer concerns are driving consumers to seek additional information about FAP procedures. Since most consumers are not directly involved in the production process of their food, they want to know how their food is produced (Anders, Malzoni, and An 2023; CFDAS and DIAL Ventures 2023; Pozelli Sabio and Spers 2022). The demand for information about how consumer food is produced suggests a critical need to be met, especially as it relates to AMU in FAP. Given the relationship and interconnection in the requirements of production practices such as RWA, animal welfare, organic, RAU, RWMIA, grass-fed, and NAH, we aim to know if providing consumers with clear information on the requirements of these practices influences consumer perception and preference for these labels.

The economic literature has explored consumer preferences for various FPA products, including the impact of information on consumer preferences. The confusion and lack of adequate knowledge about AMU in FAP calls for a deeper examination of the use of information by consumers on this subject matter of AMU. To the best of our knowledge, several studies have

looked into consumer preference for production practices such as organic and animal welfare, organic and AMU (Alonso, González-Montaña, and Lomillos 2020; Klink-Lehmann et al. 2023; Lai and Yue 2020; Lusk 2018; 2019; Paudel et al. 2022; Pozelli Sabio and Spers 2022; Schmiess and Lusk 2022; Scozzafava et al. 2020; Washio et al. 2023). However, the link or interconnectedness between these production practices, such as organic vs animal welfare vs different AMU vs NAH vs grass-fed and how information provision on the requirements of these production practices shapes consumer purchase decisions remain scarce. This study fills this gap by conducting an economic study on Canadian consumer preference and WTP for beef raised under different AMU and animal welfare practices.

1.3 RESEARCH OBJECTIVES

The primary objective of this thesis was to estimate Canadian consumer preferences and WTP for beef products (steak and ground beef) raised under different AMU and animal welfare practices. Here, we analyzed consumer preferences and WTP separately for steak and ground beef and then compared them.

Another objective of the thesis was to evaluate the impact of information provision on the WTP and Canadian consumers' preferences for ground beef and steak labels. Given the background provided in section 1.2, there is misinformation and lack of knowledge about AMU in FAP. Hence, there is a need to provide relevant information on AMU and animal welfare practices to the public. Since information provision may influence consumer preferences and purchase behaviour across diverse sectors, it becomes important to explore how the provision of information influences consumer decisions regarding preferences and purchasing behaviour for the various AMU and animal welfare practices in the beef industry. So, we sought to explore if the

random placement of respondents in treatment groups affects consumer preferences and their WTP.

Lastly, consumer choices may differ depending on their attitudes, beliefs, habits, and demographic attributes. Hence, the third objective was to identify the demographic traits that account for the discernible consumer preferences and WTP for ground beef and steak labels.

1.4 THESIS ORGANIZATION

This thesis comprises seven chapters. After the introductory section, Chapter 2 delves into a review of the existing literature on consumer perceptions regarding AMU in FPA and the impact of information on consumer behaviour. Chapter 3 outlines the research methods employed in this study, while Chapter 4 describes the data obtained for this study. Chapter 5 gives the empirical approach undertaken, and Chapter 6 describes and discusses the results of the consumer survey and choice experiment. Lastly, Chapter 7 summarizes the thesis by discussing its conclusions, implications, and limitations.

CHAPTER 2 LITERATURE REVIEW

This chapter reviews consumer preferences for and perceptions of AMU in FAP. This review is important as it reveals important insights into consumers concerns on the use of antimicrobials in FAP. In addition, I reviewed the impact of information provision on consumer behaviour.

2.1 CONSUMER PERCEPTION OF ANTIMICROBIAL USE IN FOOD-PRODUCING ANIMALS

Evidence regarding consumer preference and concerns for AMU in FAP has been established in the literature. Ritter (2021) reveals that consumers think that AMU in FAP is connected to and results in harmful antimicrobials residue levels in meat and meat products even when federal laws do not allow the sale of meats with above-safe threshold levels. This thought of residue presence in meat shows one reason why consumers are concerned about AMU in FAP. Although the Canadian beef industry has a 98.1 percent compliance rate, the challenge is that consumers may think the safe antimicrobial threshold levels should be higher, as mentioned in Chapter 1, so the compliance rate may still be problematic for the industry.

Secondly, consumers believe that restricting antimicrobial use in FAP is helpful for the welfare of the animals, but they lack awareness that restricting antimicrobial use may have negative implications on animal welfare (Goddard, Hartmann, and Klink-Lehmann 2017; Karavolias et al. 2018; Singer et al. 2019). Once animals are treated with antimicrobials, their products can no longer be labelled as RWA. Generally, it is argued that consumers lack full knowledge about AMR and AMU in agriculture (Adam and Bruce 2023; Bradford et al. 2022). This lack of awareness may explain why consumers want popular labels such as RWA and No Antibiotics Ever, thinking it ultimately serves the welfare of those animals. Furthermore, the literature points out why consumers are concerned about AMU in agricultural production. The

recurring reasons are concerns for human health and animal welfare (Barrett et al. 2021). Some consumers are also concerned that AMR bacteria might get to humans through the food chain and the environment if antimicrobial is used in FAP (Denver, Jensen, and Christensen 2021; Ma et al. 2021; Samreen et al. 2021).

A well-established body of literature has examined consumer preference and WTP for various attributes in meat products such as health, AMU practices, environment, animal welfare, feeding practices, and production systems (Lusk 2019; Paudel et al. 2022; Schmiess and Lusk 2022)(Lusk 2019; Paudel et al. 2022; Schmiess and Lusk 2022). Schmiess and Lusk (2022) examined the trade-offs consumers are willing to make between reductions in environmental impact and improvements in the animal welfare attributes of beef. Schmiess and Lusk (2022) studied consumer preference for environmental vs animal welfare attributes. The results from their work show that consumers are willing to trade reductions in environmental impact for improvement in animal welfare (Schmiess and Lusk 2022). Another study has examined consumer preference and willingness to pay for AMU vs production methods vs synthetic growth promoters attributes in pork (Paudel et al. 2022). The results from their work show that consumers are willing to pay more for antibiotic-free pork chops compared to those made from minimal antibiotic use for disease treatment and conventional antibiotic use for growth promotion.

Other studies also used attributes such as packaging type, egg colour, and the presence or absence of cage-free, omega-3, organic, natural, and non-GMO labels to assess consumer preferences for cage-free eggs (Lusk 2019). The author's work indicates that most consumers are unwilling to pay the current price premiums for cage-free eggs. Klink-Lehmann et al. (2023) investigated consumer choices in pig farming. Klink-Lehmann et al. (2023) revealed that consumers give more value to their health than considerations for animal welfare, while animal

welfare outweighs environmental-related sustainability attributes. Another study examined consumer preferences for characteristics of beef mince and its substitutes (Washio et al. 2023). The attribute categories used were country of origin and production methods. Their results showed that Japanese-origin organic beef has the highest utility among the five production methods used in the study (Washio et al. 2023).

Various factors influence consumer preferences and demand for AMU-labelled meat and dairy products. These drivers include their beliefs regarding animal welfare and the quality of meat raised without antibiotics (Bradford et al. 2022). This belief and consumer purchasing habits focused on animal welfare attributes significantly determine their willingness to purchase RWA-labeled pork. Moreover, consumers who express more serious concern about the personal impact of antimicrobial resistance (AMR) and those who support AMU for advancing animal welfare are more inclined to buy such products (Bradford et al. 2022). Also, consumer worries regarding the welfare of food-producing animals may deter them from purchasing food animal products (Alonso, González-Montaña, and Lomillos 2020). Bradford et al. (2022) found that the negative factors impacting consumers' willingness to buy pork include their acceptance of animal AMU, the perception that RWA-labeled pork is costly, and a lack of consideration for external attributes like appearance when purchasing pork.

In the context of dairy products, those who view AMU in dairy farming as a significant threat to human health are more likely to be female and exhibit a WTP more for antibiotic-free milk or would not purchase it at all (Wemette et al. 2021). Additionally, they found that consumers' WTP premium for milk from antibiotic-free cattle is tied to several other factors. These factors include the belief that AMU poses some degree of risk to human health, the perception of better treatment of cows on organic dairy farms, a household income of $50,000 or more, being born

outside the country of origin, in their case, the United States, holding a liberal social ideology, and being married or having been married before.

Consumer preferences for animal welfare practices, RWA, and AMU in meat and dairy products are influenced by various factors, including beliefs about animal welfare, health concerns, and product attributes. There is a consensus that consumer attitudes toward these factors significantly affect their willingness to purchase RWA-labeled products. Also, consumer beliefs in animal welfare and health concerns are key drivers of purchasing RWA-labeled products in both meat and dairy categories. Generally, the demand and preference for AMU-related meat and dairy products are shaped by beliefs, concerns, habits, demographic factors, and personal attributes.

2.2 IMPACT OF INFORMATION ON CONSUMER CHOICES

Recent evidence suggests that production practices related to AMU in FAP are generating increasing public concerns (Yang and Raper 2024). Consumers are curious about how their meat and milk are produced (Anders, Malzoni, and An 2023; CFDAS and DIAL Ventures 2023). This concern makes information provision important in shaping consumer choices for the food industries (Cawley, Susskind, and Willage 2020; Streletskaya, Liaukonyte, and Kaiser 2019). However, studies have shown that the impact of information provision is mixed; that is, it could be positive or negative, and it may depend on the information type and how such information is presented (Chen, Zhou, and Hu 2023; Ossokina, Kerperien, and Arentze 2021; Welling, Sagebiel, and Rommel 2023; Yang and Hobbs 2020).

Specifically, it is found that the format of information presentation matters in consumer behaviour studies and that the narrative form of information presentation reduces negative perceptions in decision-making, particularly those related to agricultural technologies (Yang and

Hobbs 2020). Ossokina, Kerperien, and Arentze (2021) also found that information provision impacts choices in different ways, positively or negatively. The authors' work revealed that when tenants were provided with the comfort-related implications of retrofitting, they were willing to pay for it. However, providing information on the financial consequences of retrofitting reduces tenant's cooperation for retrofitting. A choice experiment study in the USA found that the information did not affect consumers' choices of pork chops, likely due to their strong prior belief that AMU in livestock production could pose a human health threat (Xu et al. 2023). Generally, how information is framed and consumers' perceptions about AMU may determine how information could affect consumer choices, positively or negatively.

Tienhaara et al. (2022) studied how information impacts people's preferences for an unfamiliar environmental good, specifically agricultural genetic resources in Finland. They divided respondents into two groups based on their use of additional information and found that sociodemographic and attitudinal factors influence information use. Tienhaara et al. (2022) emphasize the importance of conserving genetic resources and considering the effects of information in choice experiments for unfamiliar goods, focusing on Finland.

It is established in the literature that consumers do not have full knowledge of AMU in FAP (Adam and Bruce 2023; Bradford et al. 2022). This knowledge gap means that consumers may not be aware of the requirements of certain FAP practices fully. For instance, the RWA label requires that no antibiotics be given at any FAP stage. Otherwise, products cannot be called RWA products. Consumers think that RWA is in the best interest of the animals, but they are unaware of the negative consequences of limiting AMU on animal welfare (Goddard, Hartmann, and Klink-Lehmann 2017). This explanation establishes a connection or relationship between the requirements of one production practice and another, as the RWA and animal welfare requirements

indicate. Similarly, animal welfare labels have AMU and NAH requirements, while organic labels have AMU and animal welfare requirements. These requirements show the relationship between the requirements of one production practice and another.

Since practices such as RWA, animal welfare, organic, RAU, RWMIA, grass-fed, and NAH have interconnected requirements as established above, this study sought to know if providing consumers with clear information on the requirements of these practices influences consumer perception and preference for these labels. An example of this is seen in the work of (Ankamah-Yeboah et al. 2019). They found that consumers are more likely to choose products with organic labelling when informed about the associated animal welfare benefits and would be willing to pay more for the organic labelled products. However, the link or interconnection between multiple production practice combinations, such as organic vs animal welfare vs different AMU vs NAH vs grass-fed, and how information provision about the requirements of these production practices influences consumer choice-making is limited. This study fills this gap by conducting an economic study on Canadian consumer preference and willingness to pay for beef raised under different AMU and animal welfare practices, considering information provision on the requirements of these production practices.

CHAPTER 3 RESEARCH METHODS

This chapter describes the stated preference (SP) method, specifically the discrete choice experiment (DCE), the major experimental design types of the DCE, and their benefits and limitations. This chapter also explains the attribute level used for this study, including the choice of products, a sample of the choice tasks, and the information treatments used. Finally, this chapter describes the survey questions, including the sampling and data collection procedures used in this study and the pilot testing process.

3.1 STATED PREFERENCE

This study uses the SP non-market valuation technique to elicit consumers' preference and willingness to pay for beef raised with different antimicrobial use (AMU) practices. The SP methods are non-market valuation techniques that estimate measures of the economic value of goods and services using responses provided to carefully designed survey questions (Champ, Boyle, and Brown 2003; Johnston et al. 2017). However, responses provided may differ from respondents' actual behaviour in the real market, a phenomenon known as hypothetical bias in the stated preference literature (Murphy et al. 2005). For this reason, some economists tend to disapprove of the SP methods because of their lack of trust in people's willingness to provide truthful and careful responses (Brown 2003). Nevertheless, rejecting the SP on this ground is insufficient because well-designed surveys can minimize this problem and help us understand people's preferences better when respondents are systematically queried about their expectations (Manski 2000).

Several logical reasons exist for considering the SP data in evaluating consumer choices and preferences. Louviere, Hensher, and Swait (2000) argue several strong reasons to consider the SP data models. First, the SP methods are relevant because organizations often desire to estimate

demand for new products with new attributes. The SP method that uses the SP data contrasts with another technique, the Revealed Preference (RP). The application to estimate this demand may require a lot of RP data that is difficult to get and may not be reliable for such processes.

Secondly, with RP data, explanatory variables have little or no variability in the market, such as prices for similar products. For instance, in a competitive world, you would often find that prices of substitute goods are identical and may stay that way for long periods. At other times, features of similar products from different brands may not be so different. With this picture in mind, it would be unhelpful to determine how consumer behaviour changes with changes in these explanatory variables. This reason is why SP data seems better than RP.

Third, with the RP data, explanatory variables are highly collinear, a common limitation of the RP data for choice analysis. This collinearity is because when we look at the data of what consumers buy in the real and competitive market, we may find that the factors that drive their decisions are closely related. For example, the price and quality of a product may be related, so it will be difficult to estimate people's choices and decision-making and what factors shape their decisions.

Fourth, the SP data allows us to introduce new variables as new attributes or product features to help us explore and explain current consumer choices. We are unable to do this with the RP data. Furthermore, SP data are worth considering because many products, such as environmental and public goods, are not traded in the real market. Yet, organizations want them valued and their benefit-cost analysis estimated.

These are some reasons why the SP techniques are important for choice analysis. Therefore, this study used the SP approach since it seeks to estimate Canadian consumers' preference and willingness to pay for beef raised with different AMU practices. Considering all

these strengths of the SP techniques over RP, this study chose to use the SP rather than the RP because the RP data available in the market that fits these research objectives is too costly and difficult to get.

3.2 DISCRETE CHOICE EXPERIMENT

The DCE is a multi-attribute SP method originally developed by Louviere and Woodworth (1983) and Louviere and Hensher (1982) as seen in the transport and marketing literature (OECD 2018). The DCE allows researchers to estimate the total value of a change in a good or service and the value of each attribute component by varying the attribute level across options and adding a monetary component such as price.

The DCE technique has several strengths and limitations. The OECD (2018) text highlights a number of them. First, DCE is uniquely useful because it is best for handling multi-dimensional changes, in which consideration of trade-offs is of interest to the researcher. DCE is unique because it can separately identify the value of each attribute of a good or product being studied. Also, the focus on attributes in a DCE increases the potential for the generalization of results, especially from a value transfer point of view. Besides, the DCE method overcomes the challenge that contingent valuation, another SP method, often faces concerning its insensitivity to the degree of changes, making the internal consistency of respondents' choices difficult. Meanwhile, the simultaneous presentation of the whole and parts in DCEs forces some internal consistency in respondents' choices. In addition, DCE is informative because respondents get multiple attempts to express their choices for a valued product over a range of bid amounts.

With all the strengths of DCE, it has its weaknesses. The OECD (2018) argues that the ability of the DCE to present respondents with multiple complex choices between bundles comes with a price, which is the cognitive difficulty associated with this presentation. Nevertheless, this

approach can help achieve better statical efficiency outcomes. On the contrary, Reed Johnson et al. (2013) contend that presenting respondents with fewer, easier trade-offs helps achieve response efficiency, making respondents perform better. In addition, using DCE could be problematic if an unbalanced number of respondents choose the status quo or baseline option, leading to a concept known as status quo bias. Besides, the DCE's welfare estimates may be sensitive to the study design, just like every other SP technique.

Nevertheless, this study chose the DCE approach to help us handle our beef products' multi-dimensional and attribute-level changes. Figure 3.1 below shows a sample choice set to give a clear picture of what a choice set of a DCE looks like.

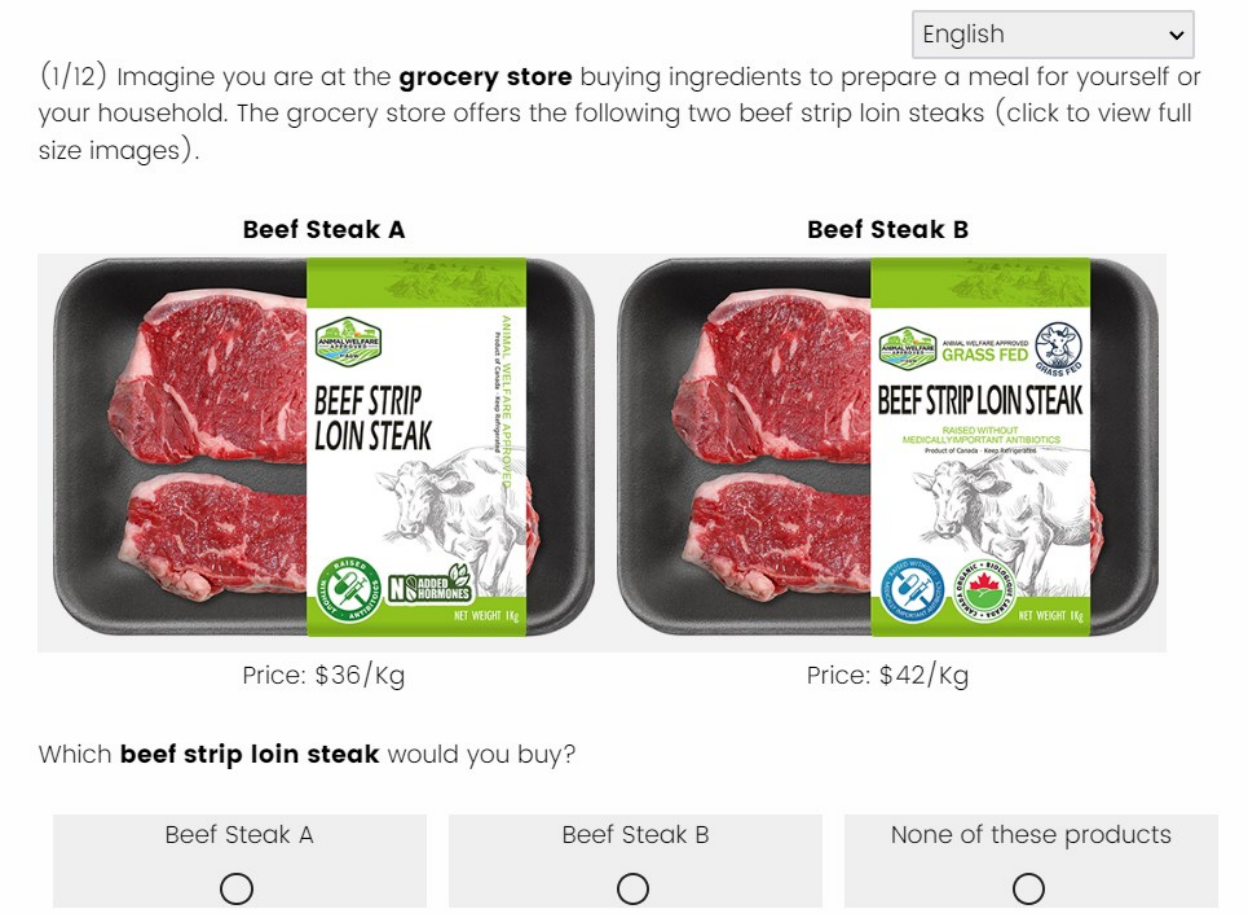

Figure 3. 1: A sample choice set

3.3 EXPERIMENTAL DESIGN FOR STATED CHOICE EXPERIMENTS

An experiment in economics is a scientific procedure under controlled conditions that involves the observation of the effect on a response variable, given the manipulations of one or more of the other variables (Hensher, Rose, and Greene 2015). The DCE helps us see how and what choices people make in different scenarios. The design of such an experiment is the basis for any quality stated choice analysis. According to the OECD (2018), choosing which experimental design to use, in terms of the attribute combinations and levels presented to respondents, is an important process in designing DCEs. The common types of experimental designs for SP studies range from orthogonal, efficient, and Bayesian designs. Please note that the software used for the experimental design process is Ngene (ChoiceMetrics 2018).

3.3.1 Attribute Levels

We used ground beef and beef steak as the products for our DCE. Ground beef was chosen because of its low price. We added beef steak to help us assess the difference in the WTP of these products, considering that steak is a higher-priced product than ground beef.

Food credence attributes are product quality characteristics that buyers cannot directly assess at the point of sale (Schrobback et al. 2023). As a result, consumers must trust the information provided by producers or certified third parties in the form of certification labels. For beef products, several credence attributes or labels exist. For this study choice experiment, we used the following credence attributes: AWA, Grass-fed, RWA, RWMIA, RAU, Organic, and NAH. In Canada, consumers are familiar with and would often find AWA, Grass-fed, Organic, RWA, and NAH meat labels in grocery stores. However, the RAU and RWMIA labels are uncommon in Canada and are new attributes we have incorporated into this design.

This study presented three unlabeled alternatives for each product (ground beef or beef steak) for each choice task. Respondents were randomly assigned to each product. This study examined three and four alternative-choice sets during the experimental design. Considering its reported low-efficiency error, we chose the three alternatives that performed well during the experimental design to avoid any potential information overload challenge. Furthermore, each alternative presented has varying attribute levels for animal welfare, feeding practices, AMU practices, production systems, and hormone use practices, as shown in Table 3.1 below.

Table 3. 1: Attribute table showing the attributes and their levels

Attributes	**Label**	**# Level**
Animal Welfare	1=Animal Welfare Approved; 0 =Otherwise.	2
Feeding Practices	1=Grass-Fed; 0 = Otherwise.	2
Antibiotic Use Practices	1=Responsible Antibiotic Use, 2=Raised Without Medically Important Antibiotics, 3=Raised Without Antibiotics; 0 = None.	4
Production Systems	1=Organic; 0 = Not organic.	2
Hormone Use Practices	1=No Added Hormones; 0 = Otherwise.	2
Price($/kg) (ground beef) Price($/kg) (beef striploin steak)	0=9, 1=12, 2=15, 3=18, 4=21, 5=24 0=30, 1=36, 2=42, 3=48, 4=54, 5=60	6 6

3.3.2 Orthogonal, Efficient, and Bayesian Design

This section presents an overview of common experimental designs for DCEs. It also describes the Full Factorial, Fractional Factorial, Efficient and Bayesian designs. It also explains the limitations and benefits of each of these designs.

3.3.2.1 Orthogonal Designs

The orthogonal experiment design is a type of design that guarantees that all specified parameters can be independently estimated and that it satisfies the attribute level balance (ChoiceMetrics 2018). There are two major types of orthogonal design. These are the full factorial (FFD) and fractional factorial designs (FrFD).

The FFD design considers all possible choice situations, including all possible identified attribute level combinations (ChoiceMetrics 2018). The limitation of the FFD is that it often generates a larger number of choice situations than a single respondent can handle. Therefore, it is only useful for the smallest problems. Nevertheless, the FFD may help generate other designs, such as some specific FrFD.

The FrFD is the type of design in which each respondent is shown a subset of S choice situations from the total number of choice situations available, as it is impossible for a single respondent to attempt all possible scenarios (ChoiceMetrics 2018). This design is done by randomly selecting choice situations among the initial FFD. Another option is to present the first block of the larger S choice situations to the first respondent, then the second respondent with the second block of main choice situations and other blocks in a similar pattern. However, these arrangements could lead to biased outcomes if respondents are faced with only low or high values of a certain attribute. These biased outcomes can be avoided by choosing the subsets that help to achieve attribute level balance (ChoiceMetrics 2018).

3.3.2.2 Efficient Designs

Although the orthogonal design has existed for a long time, the efficient design is gaining popularity among researchers (ChoiceMetrics 2018). The efficient designs in DCEs have existed

for the past decade and have become state-of-the-art in experimental design (Bliemer and Rose 2024). Unlike orthogonal designs, efficient designs try to minimize the correlation in the data needed for estimation purposes and generate data that yield parameter estimates with the least possible standard errors (ChoiceMetrics 2018).

The efficient designs rest on the idea that the asymptotic variance-covariance (AVC) matrix of the parameters can be obtained if the parameters are known (ChoiceMetrics 2018). Sadly, since the objective of the SP technique is to estimate these parameters, they are unknown (ChoiceMetrics 2018). However, suppose we have some prior information about these parameters, such as parameter estimates in the literature from related work or pilot studies. In that case, the AVC matrix can be determined, assuming that the priors used are correct (ChoiceMetrics 2018). Therefore, when information about the parameter is available, an efficient design will be useful compared to an orthogonal design. Some literature on stated choices revealed that one could use a random, efficient or orthogonal design for a pilot study, depending on certain situations. Specifically, Bliemer and Rose (2024) explained that an orthogonal design is suitable for a pilot study when most attributes have two or three levels and if there is no issue related to dominant alternatives. The authors added that orthogonal design is useful if no unrealistic attribute level combinations exist. However, when this is not the case, an efficient design could be useful for a pilot study, especially if the sample size is small, while applying possible constraints and excluding choice tasks with dominant alternatives (Bliemer and Rose 2024). For this reason, we have used an efficient design for our pilot study. We ran the pilot survey to help us get an initial idea of parameter estimates needed for the Bayesian efficient design for the main survey. This study used the weak non-zero priors for the pilot DCE design. The weak non-zero priors were used to mitigate the dominant alternatives observed in our design when we initially used zero priors.

As mentioned earlier, the weak non-zero priors in our efficient design were used to ease the issue of dominant alternatives identified in our design originally when zero priors were used. Ngene can automatically remove identical choice tasks and dominant options. This study used the row-based modified Federov algorithm, Cook and Nachtrheim (1980), rather than the column-based algorithm. The choice of the row-based algorithm over the column-based is because the former helps to easily remove bad choice situations in terms of a poor combination of attribute levels in a choice situation from a candidature set at the beginning of a design and keeps for us the best choice tasks to use in our design (Hensher, Rose, and Greene 2015). Bad choice combinations in a choice situation represent a case where options presented do not fully represent the true choice situations or the full range of preferences that may be available to a person. This situation might be seen when certain attributes are dominant over others. This weakness is why we used weak non-zero priors to mitigate the issue of any dominant alternatives in our design. Sometimes, one may see neglect or non-attendance of survey participants to certain attributes because it may not have fulfilled a true picture of their taste, a phenomenon called non-attribute attendance. This situation is also a result of bad choice combinations.

3.3.2.3 Bayesian Design

The main DCE survey used for this study employed the Bayesian efficient design. The Bayesian efficient design exists as another form of efficient design. Though efficient designs use known and fixed parameter priors, there is always some uncertainty about the true parameter values (ChoiceMetrics 2018). Therefore, these priors are never known with certainty but only by approximation. The Bayesian efficient design was developed to account for this uncertainty in parameter priors by using random priors instead of fixed priors and to reduce loss of information when the true parameter values deviate from the informative local priors (Bliemer and Rose 2024;

ChoiceMetrics 2018). The reasons explained above are why we chose the Bayesian efficient design for the main study as a more robust design strategy.

As ChoiceMetrics (2018) suggested, we first generated a non-Bayesian design with the MNL model for this process. The beta estimated from the pilot survey was used as the prior for the Bayesian design. We then generated 36 choice sets overall and applied blocking as in orthogonal designs. The 36 choice sets were blocked into three, resulting in 12 choice sets per block. A respondent can only take 12 choice sets. Blocking was necessary to ensure that respondents do not face too many choice decisions, which may place a significant cognitive burden on respondents and ultimately result in decreased response rates and reliability (Hensher, Rose, and Greene 2015).

The Bayesian design assumes the priors to be random following some given probability distribution to express the uncertainty about the true value of β. However, this design type can be computationally intensive and time-consuming when the pseudo-random Monte Carlo simulations determine each design's D-error. Therefore, Bliemer, Rose, and Hess (2008) suggested using quasi-random draws or the Gaussian quadrature techniques since they require fewer simulations to evaluate more designs simultaneously than the pseudo-random Monte Carlo simulations method.

Therefore, this study chose the Bayesian design because of its ability to achieve an improved robust design compared with the local (fixed and weak) priors, as Sandor and Wedel (2001) suggested.

3.3.3 Dummy Coding

This study used dummy coding to code for our study's AMU practice attribute, given that it is a categorical variable that exceeds two levels. Dummy coding is a non-linear coding scheme and allows a researcher to detect nonlinearities in the marginal utilities for attribute levels rather than assuming a linear relationship between attribute levels and overall utility (ChoiceMetrics 2018).

Researchers incorporating categorical product attributes in discrete choice studies often recode them using dummy or effects coding. Some studies have preferred effects coding because it helps resolve confounding problems between attributes in DCE research (Balogh et al. 2016; Hoyos 2010; Bech and Gyrd-Hansen 2005). However, a recent study argues that confounding does not exist in any of these methods, even when alternative specific constants are present in a choice model (Hu et al. 2022). Furthermore, Hu et al. (2022) maintained that the two coding schemes are equivalent. They recommend dummy coding as a better option given its lower likelihood of misinterpretation, as conversely seen with effects coding in its mishandling and misinterpreting the results for welfare and preference analysis estimates in previous studies. Therefore, this study adopted the dummy coding for our AMU practice attribute, given the evidence from Hu et al. (2022) on its equivalence with effects coding and its lower probability of misinterpretation in welfare analysis when in use.

This dummy coding process usually involves the recoding of new variables. The number of new variables being recoded will equal the number of levels associated with the attribute in question (Hensher, Rose, and Greene 2015). For example, in our design, we dummy coded for AMU practices, without interactions, that originally had four levels ($l_k = 4$). Hence, recoding the AMU practices attribute into dummy coding required the creation of three new variables ($l_k - 1 = 3$). As Hensher, Rose, and Greene (2015) explain, when using dummy coding, each newly

constructed variable must be associated with one of the original levels of that attribute, taking the value one if that level appears in the data or zero otherwise. Therefore, given this dummy coding for our AMU practice attribute, the base level receives a zero value for each newly constructed dummy variable.

3.3.4 Information Treatments

We used information treatment in the form of various AMU practice labels or claim definitions. One reason for this is to test whether the random placement of respondents in the treatment groups affects consumer preferences and WTP. We also did this to check the various consumer confusion regarding antibiotics use in food-producing animals as seen in the literature and if this provision affects their understanding (Abrams, Meyers, and Irani 2010; Barrett et al. 2021; Bradford et al. 2022; Goddard, Hartmann, and Klink-Lehmann 2017; Ritter 2021; Singer et al. 2019).

Regarding the information treatments, we had control and treatment groups for ground beef and beef steak participants. In addition, each treatment group received the claim or definitions of the attributes presented in the DCE of this study. These claims are the RWA, RWMIA, RAU, NAH, AWA, Grass-Fed, and Organic. We adapted the RWA and the NAH information from the Canadian Food Inspection Agency's webpage (CFIA 2024). Similarly, information on medically important antibiotics was extracted from the government website of the Public Health Agency of Canada (Government of Canada 2009). This study also adapted information from the Antibiotic Resistance Action Center provided at the Milken Institute School of Public Health, George Washington University, on their Certified RAU claims (Antibiotic Resistance Action Center 2022). We also adapted the AWA and Grass-Fed information from the A Greener World website (A Greener World 2022). Please see Table 3.2 for the information treatments used.

Table 3. 2: Information treatment (Label definitions)

Label/Claim	**Meaning**	**Source:**
Raised Without Antibiotics	The food-producing animal may not have been treated with antibiotics from birth to slaughter or harvest. Sick or injured animals may be given antibiotics. However, the products of treated animals cannot be labelled as "Raised without antibiotics."	Canadian Food Inspection Agency's webpage.
Medically Important Antibiotics (MIAs)	MIAs are antibiotics that are considered important to human medicine for the treatment of bacterial infections in humans. Antibiotics that are not considered MIAs are not used in human medicine.	Public Health Agency of Canada.
Responsible Antibiotic Use	Animals were raised with minimal use of medically important antibiotics. Antibiotics shall not be used for growth promotion and disease prevention. Sick and injured animals may be given antibiotics.	Antibiotic Resistance Action Center at the Milken Institute School of Public Health, George Washington University
No-added hormones	No hormones or β-agonists, such as ractopamine, were administered in any way to the animal.	Canadian Food Inspection Agency's webpage
Animal welfare approved	Animals are raised outdoors on pasture (not confined to feedlots). Requires audited high-welfare production, transport and slaughter practices. No added hormones. Antibiotics shall not be used for growth	A Greener World website

	promotion and disease prevention. Sick or injured animals may be given antibiotics. However, the products of treated animals cannot be labelled as animal welfare approved.	
Grass-fed	All requirements under the animal welfare approved claim/label, plus; Animals are fed a 100% grass and forage diet (no grain or grain by-products)	A Greener World website
Organic	During grazing season, animals must receive 30% or more of the forage in their diets from grazing on pasture. All feed and pastures for grazing must be certified as organic. No added hormones. Antibiotics shall not be used for growth promotion and disease prevention. Sick or injured animals may be given antibiotics. However, the products of treated animals cannot be labeled as organic. The farmer must respect animal welfare.	Canadian Organic Standard

3.3.5 Cheap Talk & Budget Reminder

Evidence of hypothetical bias in choice experiment studies is clear (Haghani et al. 2021a; 2021b). Because of this prevalence, Haghani et al. (2021b) suggested mitigating options for this issue, which they classified as ex-ante and ex-post bias mitigation methods. These ex-ante approaches are cheap talk, real talk, consequentiality scripts, solemn oath scripts, opt-out reminders, budget reminders, honesty priming, induced truth-telling, indirect questioning, time to think, and pivot designs. Conversely, the ex-post methods are follow-up certainty calibration scales, respondent-perceived consequentiality scales, and revealed-preference-assisted estimation.

Although various disciplines have used different mitigation strategies for this hypothetical bias issue, empirical investigations reveal that the effectiveness of cheap talk in dealing with hypothetical bias has been undertaken mostly by consumer and environmental economists (Haghani et al. 2021b). However, the review of Haghani et al. (2021b) found that a cheap talk script alone does not eliminate hypothetical bias, at least not in comparison with the other approaches like the honesty priming effect, as De-Magistris, Gracia, and Nayga Jr (2013) reveal. Furthermore, Gschwandtner and Burton (2020) compared the impact of a budget reminder with a cheap talk script against a combination of honesty priming and budget reminders within the context of food choices. They argue that using budget-reminder with cheap talk appears to be a more effective approach than the latter. This reason explains why we adopted the combination of cheap talk with a budget reminder to mitigate the hypothetical bias situation of DCE studies.

Below is a copy of the "cheap talk" script we adapted from Carlsson, Frykblom, and Lagerkvist (2007):

> "The experience from previous similar surveys is that people often respond in one way but act differently. It is particularly common that one states a higher willingness to pay than

> what one actually is willing to pay for the good in the store. We believe this is due to the fact that one does not really consider how big an impact an extra cost actually has to the family budget. It is easy to be generous when one does not really need to make the choices in a store. If you have other ideas or comments on what this behavior depends on, please provide them at the end of the survey."

3.4 SURVEY QUESTION DESCRIPTION

The survey drafts started with the development of several initial sections that supported this study's objectives and the findings from the literature on the confusion about the numerous RWA-related claims and animal welfare issues. After careful reviews from supervisors and the Genomic Canada scientific committee and the approval of the research ethics board (ID: Pro00129707) of the University of Alberta on April 17, the final survey used for this study was approved for lunch in May 2023. A pretest (pilot survey) data became available at the end of the first week of May, while a full survey lunch was completed later in May. The final version of the survey has the DCE and non-DCE components. See the Appendices chapter for the full survey.

The non-DCE section was further broken down into sections such as the introduction, demographics, and factors driving consumer beef choices. This non-DCE survey also asked about respondents' beliefs regarding beef products available on the markets, their perceptions about and attitudes toward animal welfare and antimicrobial uses in food-producing animals, and their perceptions and concerns about antimicrobial-resistant bacteria. This part of the survey also asked about respondents' consideration for future consequences (CFC) and their political attachments, but this study did not use this data for analysis.

The introduction presented the research title to the respondents and shared the survey instructions with the participants, such as the purpose of the research, what they will encounter during the survey, and the potential benefits of taking the survey as a member of the TGM Research panel. The introduction also told them about the need for consent, anonymity, and a data

management plan in the survey. The questions on the demographics included those relating to age, gender, geographical location, farm ownership status, educational level, household income before taxes in the past 12 months, household size, and the number of children (12 and under) that live in their households. These questions aim to understand the socio-economic characteristics that affect Canadian consumer choices and preferences for the beef products presented in this survey.

In addition, the survey presented factors, such as animal welfare, religious beliefs, health and product safety concerns, environmental impact, appearance, convenience, quality, brand, and origin, which may shape consumers' beef purchase decisions and asked how important those factors are for the respondents in their decision-making process. A follow-up question was asked about their beliefs on animal welfare, overuse or misuse of antibiotics, and antibiotic residues in beef products in the markets. Besides, the survey asked about respondents' attitudes toward animal welfare, antimicrobial uses in food-producing animals, and antimicrobial-resistant bacteria. These questions were included to understand the perception variables that affect consumers' choices for beef products in Canada.

Questions on respondents' CFCs were asked to know the considerations consumers would give to the issues of antibiotics, similar to how researchers think about the consequences of climate change for the future. The CFC questions used are built on those originally proposed by Strathman et al. (1994) and recently evidenced in Chng, Chew, and Joireman (2022). This survey used the 4-item CFC scale, which is valid and may potentially reduce the cognitive burden of using a long list of CFC questions. The survey also asked respondents about their political orientations to assess if this influences their perspective on the AMR topic (Naing et al. 2021). However, the data from these questions was not used in the analysis of this thesis.

This study's DCE section was dedicated to presenting the choice experiment tasks to the respondents. Lastly, this survey gave a disclaimer note about respondents' opinions about medically important antibiotics we sought. It provided them with a link to the government website to learn more about how the government is taking action to tackle AMR related to AMU in food-producing animals.

CHAPTER 4 DATA DESCRIPTION

This chapter describes the data from our survey. This chapter describes the demographic information of the survey respondents. It also describes the factors affecting consumer beef purchase decisions and AMR and AMU knowledge. This chapter also discusses the insights from the data of this study.

4.1 DEMOGRAPHICS OF RESPONDENTS

We had 2506 valid responses from our survey after applying some criteria, such as eliminating responses that missed the DCE choice and two trap questions. We also used an outlier elimination criteria for the duration spent on the survey if the duration is less than 494 seconds or greater than 2786 seconds. Given that we randomly assigned participants into control and treatment groups based on whether they received information about the requirements for various production practices, I have provided the distributions of ground beef and steak. I also showed how they are distributed by treatment groups (Treatment and Control) (See Table 4.1).

Table 4. 1: Product Distribution

Product	Product Distribution	Treatment	Control
Steak	1284	642	642
Ground beef	1222	595	627

In terms of the demographics, the respondents were a representative sample of the Canadian population based on the distribution of age, mean household size, gender, and province/territory of residence (see Table 4.2). Our data reveals that we had slightly more female respondents than males. The average age of the respondents is approximately 50 years. At the same time, we had more survey participants from the province of Ontario. Our data reveals that our sample is more educated and less wealthy than the Canadian population, as we had more samples

in the ≤$99,999 income category and less in the ≥$100,000 income category than the Canadian population. These deviations in figures from the Canadian population might be a self-selection bias issue because the survey was optional and, as such, might have skewed the results from the census figure.

Table 4. 2: Demographics of Respondents

Demographic	**Sample**	**Canadian Population[1]**
AGE (mean)	49.6	49.3[2] (mean)
GENDER (%)		
Female	50.8	50.7
Male	48.3	49.3
PROVINCE (%)		
Alberta	12.7	11.5
British Columbia	13.8	13.5
Manitoba	4.7	3.6
Newfoundland and Labrador	1.9	1.4
New Brunswick	2.4	2.1
Northwest Territories	0.1	0.1
Nova Scotia	2.7	2.6
Ontario	41.5	38.5
Prince Edward Island	0.7	0.4
Quebec	15.3	22.9
Saskatchewan	4.2	3.1
Yukon	0.1	0.1

HOUSEHOLD SIZE (mean)	2.5	2.4
NUMBER OF CHILDREN IN HOUSEHOLD UNDER 12 (mean)	1.6	1.8[3]
ANNUAL HOUSEHOLD INCOME, BEFORE TAX (%)		
49,999 and under	35.8	26.9
50,000 – 99,999	38.5	32.7
100,000 – 149,999	16.6	20.3
>=150,000	9.1	20.1
EDUCATION[4]		
Below Bachelors degree	27.7	67.1
Bachelors Degree or Univ. Diploma	54.6	23.5
Graduate or Professional Degree	17.7	9.4

[1] Data from Canada Census 2021 (Statistics Canada)

[2] The mean age for Canadians aged 18 years and older

[3] Average number of children in census families with children

[4] For ages 25-64 years

4.2 FACTORS AFFECTING BEEF PURCHASE DECISION

We included a question in our survey to identify the dietary preferences of our respondents. Specifically, we asked the respondents whether they identify as vegan, pescatarian, vegetarian,

flexitarian or regular meat consumers. Our data reveals that approximately 81 percent of the respondents regularly consume meat, fish, seafood or products derived from animals (see Table 4.3).

Table 4. 3: Diet Distribution of Respondents

Vegan	Pescatarian	Vegetarian	Flexitarian	Meat Consumer[2]	None
1%	1%	3%	10%	81%	4%

Next, we asked respondents about factors that are important to them when making their beef purchase decisions. Table 4.4 reveals that quality, product safety, appearance, price, nutrition, and origin are important for beef consumers. More than half of the respondents indicated that animal welfare is important when buying beef. These outcomes are not surprising given the concerns that consumers have shown in earlier studies about their desire to know how their food is made and the production practices involved in FAP (Anders, Malzoni, and An 2023; Barrett et al. 2021; Goddard, Hartmann, and Klink-Lehmann 2017; Yang and Raper 2024).

Table 4. 4: Factors Affecting Consumer Beef Purchase Decision – Percentage of Respondents who stated Very Important or Extremely Important

Factors	Percentage of Total
Animal Welfare	58%
Environmental Impact	48%
Religion	15%

[2] Regular Consumers of Meat, Fish, Seafood or Products Derived from Animals

Nutrition/Health	77%
Product Safety	81%
Price	85%
Quality	91%
Origin	63%
Brand	37%
Appearance	84%
Convenience	59%

4.3 ANTIMICROBIAL AND ANTIMICROBIAL RESISTANCE KNOWLEDGE

Evidence from the literature has shown that consumers lack adequate knowledge of AMR and AMU topics, especially those involving FAP (Barrett et al. 2021; Bradford et al. 2022). We asked our respondents about their knowledge of AMR using a Likert scale. Our data reveals that approximately 13 percent of the respondents are highly knowledgeable about AMR, indicating that only a few are confident about their knowledge of AMR (See Table 4.5). The evidence from the literature was why we also investigated the effect of informing consumers about the labelling requirements of different AMU practices on consumers' willingness to pay for beef products.

Table 4. 5: RESPONDENTS AMR KNOWLEDGE

Not knowledgeable	Slightly knowledgeable	Moderately knowledgeable	Very knowledgeable	Extremely knowledgeable
26%	30%	31%	10%	3%

MIAs are antibiotics that are considered important to human medicine for the treatment of bacterial infections in humans. Antibiotics that are not considered MIAs are not used in human medicine. We asked respondents about their knowledge of MIAs use in FAP in Canada. About half of the respondents agreed that all MIAs for animal use require a veterinary prescription in Canada (See Table 4.6). Our data reveals that major knowledge and awareness gaps relating to AMR and AMU exist. The role of information provision about the requirements of various production practices is needed to address the low level of knowledge and awareness.

Table 4. 6: RESPONDENTS' KNOWLEDGE OF MIAs USE IN FAP IN CANADA

Strongly disagree	Disagree	Neutral	Agree	Strongly agree
3%	7%	43%	28%	20%

CHAPTER 5 EMPIRICAL STRATEGY

This chapter discusses random utility theory (RUT), the empirical models, and welfare measures, which are key foundations for a DCE study. This chapter outlines the major model used in this study, the mixed logit (MXL) model, after a brief overview of the classic conditional logit (CL) model and its restrictive assumptions. The MXL models were estimated to help us account for preference heterogeneities.

5.1 RANDOM UTILITY THEORY

RUT is an economic theory that seeks to explain and predict the choices of individuals from a set of alternatives. Consumer choice models often employ RUT, assuming that individuals are rational decision-makers. According to RUT, individuals maximize their utilities[3] based on the options available, thereby making choices that are most satisfying to their preferences (Cascetta 2009). RUT explains that when individuals are faced with a choice between alternatives, they assign utilities to each alternative based on their preferences. These utilities are assumed to be randomly distributed, reflecting the inherent uncertainty and variation in individual preferences.

RUT distinguishes an individual's utility for each alternative into deterministic (observable) and random (unobservable) components. This deterministic part of an individual's utility function represents the underlying characteristics of the alternatives and the individual's preferences. In contrast, the random component captures the unobservable and random factors that shape choices. In addition, the random element adds variation to the choice process and may yield different decisions being made by decision-makers under the same conditions. Therefore, the random component is an integral piece of RUT when setting up the empirical model to capture

[3] Utility, in economics, basically refers to the satisfaction or pleasure that an individual derives from consuming a good or service.

unobservable factors that drive individual utility. RUT assumes that the utility derived by respondent *i* from choosing alternative *j* within the choice set *s* can be expressed as follows:

$$U_{isj} = V_{isj} + \varepsilon_{isj} \quad (5.1)$$

In the framework above, *i* ranges from 1, …, *N*; *s* from 1, …, *S*; and *j* from 1, …, *J*, with *N* respondents making choice decisions amongst *J* alternatives across *S* choice sets. In this study, *N* = 1, …, 2506; *J* = 1, …, 3; *S* = 1, …, 12. V_{isj} represents the observable component of the overall utility of choosing alternative *j*. $\mathcal{E}_{isj}$ denotes the stochastic disturbance term, incorporating characteristics not directly visible to the analyst (Lancsar, Fiebig, and Hole 2017). Thus, the probability of choosing alternative *j* is given as:

$$P_{isj} = Prob(U_{isj} - U_{isk} > 0)\ \forall k \neq j \quad (5.2)$$

While RUT has been valuable in explaining consumer behaviour, it has faced criticism regarding its accuracy in explaining individual decision-making processes (Kahneman 2011). Critics argue that this theory relies on unrealistic assumptions, such as the assumption of perfect rationality and the independence of irrelevant alternatives. However, Hess, Daly, and Batley (2018) argue that RUT substantially benefits choice modelling. Many behavioural traits can be reasonably estimated within a random utility framework, preserving its advantages (Hess, Daly, and Batley 2018). RUT maintains a strong connection to microeconomics, which is a valid basis for estimating WTP measures as marginal rates of substitution between price and other relevant alternative specific attributes. Additionally, RUT provides a justifiable framework for understanding individual behaviours.

RUT offers a valuable theoretical framework for understanding how individuals make decisions and is largely consistent with microeconomic theory. The next sections describe the empirical models for this study. Furthermore, in this chapter, the welfare measure is defined.

5.2 EMPIRICAL MODELS

This section outlines the variable details and empirical models used in this study. It begins by introducing the basic framework of the CL model, which serves as the foundation for our model specifications. Subsequently, this section delves into the MXL model, which incorporates random coefficients to account for heterogeneity in respondents' preferences.

Following the earlier utility specification for $U_{isj,}$ in equation 5.1, we have an estimation model for our choice analysis. Given the attributes and price levels, we have the model:

$$U_{isj} = ASC_{isj} + \beta_1 awa_{isj} + \beta_2 grass_{isj} + \beta_3 RWA_{isj} + \beta_4 RWMIA_{isj} + \beta_5 RAU_{isj} + \beta_6 Organic_{isj} + \beta_7 Hormone_{isj} + \beta_8 Price_{isj} + \varepsilon_{isj} \quad (5.3)$$

Table 5. 1: Variables Definition

Variable Names	Variable Meaning	Variable Coding
ASC	Alternative Specific Constant for the No Purchase Option	0 = No Purchase Option, 1= Alternative 1 or Alternative 2
awa	Animal Welfare Approved	1=Animal Welfare Approved; 0 = Otherwise
grass	Grass-Fed	1=Grass-Fed; 0 = Otherwise
RWA	Raised Without Antibiotics	1=RWA; 0=RWMIA; 0=RAU
RWMIA	Raised Without Medically Important Antibiotics	1=RWMIA; 0=RWA; 0=RAU

RAU	Responsible Antibiotic Use	1=RAU; 0=RWA; 0=RWMIA
Organic	Organic	1=Organic; 0 = Not organic
Hormone	No-Added Hormone	1=No Added Hormones; 0= Otherwise
Price	Price of the beef products	Continuous variable

In Table 5.1, the list of the main exploratory variables is presented. These variables are the alternative-specific variables provided to our respondents. In addition, all the variables in the table above are categorical except price, which is continuous.

5.2.1 Conditional Logit Model

The CL model is commonly used to analyze discrete choice circumstances where individuals choose among multiple mutually exclusive alternatives. It is a foundational model in choice modelling, developed by (McFadden 1974). Despite its wide use, it has some restrictive assumptions that may pose a challenge to a model's result usefulness and interpretation.

The major limitation of the CL model is its independence of irrelevant alternative (IIA) property (Analytics 2018). This IIA means that the relative probability of an individual choosing between two options is independent of any additional alternatives in the choice set. This IIA assumption may not always hold in certain situations, leading to potential biases in the model's estimates. Another limitation of the CL model is that it assumes individual preference homogeneity (Analytics 2018). However, more advanced choice models have been developed to address the limitations, which relax the IIA assumption and allow for more flexibility in capturing individual heterogeneity and substitution patterns.

The probability that an individual chooses a particular alternative is modelled using the multinomial logit function derived from RUT, assuming that the error component is a Type I extreme value or Gumbel distribution, as shown by Ben-Akiva and Lerman (1985). Given equation 5.1, the CL model claims that the probability that an individual *i* will choose an alternative *j* from *s* choice situation is given by:

$$P_{isj} = \frac{exp(V_{isj})}{\sum_{k \in C_S} exp(V_{isk})} \tag{5.4}$$

where:

P_{isj} is the probability of an individual *i* choosing alternative *j* from the choice situation *s.*

V_{isj} is the deterministic component of the utility function connected with the individual *i* choosing alternative *j* in choice situation *s*.

$\sum_{k \in C_S} exp(V_{ik})$ is the sum of the exponential of the deterministic utility component of all alternatives *k* in the choice situation *s*. C_s represents the set of all alternatives in choice situation *s*.

5.2.2 Mixed Logit Model

The MXL model extends the traditional CL model by allowing one or more of the parameters in the model to be randomly distributed. Thus, it is unique for choice data because it allows random coefficients. Also, the MXL is often of special interest because it relaxes the restrictive assumption of the CL model's IIA and homogeneity.

Unlike the CL model, the MXL assumes that tastes or preferences differ across individuals, following a certain probability distribution, and that these preferences are captured by a set of random parameters (Hensher, Rose, and Greene 2015). Thus, including random parameters in the

model specification helps to account for the preference heterogeneity and the unobservable factors that drive individual choices. Also, the MXL adds flexibility when capturing the variation in individual preferences compared to the classic CL model by accounting for the decision-makers preference heterogeneity arising from observed and unobserved factors.

Since the modelling of discrete choice data will often follow RUT (McFadden 1974), the utility specification described earlier in equation 5.1 then becomes:

$$U_{isj} = \beta_i X_{isj} + \varepsilon_{isj} \quad (5.5)$$

Where X_{isj} is a vector of explanatory variables including attributes of beef (ground beef or steak) and interactions of attributes and demographic variables, and interactions of attributes and treatment groups (Treated and Treatment Failure, TF), and ε_{isj} is a random term representing the unobserved utility component that affects individuals' choices (Hess and Train 2017). It is assumed to be independently and identically distributed (iid) across individuals, choice situations and alternatives with extreme value type I distribution. β_i is a conformable vector of the unknown utility weights the respondents assign to the explanatory variables.

The MXL model relaxes the IIA assumption by incorporating preference heterogeneity into the observed attributes. Therefore, the utility weight β_i for a given product attribute is given as:

$$\beta_i = \beta + \Gamma \nu_i \quad (5.6)$$

Where β is the vector of the mean attribute utility weights in the population, ν is the choice- and specific-unobserved random disturbances with mean 0 and standard deviation 1. Γ is a diagonal matrix which contains the standard deviation of the distribution of the individual preference parameter (β_i) around the population mean preference parameter, denoted as β, on its diagonal.

Following Greene's (2012) specification of the utility weight to show how heterogeneities are accommodated, we have:

$$\beta_i = \beta + \Delta z_i + \Gamma v_i \quad (5.7)$$

Where Δz_i reflects the observed heterogeneity and Γv_i reflects the unobserved heterogeneity.

The model estimated to represent the attribute-only MXL model is given by Equation (5.8):

$$\begin{aligned} U_{isj} = {} & ASC_{isj} + \beta_{iPrice} Price_{isj} + \beta_{iAWA} AWA_{isj} + \beta_{igrassfed} grassfed_{isj} + \beta_{iRWA} RWA_{isj} \\ & + \beta_{iRWMIA} RWMIA_{isj} + \beta_{iRAU} RAU_{isj} + \beta_{iorganic} Organic_{isj} \\ & + \beta_{iNAH} NAH_{isj} \end{aligned} \quad (5.8)$$

The model estimated to represent the attribute-ASC MXL interaction model is given by Equation (5.9):

$$\begin{aligned} U_{isj} = {} & ASC_{isj} + \beta_{iPrice} Price_{isj} + \beta_{iAWA} AWA_{isj} + \beta_{igrassfed} grassfed_{isj} + \beta_{iRWA} RWA_{isj} \\ & + \beta_{iRWMIA} RWMIA_{isj} + \beta_{iRAU} RAU_{isj} + \beta_{iorganic} Organic_{isj} + \beta_{iNAH} NAH_{isj} \\ & + \beta_{iAge*ASC} Age_i * ASC_{isj} + \beta_{iGender*ASC} Gender_i * ASC_{isj} + \beta_{iRural*ASC} Rural_i \\ & * ASC_{isj} + \beta_{iFarm*ASC} Farm_i * ASC_{isj} + \beta_{iEdu*ASC} Edu_i * ASC_{isj} + \beta_{iInc*ASC} Inc_i \\ & * ASC_{isj} + \beta_{iHHSize*ASC} HHSize_i * ASC_{isj} + \beta_{iNumChild*ASC} NumChild_i * ASC_{isj} \\ & + \beta_{iFoodExp*ASC} FoodExp_i \\ & * ASC_{isj} \end{aligned} \quad (5.9)$$

The model estimated to represent the attribute-demographic MXL interaction model is given by Equation (5.10):

$$U_{isj} = ASC_{isj} + \beta_{iPrice} Price_{isj} + \beta_{iX} X_{isj} + \beta_{iAge*ASC} Age_i * ASC_{isj} + \beta_{iGender*ASC} Gender_i$$
$$* ASC_{isj} + \beta_{iRural*ASC} Rural_i * ASC_{isj} + \beta_{iInc*ASC} Inc_i * ASC_{isj}$$
$$+ \beta_{iHHSize*ASC} HHSize_i * ASC_{isj} + \beta_{iNumChild*ASC} NumChild_i * ASC_{isj}$$
$$+ \beta_{iFoodExp*ASC} FoodExp_i * ASC_{isj} + \beta_{iAge*X} Age_i * X_{isj} + \beta_{iGender*X} Gender_i$$
$$* X_{isj} + \beta_{iRural*X} Rural_i * X_{isj} + \beta_{iInc*X} Inc_i * X_{isj} + \beta_{iHHSize*X} HHSize_i * X_{isj}$$
$$+ \beta_{iNumChild*X} NumChild_i * X_{isj} + \beta_{iFoodExp*X} FoodExp_i * X_{isj} \quad (5.10)$$

The MXL model was specified to assess the respondents' heterogeneity and incorporate the information treatment's interactions with the alternative specific attributes presented in this DCE study. Furthermore, the MXL model was specified to examine if the random placement of respondents in the treatment groups affects consumer preferences and WTP. We called those who received the information treatment before the DCE was presented and read it for more than 30 seconds as the Treated group. We also pulled some participants into the TF group. These are those who received the treatment information before the DCE and spent 30 seconds or less reading it. The No Information group is the control group, which includes participants who did not receive the treatment information.

The model estimated to represent the information treatment interaction MXL model is given by Equation (5.11):

$$U_{isj} = ASC_{isj} + \beta_{iPrice} Price_{isj} + \beta_{iX} X_{isj}$$
$$+ \beta_{iTreatment*ASC} Treatment_i * ASC_{isj} + \beta_{iTreatment*X} Treatment_i * X_{isj}$$
$$+ \beta_{iITT*ASC} ITT_i * ASC_{isj} + \beta_{iITT*X} ITT_i * X_{isj} \quad (5.11)$$

All attributes were dummy-coded during the modelling process except for the price attribute, which was treated as a continuous variable, as indicated in Table 5.1. All parameters were considered random and assumed to follow normal distributions, except price, which served as a fixed parameter to allow for easy estimation of the WTPs'. Also, the WTP for a specific attribute can be drawn from the specification above, defined simply as:

$$WTP = -\frac{b}{\alpha} \tag{5.12}$$

Where the negative sign is introduced to make the WTP positive (as price, the monetary attribute, usually has a negative impact on utility), *b* is the estimated coefficient for the attribute of interest, while α is the coefficient of the price attribute used in the MXL model.

The MXL models above apply simulated maximum likelihood estimation (MLE) where an individual *i* will choose an alternative *j* if $U_{isj} > U_{isk}$ for all k ≠ j. Therefore, the probability (P) of choosing alternative *j* from a set of *J* alternatives is given as:

$$Prob_{isj} = \frac{exp(\beta_i X_{isj})}{\sum_{i=1}^{J} exp(\beta_i X_{isj})} \tag{5.13}$$

CHAPTER 6 RESULTS AND DISCUSSION

This chapter describes and discusses the results of this study on Canadian consumer preference and WTP for beef raised under different antimicrobial use practices. We present all the ground beef results, followed by the steak results. First, we present the parameter estimates of the CL and MXL models for attributes of ground beef used in this study. We did this to assess the restrictive homogeneity assumption that the CL makes and confirm if this applies and why we chose to use the MXL model as our analytical model for this study. In addition, we present the WTP estimates results showing how much consumers are willing to pay for different AMU and animal welfare practices for ground beef.

Furthermore, we presented models to help us identify demographic factors that influence consumer preferences and WTP for attributes of ground beef. Also, we present the results of the information treatment model that shows how information provision on the production practice requirements of the various AMU and animal welfare attributes influence consumer WTP for ground beef. We used the same process to describe the results of the steak as we did for the ground beef. Finally, we presented a summary of the comparison of the results of ground beef and beef steak.

6.1 CANADIAN CONSUMERS' PREFERENCE AND WILLINGNESS TO PAY OUTCOMES FOR GROUND BEEF

6.1.1 Parameter Estimates for Attribute-only Conditional and Mixed Logit Model

The CL model is usually the baseline model in choice modelling. However, it has some restrictive assumptions, such as the Independence of Irrelevant Alternatives (IIA) property. The IIA property assumes that the relative probability of an individual choosing between two options is independent

of any additional alternatives in the choice set. The CL model also assumes that error terms are independent and identically distributed across observations and that no preference heterogeneity exists. These properties of the CL are not always so, and as such, the CL model may not be the best to evaluate consumer preferences. Therefore, we may need to use a less restrictive model like the MXL. The MXL model in consumer behaviour studies allows us to incorporate random parameters. In this case, this study's attributes were specified as random parameters except for price, a fixed parameter to allow for direct estimation of the WTP values. The MXL is important for us because it allows us to relax the homogeneity assumption of the CL model by allowing our parameters to be normally or log-normally distributed, thus overcoming the CL restrictive assumption.

We estimated a CL and MXL model to assess whether the homogeneity assumption holds. As shown in Table 6.1, the CL model evaluated consumers' preference for beef production practices, such as the AMU and animal welfare attributes, without considering individual characteristics. It assumes that all individuals have the same preference or taste for ground beef attributes. However, the MXL result indicates that this is not the case. Model 2 reveals that there is heterogeneity in consumer preference or taste, particularly for attributes such as RWA, RWMIA, RAU, and NAH. This result further confirms that the CL model's restrictive assumption about homogeneity in consumer taste does not hold. This result is why our main empirical model for this study is the MXL model.

Table 6. 1: Attribute-only Parameter Estimates for Ground Beef

	Model 1	Model 2	
Variable	Mean (CL)	Mean (MXL)	Std. Dev.
Price (CAD/kg)	-0.134***	-0.211***	
	(0.005)	(0.030)	
AWA	0.227***	0.398***	0.197
	(0.026)	(0.070)	(0.302)

Grass-Fed	0.294***	0.498***	-0.193
	(0.023)	(0.083)	(0.232)
RWA	0.314***	0.491***	0.799**
	(0.031)	(0.077)	(0.349)
RWMIA	0.307***	0.357***	1.411***
	(0.035)	(0.056)	(0.360)
RAU	0.113***	0.041	1.426***
	(0.035)	(0.075)	(0.531)
Organic	0.148***	0.225***	0.478
	(0.023)	(0.043)	(0.302)
NAH	0.178***	0.193***	0.883**
	(0.021)	(0.036)	(0.395)
No Purchase	-2.368***	-4.505***	2.609***
	(0.100)	(0.695)	(0.528)
N	1222	1222	
Obs	43992	43992	

*Note: ***, **, and * represent significance at the 1%, 5% and 10% respectively*

6.1.2 WTP Estimates for Attribute-only MXL Model

Following the CL and MXL model parameter estimates shown in Table 6.1 above and confirming that homogeneity does not hold, we estimated the MXL WTPs from their respective parameter estimates using the nonlinear combinations of parameters (Stata command nlcom) approach. This analysis will help us understand Canadian consumer preferences and choices for beef raised under different AMU and animal welfare practices. The estimates of the WTP values are in Canadian dollars per kilogram (CAD/kg).

The WTP estimates for the attribute-only MXL for ground beef are found in Table 6.2. The results indicate that respondents are willing to pay positive premiums for all ground beef labels, except the RAU. The grass-fed and RWA labels had the highest WTP values of $2.36 per kilogram and $2.331 per kilogram, respectively. The next set of labels the respondents indicated higher WTP values for are the AWA and RWMIA with values of $1.887 per kilogram and $1.691 per kilogram, respectively. The labels with the lowest WTP values are the NAH and organic, with values of $0.915 per kilogram and $1.066 per kilogram, respectively.

The WTP value for the organic label is expected to be larger; however, respondents are not willing to pay as much for organic as other production practice labels, such as AWA, grass-fed, RWA, and RWMIA. This result is counter-intuitive given that organic production practice requirements have grass-fed, animal welfare, and AMU requirements. Since they have indicated an interest in paying higher premiums for attributes such as AWA, grass-fed, RWA, and RWMIA, as stated above, then it is logical that they should be willing to pay more than the $1.066 per kilogram premium indicated in Table 6.2. This evidence has an implication for information provision for production practices requirements in FAP. Perhaps providing information about organic production requirements would have influenced consumer WTP more for this label. Later models will examine how information influences consumer choices and WTP for these labels. We also observe that consumers were willing to pay more to select any of the two choice alternatives rather than the No-Purchase alternative. This result was demonstrated with a WTP value of $21.368 per kilogram.

Consumer concerns about AMU in FAP, as revealed in the literature by Barrett et al. (2021), seem to be in effect when the WTP values of the AMU attributes are examined. Respondents showed strong interest and willingness to pay the highest premium for the RWA attribute at $2.331 per kilogram. Their taste gradually declined, reflected when they considered the RWMIA label, whose requirement implies that antimicrobials can be used but not medically important ones. They were not as interested as with the RWA but showed some willingness with a WTP value of $1.691 per kilogram. However, with the RAU, our result does not provide evidence indicating consumer interest, given the statistical insignificance of its WTP value. This trend in the WTP value for AMU attributes strengthens evidence of consumers growing concerns regarding production practices related to AMU in FAP.

The result above represents an aggregated result for all ground beef participants without distinguishing between those treated or not treated with information requirements for beef production practices. In later models, we will disaggregate respondents and examine how their WTP value changes with respect to information provision about the various production practice requirements in FAP.

Table 6. 2: Ground Beef WTP Estimates for Attribute-only MXL Model

	Model 3	
Variable	WTP Estimate	Standard Error
No Purchase	-21.368***	0.729
AWA	1.887***	0.153
Grass-Fed	2.360***	0.166
RWA	2.331***	0.247
RWMIA	1.691***	0.263
RAU	0.196	0.369
Organic	1.066***	0.163
NAH	0.915***	0.181
N	1222	
Obs	43992	

*Note: ***, **, and * represent significance at the 1%, 5% and 10% respectively*

6.1.3 Mixed Logit Regression Results Investigating for Demographic Factors

To examine demographic factors affecting consumers' preferences and WTP values for ground beef, we compared two models shown in Table 6.3 and 6.4. Model 4 is a simpler model of model 5, where we interacted selected demographic variables with the alternative 3 (Alt 3) of the No Purchase option, as shown in equation 5.9. These demographic variables of interest are the age and gender of respondents, living in rural or urban areas, farming background, and their level of education. We also used their income, household size, weekly food expenses, and the number of children under 12 years of age in their household as other explanatory variables. We did this to identify what variables are important for further analysis to test the demographic factors that drive consumer preference and willingness to pay for these beef AMU and animal welfare attributes.

Model 5 here is a nested model of model 4, allowing the interaction of demographic variables from model 4 that were significant to have interacted with the attributes of beef presented to respondents in this study, as shown in equation 5.10 in Chapter 5.

The most important insight from model 4, the simpler model, is that age, gender, living in rural or urban areas, income, household size, number of children under 12 years of age, and weekly food expenses will probably influence consumer preferences and willingness to pay for beef raised under different AMU practices. The result from model 4 provides us with evidence to run a more complicated model to investigate the impact of demographic variables on WTP for those production practice labels.

Given the outcome above, we estimated model 5, the more complicated model, where we interacted all product attributes with the statistically significant demographic variables from model 4. These demographic variables are age, gender, living in rural or urban areas, income, household size, number of children under 12 years, and weekly food expenses. Our results found that age, income, household size, and number of children under 12 years negatively impacted the WTP for attributes of ground beef. Living in rural or urban areas revealed a mixed impact on WTP values for ground beef labels. Conversely, gender and weekly food expenses influence consumers' WTP values for ground beef labels.

Specifically, as consumers age by one year, their WTP values for organic, RWMIA, grass-fed, and AWA attributes of ground beef decrease by at least 2 cents per kilogram. As the age of respondents increases by one year, say 20 to 21 years, their WTP for organic, AWA, RWMIA, and grass-fed labels of ground beef decreases by 4.9 cents per kilogram, 3.7 cents per kilogram, 2.7 cents per kilogram, and 2.1 cents per kilogram, respectively. We found that as income decreases by 1000 dollars, consumers are willing to pay 7 dollars per kilogram more for the grass-fed

attribute. In general, as household size increases by one additional person, households' WTP for the organic label of ground beef decreases by 27.3 cents per kilogram.

Similarly, as the number of children under 12 years of age in a family increases by an additional child, the WTP value for the AWA label decreases by 55.7 cents per kilogram. Our results indicate that families with more children under 12 years of age are willing to pay less for most ground beef labels, including the AWA, except for the NAH and RAU. It could be that parents with younger children who may be under tight budget constraints prefer to use their limited resources for what they perceive would benefit their kids more, nutrition- and health-wise. Perhaps this could explain why they showed positive interest in the NAH and RAU, although our result could not provide statistical evidence for these interests as they are not statistically significant. Hence, qualities such as AWA, grass-fed, RWA, RWMIA, and organic may not be a priority because of the category of children they have, which may not address their family's immediate needs as they perceive it.

Also, those living in rural areas are willing to pay 75.8 cents per kilogram more than urban dwellers for the grass-fed ground beef label, while urban dwellers are willing to pay 61.6 more than rural dwellers for the organic label. These findings seem counter-intuitive on why rural residents prefer to pay more for grass-fed while urban dwellers are willing to pay more for organic. A possible explanation for this could be that rural dwellers appreciate the 100 percent grass and forage requirements in grass-fed areas since the rural setting encourages such intensive pasture grazing. This practice may yield economic returns or benefits to rural communities where it is practiced, unlike urban locations where there is no space to do that due to priorities for infrastructure development. For the reaction we see from urban vs rural dwellers for the organic in terms of the higher premium urban dwellers are willing to offer than rural dwellers, it could be

that rural dwellers do not trust the organic label. Another reason could be the halo effect of organic labels since rural dwellers are more informed about animal production than urban residents. These reasons may explain why rural residents are negatively disposed to paying less for organic attribute of ground beef.

However, females are willing to pay more than males for AWA, RWA, and grass-fed ground beef labels. Females are willing to pay 86.7 cents per kilogram more than males for AWA. This result is expected as the literature reveals that females are more concerned about and support animal welfare than males (Phillips et al. 2010; Randler et al. 2021; Wu, Bains, and Preston 2023). Females are willing to pay 75.1 cents per kilogram more than male consumers for RWA. This result is not surprising. The literature reveals that significant differences in behavioural beliefs based on gender exist, as females believed RWA-labelled pork to have higher animal welfare requirements in comparison to traditional pork than men (Bradford et al. 2022). This argument can be extended to the findings of ground beef. Finally, our result shows that females are willing to pay 72.8 cents per kilogram more than their male counterparts for the grass-fed label, which resonates with evidence from the literature as reported by (Stampa, Schipmann-Schwarze, and Hamm 2020). The average weekly food expenses reported by our respondents is approximately $155. We observe that as respondents' average weekly food expenses increase by 100 dollars, their willingness to pay for AWA, grass-fed, and RWMIA attributes of ground beef also increase by 70 cents per kilogram for AWA and by 60 cents per kilogram for grass-fed and RWMIA.

Table 6. 3: Demographic Factors Influencing Consumer Preference and Willingness to Pay for Ground Beef Attributes

	Model 3		Model 4	
Variable	Mean WTP	Std. Err	Mean WTP	Std. Err.
No Purchase	-21.368***	0.729	-24.248***	1.797
AWA	1.887***	0.153	1.864***	0.157
Grass-Fed	2.360***	0.166	2.279***	0.176
RWA	2.331***	0.247	2.419***	0.282
RWMIA	1.691***	0.263	1.840***	0.288
RAU	0.196	0.369	0.275	0.402
Organic	1.066***	0.163	1.177***	0.164
NAH	0.915***	0.181	0.885***	0.239
Age (Alt 3)			0.135***	0.014
Gender (Alt 3)			2.164***	0.403
Rural (Alt 3)			1.127**	0.474
Farm Background (Alt 3)			0.145	0.585
Education (Alt 3)			0.298	0.298
Income (Alt 3)			-0.022***	0.005
Household size (Alt 3)			-0.804***	0.247
Children under 12 yrs (Alt 3)			-1.091***	0.406
Food Expenses (Alt 3)			-0.015***	0.003

*Note: ***, **, and * represent significance at the 1%, 5% and 10% respectively*

Table 6. 4: Demographic Factors Influencing Consumer Preference and Willingness to Pay for Ground Beef Attributes

	Model 5							
Variable	Mean	Age	Gender	Rural	Income	HH Size	Child <=12yrs	Food Exp
No Purchase	-22.244***	0.076***	3.524***	0.648	-0.024***	-1.140***	-1.580***	-0.003
	(1.841)	(0.019)	(0.569)	(0.676)	(0.007)	(0.324)	(0.522)	(0.004)
AWA	3.059***	-0.037***	0.867***	-0.154	-0.003	-0.143	-0.557**	0.007***
	(0.798)	(0.010)	(0.304)	(0.372)	(0.004)	(0.162)	(0.257)	(0.002)
Grass-Fed	3.827***	-0.021**	0.728**	-0.758**	-0.007*	-0.223	-0.109	0.006***
	(0.834)	(0.010)	(0.313)	(0.371)	(0.004)	(0.164)	(0.264)	(0.002)
RWA	1.759	-0.013	0.751*	0.373	0.002	0.008	-0.259	0.004
	(1.199)	(0.014)	(0.442)	(0.531)	(0.005)	(0.236)	(0.378)	(0.003)
RWMIA	2.234*	-0.027*	0.076	0.075	-0.001	-0.118	-0.232	0.006**
	(1.236)	(0.015)	(0.468)	(0.556)	(0.005)	(0.247)	(0.396)	(0.003)
RAU	0.501	-0.020	0.183	-0.250	0.000	-0.068	0.131	0.006*
	(1.276)	(0.015)	(0.474)	(0.563)	(0.003)	(0.248)	(0.399)	(0.003)
Organic	2.142***	-0.049***	0.283	0.616*	0.002	-0.273*	-0.185	0.009***
	(0.778)	(0.010)	(0.294)	(0.354)	(0.003)	(0.155)	(0.249)	(0.002)
NAH	1.018	-0.001	-0.017	-0.228		0.016	0.020	-0.001
	(0.784)	(0.010)	(0.294)	(0.352)		(0.154)	(0.248)	(0.002)
N	1184							
Obs	42624							

*Note: ***, **, and * represent significance at the 1%, 5% and 10% respectively*

6.1.4 Impact of Information Provision on Consumer Willingness to Pay for Ground Beef Attributes

We estimated the impact of information provision on consumers' WTP for ground beef labels. We did this by interacting information about the production practice requirements of AWA, grass-fed, RWA, RWMIA, RAU, organic, and NAH with the treated and the treatment failure (TF) groups as shown in Model 6 and earlier specified in equation 5.11. We have the control group, which was not provided with any information, and a treatment group that received information and spent over 30 seconds on the information page. This group is information-seeking and cares about the information on the requirements of the production practices. We called this the Treated Group. We have another treatment group that received the information about the requirements of the production practices used in this study but spent 30 seconds or less on the information page. We called this group the TF group.

The grouping of the treatment into treated and TF was adopted to follow the treatment received (TR) or per-protocol approach which stipulates that participants should be analyzed based on the treatment they get unlike the Intent-To-Treat (ITT) that ignores non-compliance (Ahn and Kang 2023). Both TR and ITT approaches are commonly used in randomized controlled trial (RCT) studies. The ITT analysis is generally used in the academic literature to mean a method for analyzing results in an RCT study where all randomized participants are included in the statistical analysis and analyzed based on their originally assigned group, regardless of what treatment they get (McCoy 2017). In RCT, the ITT is preferred for superiority trials while TR approach is preferred for equivalence and non-inferiority trials (Ahn and Kang 2023).

In this study, we used the TF to mean respondents who received the treatment in the form of the requirements for production practices but took 30 seconds or less to read these requirements.

Originally, we randomly assigned respondents into a treatment group and then differentiated the original group by time spent reading the treatment information. The respondents were considered to have read the production practices requirement if they had spent more than 30 seconds and, as such, be treated and termed the Treated group, similar to (Tienhaara et al. 2022). Otherwise, they did not peruse the information and may not have been treated in 30 seconds or less. This thought led to TF notation for the group who spent 30 seconds or less on the treatment information. The 30-second time stamp was chosen after performing a Kernel Density estimation analysis on stata on the information label variable. We observed a log-normal distribution for the information page variable with a median of 31.6 seconds. This study chose 30 seconds as the time stamp for information treatment analysis, similar to other studies like Tienhaara et al. (2022) who applied the 30 seconds threshold. We also performed a robustness check using the time spent on the information page from 20-40 seconds. The robustness check revealed that the results are generally consistent for the different time thresholds.

Given the definition of the TF group, we can deduce a few things about the type of consumers that would belong to the TF group. As explained previously, the TF group spent 30 seconds or less reading the production practices requirement provided as treatment. One reason for this could be that they were more familiar with some of the requirements of the production practices offered to them. For this reason, there is no cause for these respondents to dwell more on this but to focus on completing the rest of the survey so they can get their dollar incentive for survey completion. This reason resonates with the findings of (Tienhaara et al. 2022). The authors found that respondents who were very familiar with native animal breeds and plant varieties were less likely to read the additional information they provided to them during the survey. Also, examining the demographics of those in the TF group (see Table 6.5), we found that there were

more males than females and had at least approximately two children in their household under 12 years of age. The work of Tienhaara et al. (2022) revealed that females were likely to read the additional information provided during their survey. Another similar study from Hu, Adamowicz, and Veeman (2009) where they modelled information access in a DCE setting, revealed that male respondents were less likely to access information, and the more children in a household, the less they were likely to access or use information. Their work also revealed that those in rural areas are more likely to access information (Hu, Adamowicz, and Veeman 2009). Our TF group had more urban dwellers, approximately 80%. The location of respondents may also explain why the TF group disregarded the information we gave them by spending less time reading them.

Table 6. 5: Demographics of the TF Group and Full Sample

Demographic variables	**TF**	**Sample**
Gender (Males)	51.3	48.3
Urban[4]	79.9	77.5
Number of children in household under 12 yrs (mean)	1.5	1.6

Our results in Table 6.6 reveal that compared to the control group, the treated group (those who cared for the information as explained above) had WTP value for RWA decreased by 1.004 dollars per kilogram when given the information on the production practice requirements of attributes of ground beef. The treated group showed a WTP of $1.004 per kilogram less than the control group for RWA when the labelling requirements for production practices were provided. This result suggests a negative impact of information provision on consumers' WTP. This negative

[4] Gender and Urban are in percentages while the number of children in household under 12 years is the mean value.

WTP may be because of the animal welfare implications in RWA that they just knew about when offered the information. This information provision may have changed their prior perception and expectations of RWA in ground beef so that they would not want to pay so much. Hence, a likely reason for the downward valuation of the RWA attribute in ground beef. For the other labels, we also observed that respondents showed negative WTP values for most of the labels in the treated group compared to the control group, although they are not statistically significant. These negative values can be explained as their little interest, care for those labels, and willingness to pay less. The effect may be small and can explain the statistical insignificance we see for AWA, grass-fed, RWMIA, and RAU labels. In general, having information about the production practices of AMU and animal welfare resulted in a lower valuation of the RWA attribute in ground beef.

The control group, the no information group, reported a positive premium for all ground beef labels, except the RAU, for which they showed no concern as suggested by our result. Specifically, respondents are willing to pay 1.816 dollars per kilogram, 2.488 dollars per kilogram, 2.741 dollars per kilogram, 1.955 dollars per kilogram, 88.9 cents per kilogram, and 98.7 dollars per kilogram more for AWA, grass-fed, RWA, RWMIA, organic, and NAH attributes of ground beef, respectively.

The TF group, which showed they cared less about the information we provided during the survey by spending 30 seconds or less of the information supplied, indicated a positive value for most attributes in general, even though only the organic data was statistically significant. Compared to the control group, they are willing to pay more for AWA (55.5 cents per kilogram), grass-fed (5.2 cents per kilogram), RAU (50.5 cents per kilogram), and organic (71.8 cents per kilogram). At the same time, the respondents indicated a willingness to pay less for RWA (61.1 cents per kilogram), RWMIA (40.8 cents per kilogram), and NAH (49.9 cents per kilogram).

However, our result only provides evidence for the impact of information on organic attributes with a statistically significant positive WTP value of 71.8 cents per kilogram more than the control group.

Table 6. 6: Impact of Information Provision on Consumer WTP for Ground Beef Attributes

		Model 6		
		Attribute-Information Treatment Interaction		
Variables	Model 3	No Information	Treated	TF
No Purchase	-21.368***	-21.013***	-0.783	-1.015
	(0.729)	(0.772)	(0.640)	(0.708)
AWA	1.887***	1.816***	-0.182	0.555
	(0.153)	(0.210)	(0.353)	(0.390)
Grass-Fed	2.360***	2.488***	-0.504	0.052
	(0.166)	(0.221)	(0.361)	(0.393)
RWA	2.331***	2.741***	-1.004**	-0.611
	(0.247)	(0.319)	(0.508)	(0.560)
RWMIA	1.691***	1.955***	-0.665	-0.408
	(0.263)	(0.344)	(0.541)	(0.595)
RAU	0.196	0.155	-0.219	0.505
	(0.369)	(0.441)	(0.551)	(0.600)
Organic	1.066***	0.889***	0.073	0.718*
	(0.163)	(0.215)	(0.343)	(0.374)
NAH	0.915***	0.987***	0.173	-0.499
	(0.181)	(0.229)	(0.340)	(0.370)
N	1222		1222	
Obs	43992		43992	

*Note: ***, **, and * represent significance at the 1%, 5% and 10% respectively*

6.2 CANADIAN CONSUMERS' PREFERENCE AND WILLINGNESS TO PAY OUTCOMES FOR STEAK

6.2.1 WTP Estimates for Attribute-only MXL Model

Following the parameter estimates of the CL and MXL models for steak, which indicate that homogeneity in taste or preference does not hold, we estimated the WTP for the different AMU and animal welfare practices using the MXL model. The WTP estimates for the attribute-only MXL for steak are found in Table 6.7. The results reveal that respondents are willing to pay positive premiums for all steak labels except the RAU. The RWA, organic, and NAH had the highest WTP values of 4.792 dollars per kilogram, 4.611 dollars per kilogram, and 4.051 dollars per kilogram, respectively. The labels that follow in terms of magnitudes of consumers' WTP values are grass-fed, AWA, and RWMIA, with 3.564 dollars per kilogram, 3.152 dollars per kilogram, and 2.785 dollars per kilogram.

We observe the same pattern in the ground beef regarding consumer WTP positive premiums for the different AMU attributes such as RWA, RWMIA, and RAU. Our results indicate that respondents were willing to pay the highest premium for the RWA label, valued at 4.79 dollars per kilogram. We observed that consumers' WTP gradually declined as we move from RWA to RWMAI and RAU. With the RWMIA label, they were only willing to pass as much as 2.79 dollars per kilogram. Recall that the RWMIA implies that antimicrobials can be used, but not the medically important ones. However, with the RAU, our result is not statistically significant.

Note that these results represent an aggregated result for all participants without a distinction between those treated or not treated with information about the requirements for production practice, which we will show later.

Table 6. 7: Steak Attribute-only Mixed Logit WTP

	Model 7	
Variable	WTP Estimate	Standard Error
No Purchase	-63.333***	3.388
AWA	3.152***	0.372
Grass-Fed	3.564***	0.343
RWA	4.792***	0.459
RWMIA	2.785***	0.423
RAU	0.079	0.635
Organic	4.611***	0.292
NAH	4.051***	0.284
N	1284	
Obs	46224	

*Note: ***, **, and * represent significance at the 1%, 5% and 10% respectively*

6.2.2 Mixed Logit Regression Results Investigating for Demographic Factors

We examined the demographic variables that affect consumers' WTP values for steak by comparing two models, as shown in Table 6.8 and Table 6.9, following the specification in Equations 5.9 and 5.10. Model 8 is the simpler MXL model for steak attributes where we interacted the Alt 3 (the No Purchase alternative) with selected demographic factors. The demographic variables of interest are the age and gender of respondents, living in rural or urban areas, farming background, and their level of education of respondents. We also used respondents' incomes, household size, weekly food expenses, and the number of children under 12 years of age in their households. As explained earlier for ground beef, this was done to identify important variables for deeper analysis to examine factors that influence consumer preference and WTP for steak different AMU and animal welfare labels. The key outcome from model 8 is that age, gender, rural or urban living, farming background, and weekly food expenses will influence consumer WTP for steak with different AMU and animal welfare labels.

Following this outcome, we estimated a complex model 9, where we interacted all attributes with significant demographic variables that emerged from model 8. Our results reveal

that gender, living in rural or urban, and weekly food expenses positively influence consumers' WTP for steak's AMU and animal welfare practices. On the contrary, farming background and age negatively impact consumers' WTP for steak AMU and animal welfare practices.

Specifically, as consumers age by one year, their WTP decreases by 8.2 cents per kilogram for RAU, 6.6 cents per kilogram for AWA, and 4.2 cents per kilogram for organic. In contrast, as consumers grow older by a year, their WTP increases by 3.7 cents per kilogram for the grass-fed label of steak. The result we see for the grass-fed label of steak could be that older people are very concerned about their health and lifestyle, preferring a more natural composition that the grass-fed represents since the grass-fed label requires that FPAs are fed a 100% grass and forage diet (no grain or grain by-products). These reasons may explain their WTP more for grass-fed than other labels of steak.

Also, our results indicate that those without a farming background are willing to pay more than those with a farming background for AWA and the NAH, with WTP values of 1.636 dollars per kilogram and 1.451 dollars per kilogram, respectively. For the NAH, it should be expected, given their lack of farming knowledge about hormones in FAP. This result also strengthens the evidence for the need for information provision regarding the requirements for production practices related to AMU and animal welfare practices in FAP.

Females are willing to pay larger positive premiums than males for RWA of steak with a WTP value of 2.246 dollars per kilogram. Those who live in urban locations reported larger WTP for RAU and organic labels of steak than those in rural areas, with values of 3.821 dollars per kilogram and 2.952 dollars per kilogram, respectively. The organic result is expected as most people in urban locations are likely to be financially better off than those in rural locations as suggested by (John et al. 2022). The urban dwellers' willingness to pay more for RAU but not

RWMAI and RWA is interesting. This outcome could be a result of the effect of public campaigns about AMR and AMU in FAP. So, they may see RAU as a balanced approach to animal welfare and public health. Similarly, as the average weekly food expenses increase by $100, steak respondents are willing to pay 1.1 dollars per kilogram more for RWA and RAU labels and 1 dollar per kilogram more for the organic label of steak.

Table 6. 8: Demographic Factors Influencing Consumer Preference and Willingness to Pay for Steak Attributes

	Model 7		Model 8	
Variable	Mean WTP	Std. Err	Mean WTP	Std. Err.
No Purchase	-63.333***	3.388	-88.248***	7.874
AWA	3.152***	0.372	3.225***	0.416
Grass-Fed	3.564***	0.343	3.560***	0.409
RWA	4.792***	0.459	4.466***	0.485
RWMIA	2.785***	0.423	2.650***	0.450
RAU	0.079	0.635	0.323	0.630
Organic	4.611***	0.292	4.687***	0.301
NAH	4.051***	0.284	4.246***	0.329
Age (Alt 3)			0.688***	0.080
Gender (Alt 3)			11.732***	1.713
Rural (Alt 3)			-7.840***	1.764
Farm Background (Alt 3)			-6.722***	1.972
Education (Alt 3)			0.567	0.960
Income (Alt 3)			-0.025	0.016
Household size (Alt 3)			-0.231	0.670
Children under 12 yrs (Alt 3)			0.890	1.232
Food Expenses (Alt 3)			-0.070***	0.012

*Note: ***, **, and * represent significance at the 1%, 5% and 10% respectively*

Table 6. 9: Demographic Factors Influencing Consumer Preference and Willingness to Pay for Steak Attributes

	Model 9					
Variable	Mean	Age	Gender	Rural	Farm	Food Exp
No Purchase	-85.436***	0.571***	11.692***	-2.991	-9.592***	-0.051***
	(6.144)	(0.071)	(1.630)	(1.912)	(2.115)	(0.011)
AWA	4.676***	-0.066***	0.204	1.282	-1.636*	0.006
	(1.524)	(0.020)	(0.634)	(0.818)	(0.904)	(0.004)
Grass-Fed	0.938	0.037**	-0.543	0.249	1.202	0.004
	(1.352)	(0.018)	(0.579)	(0.760)	(0.808)	(0.003)
RWA	0.338	0.004	2.246**	1.694	-1.127	0.011**
	(2.114)	(0.028)	(0.887)	(1.128)	(1.288)	(0.005)
RWMIA	2.574	-0.039	1.366	1.103	-1.699	0.004
	(2.008)	(0.026)	(0.849)	(1.093)	(1.209)	(0.005)
RAU	-0.288	-0.082**	-1.221	3.821***	-0.070	0.011*
	(2.413)	(0.032)	(1.024)	(1.326)	(1.456)	(0.006)
Organic	2.674**	-0.042**	0.571	2.952***	-0.768	0.010***
	(1.303)	(0.018)	(0.548)	(0.756)	(0.782)	(0.003)
NAH	4.741***	-0.026	0.502	0.260	-1.451*	0.003
	(1.288)	(0.017)	(0.544)	(0.693)	(0.763)	(0.003)
N				1233		
Obs				44388		

*Note: ***, **, and * represent significance at the 1%, 5% and 10% respectively*

6.2.3 Impact of Information Provision on Consumer Willingness to Pay for Steak Attributes

We estimated the impact of information about the production practice requirements of AWA, grass-fed, RWA, RWMIA, RAU, organic, and NAH labels on consumers' WTP for steak, similar to ground beef, as shown in Table 6.10. An explanation of the groups we have (control, treated, and TF) has been made in 6.1.4.

Our results reveal that the treated group, which received the information about production practice requirements for the labels used in this study, had lower WTP than the control group, which received no information. Compared to the control group, the WTP of the treated group decreased by 1.711 dollars per kilogram for AWA, by 2.719 dollars per kilogram for RWA, by 4.085 dollars per kilogram for RWMIA, by 3.233 dollars per kilogram for RAU, by 2.164 dollars per kilogram for NAH when they received the labelling requirements of those production practices. Upon receiving the production practice requirements for these practices, including the RWA, and finding out the animal welfare implications this may have on beef cattle, we observed that their valuation of RWA lowered compared to the control group.

The TF group reported a positive and increased WTP compared to the control group. This result shows that they care about the grass-fed label of steak even though they are not affected by the information provided. The TF group is willing to pay 1.794 dollars per kilogram more than the control group for grass-fed when purchasing steak.

The control group, the no information group, reported a positive premium for all steak labels, except the RAU. Specifically, respondents are willing to pay a premium of 3.63 dollars per kilogram, 3.043 per kilogram, 5.424 dollars per kilogram, 3.817 dollars per kilogram, 4.779 dollars

per kilogram, and 4.688 dollars per kilogram for AWA, grass-fed, RWA, RWMIA, organic, and NAH attributes of steak, respectively.

Generally, our results suggest that the information provision decreased consumers' WTP for steak production practices, such as AWA, RWA, RWMIA, NAH, and NAH labels.

Table 6. 10: Impact of Information Provision on Consumer WTP for Steak Attributes

		Model 10		
		Attribute-Information Treatment Interaction		
Variables	Model 7	No Information	Treated	TF
No Purchase	-63.333***	-61.651***	2.540	-3.119*
	(3.388)	(2.969)	(1.823)	(1.784)
AWA	3.152***	3.630***	-1.711**	-0.046
	(0.372)	(0.490)	(0.792)	(0.779)
Grass-Fed	3.564***	3.043***	0.387	1.794**
	(0.343)	(0.490)	(0.711)	(0.717)
RWA	4.792***	5.424***	-2.719**	-0.203
	(0.459)	(0.666)	(1.194)	(1.104)
RWMIA	2.785***	3.817***	-4.085***	-0.485
	(0.423)	(0.605)	(1.071)	(1.047)
RAU	0.079	0.620	-3.233**	0.944
	(0.635)	(0.816)	(1.301)	(1.249)
Organic	4.611***	4.779***	-0.944	0.242
	(0.292)	(0.419)	(0.693)	(0.678)
NAH	4.051***	4.688***	-2.164***	-0.319
	(0.284)	(0.391)	(0.673)	(0.670)
N	1284		1284	
Obs	46224		46224	

*Note: ***, **, and * represent significance at the 1%, 5% and 10% respectively*

6.3 COMPARISON OF GROUND BEEF AND STEAK RESULTS

Here, we compare ground beef and steak results to identify resemblances and distinctions in consumers' preferences for these two products. First, a similarity exists between the ground beef and steak WTP results. Our findings show that consumers are willing to pay positive premiums for all attributes of steak and ground beef except the RAU, which is not statistically significant for both products.

Second, the difference in the results of both products can be seen in their attribute-only (model 3 and 7) results. The steak results have larger WTP values for all the attributes compared to ground beef except for RAU. The magnitude difference between steak and ground beef seen in all attributes is due to the price variable and the corresponding price coefficient from the corresponding parameter estimates used in computing the WTP estimates. Recall that the steak is a higher-priced product than ground beef. Hence, there is a difference in the magnitude of the WTP of these two products.

Also, regarding the ranks of their various attributes, our results show that RWA, organic, and NAH are the highest-ranked attributes for steak, while grass-fed and RWA are the highest-ranked attributes for ground beef. Respondents valued grass-fed and RWA more in ground beef but valued RWA, organic, and NAH more in steak. In addition, we observe a similar pattern in terms of their WTP for the AMU attributes. In both products, consumers exhibited higher WTP for RWA, followed by the RWMIA and then the RAU. This pattern can be explained in connection to evidence in the literature on consumers' concerns and attitudes towards AMU in FAP, as Barrett et al. (2021) find, and also explained in 6.1.2 and 6.2.1 earlier. These comparisons are shown in Figure 6.1.

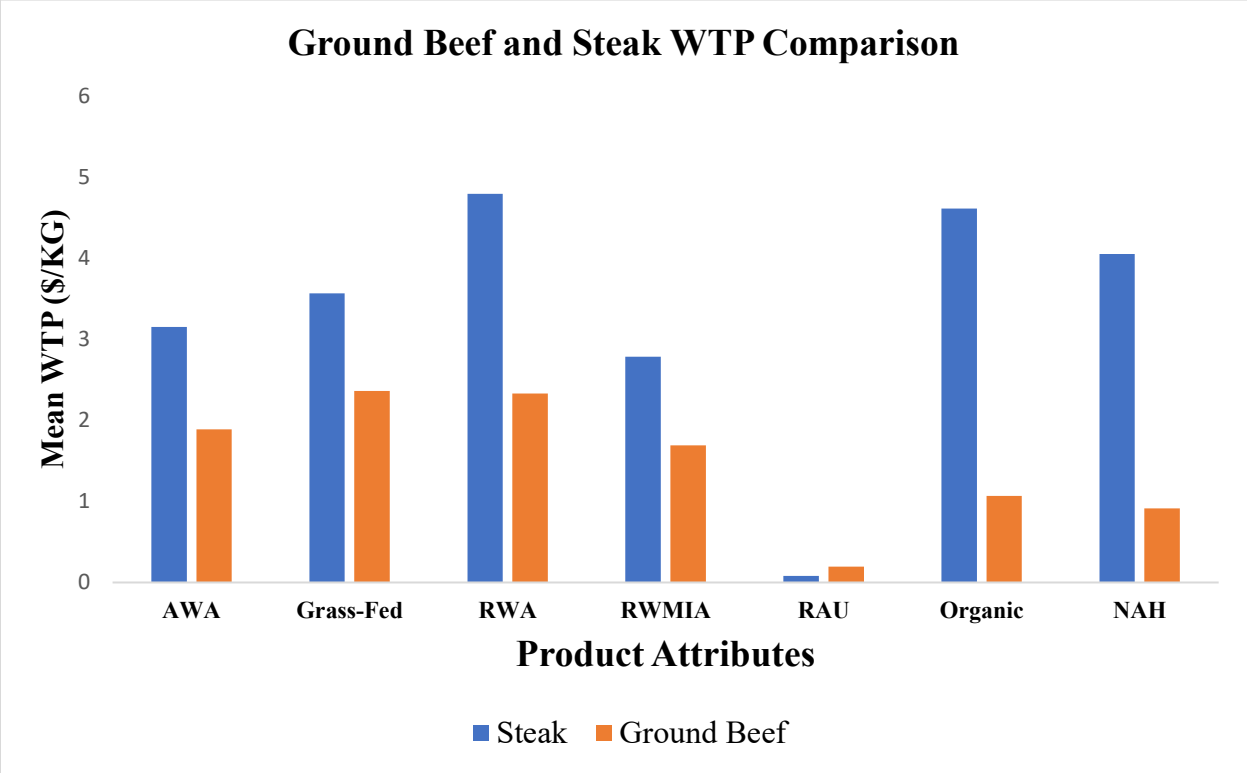

Figure 6. 1: Ground Beef and Steak WTP Comparisons

Regarding the demographic variables results, some similarities emerged from both product's results. Our results reveal that gender positively impacts the WTP for the labels of both products. We also found that age and weekly food expenses negatively affect the WTP of consumers for ground beef and steak labels.

Regarding the impact of information provision, Figure 6.2 reveals that the groups that do not have production practice requirement information on steak and ground beef are willing to pay for all AMU and animal welfare labels. Although, the RAU WTPs in both products are not statistically significant. We observe similar patterns in the WTPs of ground beef and steak AMU labels. The chart in Figure 6.2 shows that consumers are willing to pay the highest for RWA, followed by RWMIA and RAU for both products. The difference in the no information group of

ground beef and steak is seen in their magnitude. Figure 6.2 indicates that the no information group in steak has higher WTP values for all attributes than the ground beef. The most plausible reason for this is that steak is a higher-priced product than ground beef.

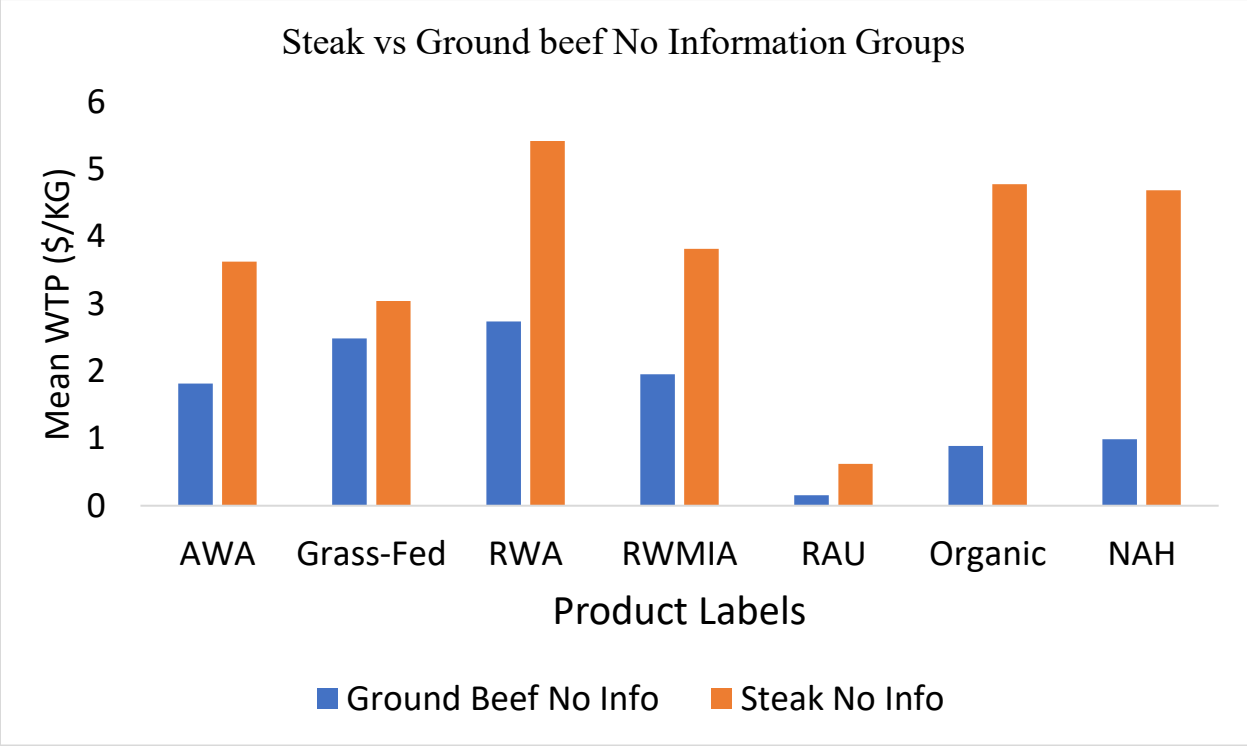

Figure 6. 2: No Information Treatment Product Comparison

For the treated group, steak consumers are willing to pay less than ground beef consumers for product labels, compared to the no information group, except for the grass-fed label, where ground beef consumers are willing to pay less than steak consumers compared to the no information group (see Figure 6.3). However, only RWA WTP is statistically significant in ground beef, while AWA, RWA, RWMIA, RAU, and NAH are the statistically significant WTPs. As the chart in Figure 6.3 shows ground beef consumers were willing to pay more for organic and NAH compared to the control group. In contrast, steak respondents were willing to pay more for only the grass-fed label when compared to the control group.

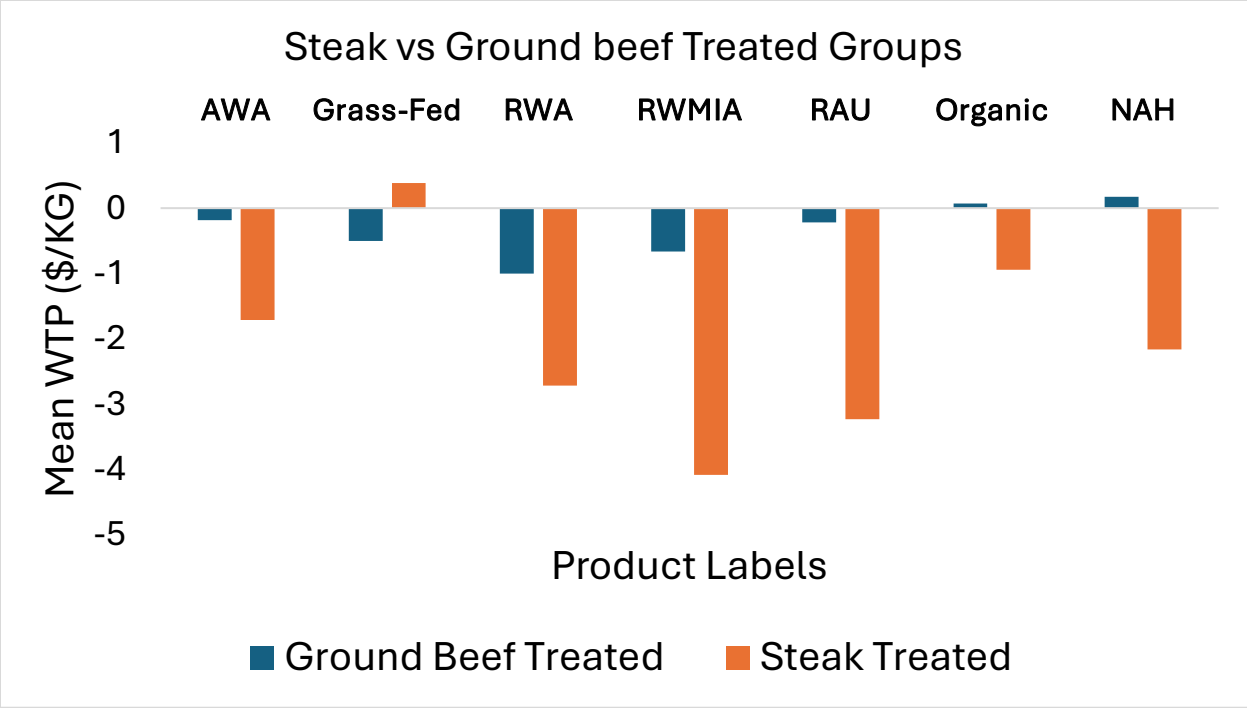

Figure 6. 3: Treated Groups Product Comparison

With regards to TF respondents (those who received the requirements of production practices requirements but are not affected by it), Figure 6.4 reveals that ground beef and steak respondents are willing to pay less for all product labels except for grass-fed, RAU and organic when compared to the control group. The contrast between steak and ground beef is seen in AWA where only steak respondents are willing to pay less for AWA compared to the control group. Please note that only the organic (ground beef) and grass-fed (Steak) label WTPs are statistically significant.

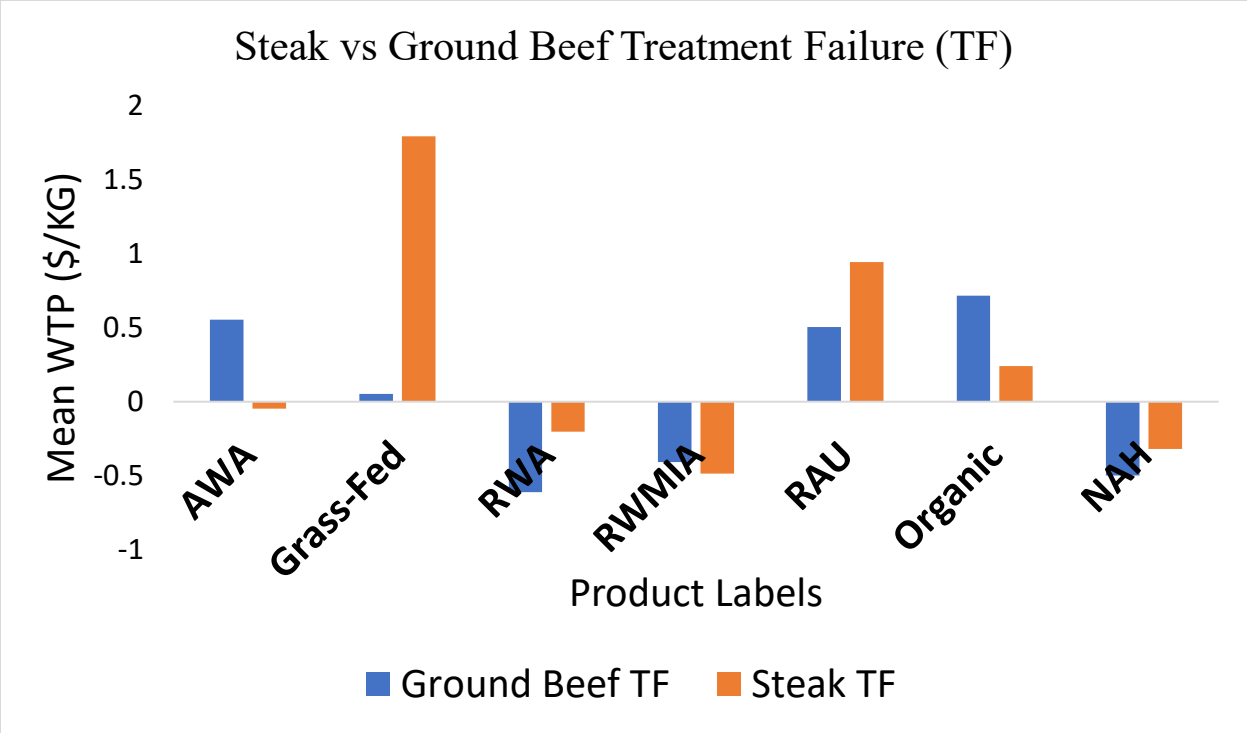

Figure 6. 4: TF Product Comparison

CHAPTER 7 CONCLUSION

7.1 STUDY FINDINGS

The overall objective of the thesis was to assess consumer preference and willingness to pay for beef raised under different AMU practices. To summarize our findings, this study has answered the following research objectives presented at the beginning of this thesis:

1. How much are consumers willing to pay for labels for ground beef and steak production practices?

Generally, our study found that consumers are willing to pay for all ground beef and steak labels except RAU. For ground beef, the labels for which consumers had the highest WTP values are grass-fed and RWA, with values of $2.36/kg and $2.331/kg, respectively. The labels that ground beef consumers had medium WTP values are AWA and RWMIA, with values of $1.887/kg and $1.691/kg, respectively. The labels with the lowest WTP values are NAH and organic, with values of $0.915/kg and $1.066/kg, respectively. For steak, the labels with the higher WTP values are RWA, Organic, and NAH, with values of $4.792/kg, $4.611/kg, and $4.051/kg, respectively. The labels with lower WTP values were grass-fed, AWA, and RWMIA, with $3.564/kg, $3.152/kg, and $2.785/kg, respectively.

2. What demographic variables impact consumers' WTP for beef labels?

This study found that several demographic variables, including age, income, household size, living in rural areas, farming background, and the presence of children under the age of 12 years old in a family, have a negative impact on consumers' WTP for beef labels, like AWA, grass-fed, RWMIA, and organic. Specifically, as consumers age by one year, their WTP for organic, RWMIA, grass-fed, and AWA labels of ground beef decreases by at least 2 cents per kilogram. Similarly, as

consumers age by one year, their WTP values for organic, RWMIA, grass-fed, and AWA labels of steak decrease by at least 4 cents per kilogram. Additionally, we found that females are willing to pay an additional $0.75 per kilogram and $2.25 per kilogram for RWA in ground beef and steak, respectively. Those who reside in urban areas are willing to pay an extra $0.62 per kilogram and $2.95 per kilogram for the organic labels of ground beef and steak. Furthermore, we found that those without a farming background are willing to pay $1.45 per kilogram and $1.64 per kilogram more than those with a farming background for steaks labelled NAH and AWA, respectively.

3. How does information provision impact consumers' WTP for ground beef and steak with different AMU and animal welfare production claims?

For the ground beef, compared to the control group, the treated group had a WTP value for RWA that decreased by $1.004 per kilogram when given the information on the production practice requirements of attributes of ground beef. This result suggests a negative impact of information provision on consumers' WTP. The control group indicated a positive premium for all ground beef labels except the RAU. Respondents are willing to pay $1.816, $2.488, $2.741, $1.955, $0.889, and $98.7 more per kilogram for AWA, grass-fed, RWA, RWMIA, organic, and NAH attributes of ground beef, respectively. The TF group demonstrated a lack of interest in the information we presented throughout the survey. In comparison to the control group, they exhibit a greater willingness to pay for AWA (55.5 cents per kilogram), grass-fed (5.2 cents per kilogram), RAU (50.5 cents per kilogram), and organic (71.8 cents per kilogram). Simultaneously, the participants expressed a lower WTP for RWA (61.1 cents per kilogram), RWMIA (40.8 cents per kilogram), and NAH (49.9 cents per kilogram).

For steak, our results show that treated group experienced a decrease in WTP compared to the control group. Specifically, the WTP decreased by 1.711 dollars per kilogram for AWA, by

2.719 dollars per kilogram for RWA, by 4.085 dollars per kilogram for RWMIA, by 3.233 dollars per kilogram for RAU, and by 2.164 dollars per kilogram for NAH when they were subjected to the labelling requirements associated with those production practices. The TF group had a positive WTP in comparison to the control group. This result indicates that individuals value the grass-fed label of steak, even if they are not influenced by the information presented. The TF group is willing to offer an additional 1.794 dollars per kilogram compared to the control group when buying grass-fed steak. The control group reported a positive premium for all steak labels except for the RAU label. Respondents are willing to pay the following premiums per kilogram for different attributes of steak: 3.63 dollars for AWA, 3.043 dollars for grass-fed, 5.424 dollars for RWA, 3.817 dollars for RWMIA, 4.779 dollars for organic, and 4.688 dollars for NAH.

Generally, the impact of information on consumers' WTP for animal welfare and AMU labels of beef cattle products is negative. This result concerning the impact of information on consumer choices is consistent with some previous studies (Bieberstein et al. 2013; Fosgaard, Pizzo, and Sadoff 2024). Bieberstein et al. (2013) in an experiment examined consumer choices for nano-food and nano-packaging in orange juice in France and Germany with environmental, societal and health attributes incorporated into their treatment information. Their findings reveal that detailed information on nanotechnology negatively impacts consumer preferences when voluntary access to relevant information is guaranteed. Fosgaard, Pizzo, and Sadoff (2024) did a randomized field experiment study to investigate how individualized information about greenhouse gas emissions influences consumer grocery purchases. The study compared the effects of personalized information on the carbon footprint of grocery purchases to individualized information on grocery spending provided via a smartphone app. The findings revealed that compared to the spending information, the carbon footprint information led to a 27 percent

reduction in grocery-related emissions during the first month of treatment, with a 45 percent decrease in emissions from beef, the food group with the highest emissions (Fosgaard, Pizzo, and Sadoff 2024).

However, our result contradicts the findings from (Chalak and Abiad 2012; Paudel et al. 2022; Tienhaara et al. 2022). These latter authors conclude that the provision and use of information positively impact and increase consumer preferences and WTP. In a shawarma sandwich choice experiment study that examined how effective information provision is in shaping food safety related to purchasing decisions, Chalak and Abiad (2012) presented respondents with attributes like location, certifications, portion size and price. The study shows that once consumers are informed about the role of each certification (quality management (ISO 9001) and safety (ISO 22000 and ServSafe®)), their preference for each food certification increases significantly, with a more pronounced and diverse preference for food safety certifications, ISO 22000 and ServSafe, compared to ISO 9001. Paudel et al. (2022) examined consumers' WTP for pork produced with different antibiotic levels with attributes such as production methods, use of synthetic growth promoters, antibiotic-use level and price. Their findings indicate that information provision on the different usage levels of antibiotics yields a higher premium. Tienhaara et al. (2022) examine the effects of information on stated preferences for an unfamiliar environmental good, agricultural genetic resources. The authors used attributes like native food plant varieties in gene banks, farms growing native food plants, native breeds on farms, native breeds in gene banks and native ornamental plant varieties mapped and in gene banks. The findings from this study showed that the group that accessed information had a higher WTP for all attributes presented compared with the group that did not access the information.

7.2 RECOMMENDATIONS

We have shown how much consumers are willing to pay for ground beef and steak production practice labels in the absence of any information about those labels. We observed that they are willing to pay positive premiums for all labels except RAU. However, when provided with information, we found that when ground beef consumers were made aware of the labelling requirements of the production claims, their willingness to pay for the RWA label dropped. Similarly, steak consumers dropped their WTP for production claims like AWA, RWA, RWMIA, NAH, and RAU. These findings suggest that information about the labelling requirements of different beef production claims is important in helping consumers make informed choices.

The results have several implications for the different stakeholders in the beef market, such as producers, the beef processing industry, retailers, and regulators. For regular beef producers who use antimicrobials, the decreased valuation of consumers for those labels might be positive. For example, regular beef producers now know that with the correct information in the hands of consumers about those production requirements, they can produce more of their regular beef that are raised with antimicrobials and drive their revenue upwards. Producers who are aware that disclosing production practices' requirements decreases consumers' valuation for those practices and premiums for the labels of those practices might not be encouraged to reveal those requirements fully. If they are mandated by law, they may have to reduce their investments for those labels or differentiate their product and consumer base. For the RWA producers, they know now that this information provision about those production requirements will decrease consumers' willingness to pay higher premiums than when they are not aware, therefore reducing their profit margin and ultimately affecting future volume of production and revenue given that retailers may have to reduce their purchases from them. For instance, they may still produce the RWA but only

a small share for those interested in RWA while maintaining their production share for beef raised with antimicrobials.

For retailers, this suggests that products for which consumers have shown lower valuation after the production requirements of those labels are disclosed may risk sitting on the shelves longer and potentially going bad if there is insufficient demand. To prevent these products from remaining unsold, retailers may be forced to sell at prices below the typical market value that those products usually dictate in the market.

For regulators, it is complex as they must balance the various implications of information provision on consumers and the different stakeholders in the beef industry. The challenge lies in ensuring that no stakeholder or group in the industry, such as producers who avoid antimicrobial use, is unfairly disadvantaged by regulations emerging from these results. At the same time, catering to the preference of RWA consumers may also raise ethical concerns from those who know that the welfare of beef cattle may be compromised by restricting AMU. Regulators must ensure that producers/retailers fully disclose the requirements of the practices used in producing their beef so that consumers can understand what they are purchasing and get full utility for their choices. Regardless, regulators must maintain a good balance between ensuring transparency to consumers and maintaining market dynamics in the beef cattle supply chain, and ensure all stakeholders are treated fairly by their policies

7.3 AREAS FOR FURTHER RESEARCH

This thesis has contributed to the literature by looking at the interconnection or link between the requirements of multiple production practices, especially those related to antimicrobial use and animal welfare and how this affects consumers' WTP. The topic of AMU in FAP and its impacts

on consumer behaviour is complex. The limitations I encountered during this research include challenges running my MXL models and other complex MXL models on my computer and the department's lab computers. These analyses often take me longer than usual, running into countless hours of data analysis. These issues affected how far and deeper I could have gone with my analysis. Given these limitations, the following areas for further research are suggested:

1. Factors that explain why consumer WTP decreased when presented with information about the labelling requirements of different beef production claims. Our findings show that information decreased consumers' WTP for beef labels. This research did not further examine factors that may be responsible for these findings. A future study that uses perception variables may be able to explain the impact of information better.
2. How different information presentation approaches might have affected consumers' WTP for ground beef and steak with different AMU and animal welfare production claims. Evidence in the literature has shown that the impact of information on consumer choices is often mixed and may depend on how the information is presented. It may be helpful to see how different presentation forms can affect consumer choices for beef produced under different AMU and animal welfare practices.

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APPENDIX

Please see the next page for the full survey.

English

Consent

UNIVERSITY OF ALBERTA

Title of Study: Consumer preferences for beef products from animals raised under different antibiotic use practices

Participant Information

I appreciate your interest in participating in this research study. Before you begin, it is important that you are informed about the purpose of this research and how it will be conducted. Please read the following information carefully.

Purpose of this research

The purpose of this research is to gain insights into consumer preferences for beef products from animals raised under different antibiotic use practices and their concerns around antibiotic resistance and animal welfare. This research can help us to better understand the factors driving consumer preferences for beef products.

What to expect from this study

First, you will be asked to answer questions on factors affecting your beef purchasing decision. You will also be asked about your attitudes toward different antibiotic use practices in food animals. We will then ask you to choose your preferred beef products among several options. Lastly, you will be asked a few questions about your demographic information.

What are the benefits to me?

As a member of the TGM Research panel, you will be credited with incentives for participating in this research study. The incentives you will receive are listed in the TGM panel portal when you choose to start this survey.

Anonymity

Data collected for this research will only be accessible to members of the research team at the University of Alberta. No personally identifying information will be collected. The information gathered from the survey will be stored for at least five years on password-encrypted computers owned by the University of Alberta and secure servers hosted in Canada. Data collected will not be entered into a data repository. The reported data will be used for descriptive statistical purposes only, and statistical results may be reported in research papers, technical reports, conference presentations, graduate student theses, and academic journals.

About this study

- Participation will take about 15 minutes.
- Your participation is completely voluntary, and you can withdraw from the research study anytime.
- You can leave questions you are uncomfortable with unanswered, which will not affect the incentives you receive.
- Your decision will not be held against you.

If you have questions, concerns, or complaints, please contact:

Dr. Xiaoli Fan
University of Alberta
Email: xiaoli@ualberta.ca
Tel: 780-802-9916

If you have any questions regarding your rights as a research participant, you may contact the University of Alberta Research Ethics Office at reoffice@ualberta.ca or 780-492-2615 and quote Ethics ID Pro00129707 (Version: April 5, 2023). This office is independent of the study investigators.

By selecting "I consent to participate", you consent to the terms and conditions described above.

- ○ I consent to participate
- ○ I do **NOT** consent to participate

DEM1

At the beginning of this survey, we'd like to ask you for some information about yourself...

What is your age?

[ ]

How do you describe yourself?

- ○ Male
- ○ Female
- ○ Non-binary / third gender

bacteria might spread through the food chain and the environment to humans.

AMU_Attitude

To what extent do you agree with the following statements about the "**raised without antibiotics (RWA)**" claim for beef products?

	Strongly disagree				Strongly agree
RWA labelled beef products are safer to eat.	○	○	○	○	○
RWA labelled beef products are free from antibiotics.	○	○	○	○	○
Under the RWA practice, cattle have a better life and do not get sick.	○	○	○	○	○
RWA labelled beef products have higher animal welfare standards.	○	○	○	○	○

To what extent do you agree with the following statements related to **antibiotic residues** present in meat products?

	Strongly disagree				Strongly agree
All meat products sold in Canada are regulated by the government to ensure that antibiotic residues are far below the amount that could pose a health concern.	○	○	○	○	○
If food producing animals are treated with antibiotics, antibiotics will be present in the meat.	○	○	○	○	○

Perception_AMU_AW

Beef producers use antibiotics to treat, control, and prevent infections. If antibiotic use is restricted, sick or injured animals might not get proper treatment, and their welfare might be compromised.

To what extent do you agree with the following statements related to **antibiotic use and animal welfare**?

	Strongly disagree				Strongly agree
Raising food-producing animals without the ability to use antibiotics when needed reduces their welfare.	○	○	○	○	○
Antibiotic use for **growth promotion** enhances animal welfare	○	○	○	○	○
Restricting antibiotic use for **disease treatment** purposes reduces animal welfare.	○	○	○	○	○
Restricting antibiotic use for **disease prevention** purposes reduces animal welfare.	○	○	○	○	○

Beef producers use antibiotics to treat, control, and prevent infections. If antibiotic use is restricted, sick or injured animals might not get proper treatment, and their welfare might be compromised.

To what extent do you agree with the following statements related to **antibiotic use and animal welfare**?

	Strongly disagree				Strongly agree
Raising food-producing animals without antibiotics reduces their welfare.	○	○	○	○	○
Antibiotic use for **growth promotion** purposes reduces animal welfare.	○	○	○	○	○
Restricting antibiotic use for **disease treatment** purposes reduces animal welfare.	○	○	○	○	○
Restricting antibiotic use for **disease prevention** purposes reduces animal welfare.	○	○	○	○	○

AMR_Attitude

To what extent do you agree with the following statements about **antibiotic use in food-producing animals**?

Note: Medically important antibiotics (MIAs) are antibiotics that are considered important to human medicine for the treatment of bacterial infections in humans. Antibiotics that are not considered MIAs are not used in human medicine.

	Strongly disagree				Strongly agree
Many antibiotics used in food-producing animals are also used in human medicine.	○	○	○	○	○

	Strongly disagree				Strongly agree
In Canada, all MIAs for animal use requires a veterinary prescription.	○	○	○	○	○
Antibiotic use in food-producing animals reduces the effectiveness of antibiotics in human medicine.	○	○	○	○	○

Please indicate how concerned you are with the following uses of antibiotics in food-producing animals regarding their contribution to antibiotic resistance in human medicine.

Note: MIAs = Medically important antibiotics.

	Not at all concerned				Extremely concerned
Using MIAs for disease treatment	○	○	○	○	○
Using MIAs for disease prevention	○	○	○	○	○
Using MIAs for growth promotion	○	○	○	○	○
Using non-MIAs for disease treatment	○	○	○	○	○
Using non-MIAs for disease prevention	○	○	○	○	○
Using non-MIAs for growth promotion	○	○	○	○	○

To what extent do you agree with the following statements about the **spread of antibiotic-resistant bacteria**?

Note: MIAs = Medically Important Antibiotics.

	Strongly disagree				Strongly agree
Antibiotic-resistant bacteria can spread from food-producing animals to humans.	○	○	○	○	○
Antibiotic-resistant bacteria can spread from meat products to humans.	○	○	○	○	○
Antibiotic-resistant bacteria can spread through the environment to humans.	○	○	○	○	○

	Strongly disagree				Strongly agree
There are risks that the final meat products might be contaminated with antibiotic-resistant bacteria (e.g., meat packing plants), even if antibiotics were never used to raise the animal.	○	○	○	○	○

Are you afraid antibiotic resistance might affect you one day?

Not at all	A little	A moderate amount	A lot	A great deal
○	○	○	○	○

AMU_AMR

To what extent do you agree or disagree with the following statements?

	Strongly disagree				Strongly agree
Without antibiotics, it is impossible to produce high-quality and economically priced beef.	○	○	○	○	○
There is a good reason certain antibiotics are used in food-producing animals.	○	○	○	○	○
Antibiotics should never be used in food-producing animals, even for disease treatment purposes, since it is critical to maintain useful antibiotics for public health use.	○	○	○	○	○
Overall, the use of antibiotics in food-producing animals delivers more benefits than harm.	○	○	○	○	○
Use of antibiotics in food-producing animals cannot be seriously harmful; otherwise, authorities would ban the use.	○	○	○	○	○

Att_Check_1

To ensure the next section of the survey loads correctly, please select the word "Green" from below.

- ○ Green
- ○ Blue
- ○ Red

- ○ Other
- ○ Yellow

Info_Label

Consumers are sometimes confused about the meanings of different food labels and claims. Below are the definitions (click for details) of the food labels and claims used in this survey.

Raised Without Antibiotics	+
Medically important antibiotics (MIAs)	+
Responsible Antibiotic Use	+
No-Added Hormones	+
Animal Welfare Approved	+
Grass-Fed	+
Organic	+

Cheap_talk

What has been your (or your household's) usual **weekly expense for food** bought during grocery shopping (consider both in-person and online)?

- ○ Less than $50
- ○ $50-$99
- ○ $100-$149
- ○ $150-$199
- ○ $200-$250
- ○ $250-$299
- ○ $300-$399
- ○ $400 and more

The experience from previous similar surveys is that people often respond in one way but act differently. It is particularly common that one states a **higher** willingness to pay than what one actually is willing to pay for the good in the store. We believe this is due to the fact that one does not really consider how big an impact an extra cost actually has on the family

budget. It is easy to be generous when one does not really need to make the choices in a store. If you have other ideas or comments on what this behavior depends on, please provide them at the end of the survey.

CE_Steak1_Text

(${lm://CurrentLoopNumber}/${lm://TotalLoops}) Imagine you are at the **grocery store** buying ingredients to prepare a meal for yourself or your household. The grocery store offers the following two beef strip loin steaks.

	Beef Steak A	**Beef Steak B**
Animal Welfare	${lm://Field/2}	${lm://Field/8}
Feeding Practice	${lm://Field/3}	${lm://Field/9}
Antibiotic Use Practice	${lm://Field/4}	${lm://Field/10}
Production System	${lm://Field/5}	${lm://Field/11}
Hormone Use Practice	${lm://Field/6}	${lm://Field/12}
Price ($/Kg)	${lm://Field/7}	${lm://Field/13}

Which **beef strip loin steak** would you buy?

○ Beef Steak A ○ Beef Steak B ○ None of these products

Definitions (click for details) **of the food labels and claims used in this survey:**

- **Raised Without Antibiotics** +
- **Medically Important antibiotics (MIAs)** +
- **Responsible Antibiotic Use** +
- **No-Added Hormones** +
- **Animal Welfare Approved** +
- **Grass-Fed** +
- **Organic** +

CE_Steak2_Text

(${lm://CurrentLoopNumber}/${lm://TotalLoops}) Imagine you are at the **grocery store** buying ingredients to prepare a meal for yourself or your household. The grocery store offers the following two beef strip loin steaks.

	Beef Steak A	**Beef Steak B**
Animal Welfare	${lm://Field/2}	${lm://Field/8}
Feeding Practice	${lm://Field/3}	${lm://Field/9}
Antibiotic Use Practice	${lm://Field/4}	${lm://Field/10}
Production System	${lm://Field/5}	${lm://Field/11}
Hormone Use Practice	${lm://Field/6}	${lm://Field/12}
Price ($/Kg)	${lm://Field/7}	${lm://Field/13}

Which **beef strip loin steak** would you buy?

Beef Steak A ○ Beef Steak B ○ None of these products ○

Definitions (click for details) **of the food labels and claims used in this survey:**

Raised Without Antibiotics	+
Medically important antibiotics (MIAs)	+
Responsible Antibiotic Use	+
No-Added Hormones	+
Animal Welfare Approved	+
Grass-Fed	+
Organic	+

CE_Steak3_Text

(${lm://CurrentLoopNumber}/${lm://TotalLoops}) Imagine you are at the **grocery store** buying ingredients to prepare a meal for yourself or your household. The grocery store offers the following two beef strip loin steaks.

	Beef Steak A	**Beef Steak B**
Animal Welfare	${lm://Field/2}	${lm://Field/8}
Feeding Practice	${lm://Field/3}	${lm://Field/9}
Antibiotic Use Practice	${lm://Field/4}	${lm://Field/10}

Production System	${lm://Field/5}	${lm://Field/11}
Hormone Use Practice	${lm://Field/6}	${lm://Field/12}
Price ($/Kg)	${lm://Field/7}	${lm://Field/13}

Which **beef strip loin steak** would you buy?

Beef Steak A | Beef Steak B | None of these products

Definitions (click for details) **of the food labels and claims used in this survey:**

- **Raised Without Antibiotics** +
- **Medically important antibiotics (MIAs)** +
- **Responsible Antibiotic Use** +
- **No-Added Hormones** +
- **Animal Welfare Approved** +
- **Grass-Fed** +
- **Organic** +

CE_Steak1_Visual

(${lm://CurrentLoopNumber}/${lm://TotalLoops}) Imagine you are at the **grocery store** buying ingredients to prepare a meal for yourself or your household. The grocery store offers the following two beef strip loin steaks.

	Beef Steak A	**Beef Steak B**
Animal Welfare		
Feeding Practice		
Antibiotic Use Practice		
Production System		

Antibiotic Use Practice		
Production System		
Hormone Use Practice		
Price ($/Kg)	${lm://Field/7}	${lm://Field/13}

Which **beef strip loin steak** would you buy?

Beef Steak A ○ Beef Steak B ○ None of these products ○

Definitions (click for details) **of the food labels and claims used in this survey:**

- **Raised Without Antibiotics** +
- **Medically important antibiotics (MIAs)** +
- **Responsible Antibiotic Use** +
- **No-Added Hormones** +
- **Animal Welfare Approved** +
- **Grass-Fed** +
- **Organic** +

CE_Steak1_Label

(${lm://CurrentLoopNumber}/${lm://TotalLoops}) Imagine you are at the **grocery store** buying ingredients to prepare a meal for yourself or your household. The grocery store offers the following two beef strip loin steaks (click to view full size images).

Beef Steak A

Beef Steak B

Price: ${lm://Field/3}

Price: ${lm://Field/5}

Which **beef strip loin steak** would you buy?

Beef Steak A | Beef Steak B | None of these products

Definitions (click for details) **of the food labels and claims used in this survey:**

- **Raised Without Antibiotics** +
- **Medically important antibiotics (MIAs)** +
- **Responsible Antibiotic Use** +
- **No-Added Hormones** +
- **Animal Welfare Approved** +
- **Grass-Fed** +
- **Organic** +

CE_Steak2_Label

(${lm://CurrentLoopNumber}/${lm://TotalLoops}) Imagine you are at the **grocery store** buying ingredients to prepare a meal for yourself or your household. The grocery store offers the following two beef strip loin steaks (click to view full size images).

Beef Steak A

Price: ${lm://Field/3}

Beef Steak B

Price: ${lm://Field/5}

Which **beef strip loin steak** would you buy?

Beef Steak A | Beef Steak B | None of these products

Definitions (click for details) **of the food labels and claims used in this survey:**

- **Raised Without Antibiotics** +
- **Medically important antibiotics (MIAs)** +
- **Responsible Antibiotic Use** +
- **No-Added Hormones** +

Animal Welfare Approved	+
Grass-Fed	+
Organic	+

CE_Steak3_Label

(${lm://CurrentLoopNumber}/${lm://TotalLoops}) Imagine you are at the **grocery store** buying ingredients to prepare a meal for yourself or your household. The grocery store offers the following two beef strip loin steaks (click to view full size images).

Beef Steak A	**Beef Steak B**
	
Price: ${lm://Field/3}	Price: ${lm://Field/5}

Which **beef strip loin steak** would you buy?

Beef Steak A	Beef Steak B	None of these products
○	○	○

Definitions (click for details) **of the food labels and claims used in this survey:**

Raised Without Antibiotics	+
Medically important antibiotics (MIAs)	+
Responsible Antibiotic Use	+
No-Added Hormones	+
Animal Welfare Approved	+
Grass-Fed	+
Organic	+

CE_Ground1_Text

(${lm://CurrentLoopNumber}/${lm://TotalLoops}) Imagine you are at the **grocery store** buying ingredients to prepare a meal for yourself or your household. The grocery store offers the following two ground beef products.

	Ground Beef A	**Ground Beef B**

Ground Beef A | Ground Beef B | None of these products

Definitions (click for details) **of the food labels and claims used in this survey:**

Raised Without Antibiotics +
Medically important antibiotics (MIAs) +
Responsible Antibiotic Use +
No-Added Hormones +
Animal Welfare Approved +
Grass-Fed +
Organic +

CE_Ground3_Text

(${lm://CurrentLoopNumber}/${lm://TotalLoops}) Imagine you are at the **grocery store** buying ingredients to prepare a meal for yourself or your household. The grocery store offers the following two ground beef products.

	Ground Beef A	**Ground Beef B**
Animal Welfare	${lm://Field/2}	${lm://Field/8}
Feeding Practice	${lm://Field/3}	${lm://Field/9}
Antibiotic Use Practice	${lm://Field/4}	${lm://Field/10}
Production System	${lm://Field/5}	${lm://Field/11}
Hormone Use Practice	${lm://Field/6}	${lm://Field/12}
Price ($/Kg)	${lm://Field/7}	${lm://Field/13}

Which **ground beef product** would you buy?

Ground Beef A | Ground Beef B | None of these products

Definitions (click for details) **of the food labels and claims used in this survey:**

Raised Without Antibiotics +
Medically important antibiotics (MIAs) +

Responsible Antibiotic Use	+
No-Added Hormones	+
Animal Welfare Approved	+
Grass-Fed	+
Organic	+

CE_Ground1_Visual

(${lm://CurrentLoopNumber}/${lm://TotalLoops}) Imagine you are at the **grocery store** buying ingredients to prepare a meal for yourself or your household. The grocery store offers the following two ground beef products.

	Ground Beef A	**Ground Beef B**
Animal Welfare		
Feeding Practice		
Antibiotic Use Practice		
Production System		
Hormone Use Practice		
Price ($/Kg)	${lm://Field/7}	${lm://Field/13}

Which **ground beef product** would you buy?

Ground Beef A ○ Ground Beef B ○ None of these products ○

Definitions (click for details) **of the food labels and claims used in this survey:**

Raised Without Antibiotics	+
Medically important antibiotics (MIAs)	+
Responsible Antibiotic Use	+
No-Added Hormones	+
Animal Welfare Approved	+
Grass-Fed	+
Organic	+

CE_Ground2_Visual

(${lm://CurrentLoopNumber}/${lm://TotalLoops}) Imagine you are at the **grocery store** buying ingredients to prepare a meal for yourself or your household. The grocery store offers the following two ground beef products.

	Ground Beef A	**Ground Beef B**
Animal Welfare		
Feeding Practice		
Antibiotic Use Practice		
Production System		
Hormone Use Practice		
Price ($/Kg)	${lm://Field/7}	${lm://Field/13}

Which **ground beef product** would you buy?

Ground Beef A ○ Ground Beef B ○ None of these products ○

Definitions (click for details) **of the food labels and claims used in this survey:**

Raised Without Antibiotics	+
Medically important antibiotics (MIAs)	+
Responsible Antibiotic Use	+
No-Added Hormones	+
Animal Welfare Approved	+
Grass-Fed	+
Organic	+

CE_Ground3_Visual

(${lm://CurrentLoopNumber}/${lm://TotalLoops}) Imagine you are at the **grocery store** buying ingredients to prepare a meal for yourself or your household. The grocery store offers the following two ground beef products.

	Ground Beef A	**Ground Beef B**
Animal Welfare		
Feeding Practice		
Antibiotic Use Practice		
Production System		
Hormone Use Practice		

Price ($/Kg)	${lm://Field/7}	${lm://Field/13}

Which **ground beef product** would you buy?

Ground Beef A ○ Ground Beef B ○ None of these products ○

Definitions (click for details) **of the food labels and claims used in this survey:**

- **Raised Without Antibiotics** +
- **Medically important antibiotics (MIAs)** +
- **Responsible Antibiotic Use** +
- **No-Added Hormones** +
- **Animal Welfare Approved** +
- **Grass-Fed** +
- **Organic** +

CE_Ground1_Label

(${lm://CurrentLoopNumber}/${lm://TotalLoops}) Imagine you are at the **grocery store** buying ingredients to prepare a meal for yourself or your household. The grocery store offers the following two ground beef products (click to view full size images).

Ground Beef A	**Ground Beef B**
	
Price: ${lm://Field/3}	Price: ${lm://Field/5}

Which **ground beef product** would you buy?

Ground Beef A ○ Ground Beef B ○ None of these products ○

Definitions (click for details) **of the food labels and claims used in this survey:**

- **Raised Without Antibiotics** +

Medically important antibiotics (MIAs)	+
Responsible Antibiotic Use	+
No-Added Hormones	+
Animal Welfare Approved	+
Grass-Fed	+
Organic	+

CE_Ground2_Label

(${lm://CurrentLoopNumber}/${lm://TotalLoops}) Imagine you are at the **grocery store** buying ingredients to prepare a meal for yourself or your household. The grocery store offers the following two ground beef products (click to view full size images).

Ground Beef A

Price: ${lm://Field/3}

Ground Beef B

Price: ${lm://Field/5}

Which **ground beef product** would you buy?

Ground Beef A ○ Ground Beef B ○ None of these products ○

Definitions (click for details) **of the food labels and claims used in this survey:**

Raised Without Antibiotics	+
Medically important antibiotics (MIAs)	+
Responsible Antibiotic Use	+
No-Added Hormones	+
Animal Welfare Approved	+
Grass-Fed	+
Organic	+

CE_Ground3_Label

(${lm://CurrentLoopNumber}/${lm://TotalLoops}) Imagine you are at the **grocery store** buying ingredients to prepare a meal for yourself or your household. The grocery store offers the following two ground beef products (click to view full size images).

Ground Beef A	**Ground Beef B**
	
Price: ${lm://Field/3}	Price: ${lm://Field/5}

Which **ground beef product** would you buy?

Ground Beef A	Ground Beef B	None of these products
○	○	○

Definitions (click for details) **of the food labels and claims used in this survey:**

Raised Without Antibiotics	+
Medically important antibiotics (MIAs)	+
Responsible Antibiotic Use	+
No-Added Hormones	+
Animal Welfare Approved	+
Grass-Fed	+
Organic	+

Trust_Label

How much do you trust the following claims on food labels?

	Not at all	A little	A moderate amount	A lot	A great deal
Animal Welfare Approved	○	○	○	○	○
Responsible Antibiotic Use	○	○	○	○	○
No Added Hormones	○	○	○	○	○
Organic	○	○	○	○	○
Raised Without Antibiotics	○	○	○	○	○
Raised Without Medically Important Antibiotics	○	○	○	○	○

	Not at all	A little	A moderate amount	A lot	A great deal
Grass-Fed	○	○	○	○	○

AMU_Policy

Many countries have introduced policies to address the antibiotic resistance threat. This can include the implementation of laws aiming to reduce antibiotic use in food-producing animals, for example.

Please indicate your level of support for the following policies regarding **antibiotic use in food-producing animals.**

Note: MIAs = Medically important antibiotics.

	Strongly supportive				Strongly against
Ban MIAs for disease treatment	○	○	○	○	○
Ban MIAs for disease prevention	○	○	○	○	○
Ban MIAs for growth promotion	○	○	○	○	○
Ban non-MIAs for disease treatment	○	○	○	○	○
Ban non-MIAs for disease prevention	○	○	○	○	○
Ban non-MIAs for growth promotion	○	○	○	○	○

To what extent do you agree or disagree with the following statements?

	Strongly disagree				Strongly agree
The government is too influenced by special interest groups regarding antibiotic regulation in food-producing animals.	○	○	○	○	○
The government intentionally exaggerates the hazards associated with antibiotic use in food-producing animals	○	○	○	○	○
The government follows scientific evidence when making policies for antibiotic use in food-producing animals.	○	○	○	○	○

To what extent do you agree or disagree with the following statements about **antibiotic**

resistance?

	Strongly disagree				Strongly agree
To show us that you are still paying attention, please select **"strongly disagree"**.	○	○	○	○	○
We do not need to worry about antibiotic resistance because in the end, these problems will always be resolved by scientific innovations.	○	○	○	○	○
Antibiotic resistance is not entirely out of control, but the government should dictate clear rules about what is and what is not allowed.	○	○	○	○	○
Antibiotic resistance can only be controlled by enforcing radical changes in human behavior in society as a whole.	○	○	○	○	○

CFF

How well does each of the following statements describe you?

	Does not describe me at all				Describes me extremely well
My behavior is only influenced by the immediate (i.e., a matter of days or weeks) outcomes of my actions	○	○	○	○	○
When I make a decision, I think about how it might affect me in the future	○	○	○	○	○
My behaviour is generally influenced by future consequences	○	○	○	○	○
I only act to satisfy immediate concerns, figuring the future will take care of itself	○	○	○	○	○

DEM2

You're almost finished! There are just a couple of short questions left.

Which of the following best describes the area you live in?

○ Rural

○ Urban

Do you, or someone you are related to, own, live, or work on a farm?

- ○ Yes
- ○ Maybe
- ○ No
- ○ Don't know

What is the highest level of education you have completed?

- ○ Primary education
- ○ Secondary education (e.g., high school)
- ○ Higher education (e.g., university degree or higher education diploma)
- ○ Graduate or Professional Degree (MA, MSc, MAB, PhD, JD, MD, DDS, DVM, etc.)
- ○ Did not attend school

What was your total household income before taxes during the past 12 months?

- ○ Less than $25,000
- ○ $25,000 - $49,999
- ○ $50,000 - $74,999
- ○ $75,000 - $99,999
- ○ $100,000 - $149,999
- ○ More than $150,000
- ○ Prefer not to say

How many people live in your household?

☐

How many **children (12 and under)** live in your household?

☐

Political orientations are often classified on a left-right spectrum or a liberal-conservative spectrum. Please indicate your political orientation.

Disclaimer

Thank you for completing our survey! Is there anything else you would like to share?

Disclaimer. In this survey, we asked your opinion about using medically important antibiotics (MIAs) in food-producing animals for growth promotion purposes. We'd like to bring to your attention that "**as of December 1, 2018, Canadian producers were no longer allowed to use MIAs to promote growth in food-producing animals**."

If you are interested in knowing more about how the government is taking action to address antimicrobial resistance related to the use of antimicrobials in animals, please visit this website: https://www.canada.ca/en/public-health/services/antibiotic-antimicrobial-resistance/animals/actions.html.

EndSurvey

As explained in the study consent, you can withdraw from this research study at anytime. Due to the anonymous nature of the survey, you will not be able to withdraw your responses

after this point.

- ○ Yes, I would like to submit my responses
- ○ No, I would like to have my responses withdraw from the study