CONSUMER PREFERENCES FOR BRANDED BEEF PRODUCTS: COMPARING CONVENTIONAL VERSUS DAIRY-BEEF

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ABSTRACT

Beef products, while traditionally associated with cattle breeds such as Angus or Hereford, can also come from dairy-type cattle, such as Holsteins. These dairy-type steers represent a significant source of U.S. feedlot cattle with around 3 to 4 million calves entering the nation's beef supply annually. Holstein meat sensory qualities such as juiciness and tenderness as well as overall acceptability may be indistinguishable, or even superior, to those of traditional beef breeds. Thus, Holstein cattle can provide consistent, high-quality products. However, finding opportunities to market Holstein beef products has been a challenge for producers. In December 2016, Tyson Foods, Inc. announced that it would no longer slaughter finished Holstein steers at their Joslin, Illinois facility, creating a competitive disadvantage for Holstein suppliers and an unstable market. Seeking ways to increase the value of Holstein cattle, there has been a recent shift towards beef x dairy crossbreeding where lower milk-producing dairy dams are bred to beef sires, commonly known as "beef-on-dairy" or "dairy-beef." However, little is known about consumer acceptance of dairy-beef. Additionally, as interest in food traceability increases, traceability may be another way for the dairy-beef producers to differentiate their products. This study uses a consumer discrete choice experiment (DCE) with a reference-price-informed design (RP) to evaluate relative preferences and willingness-to-pay (WTP) for traceability and dairy-beef breed labels on ground beef and ribeye steak. Consumers were willing to pay the highest premium for Certified Angus Beef for both ground beef and ribeye steak followed by Certified Holstein Beef, Traceability, and Certified Dairy-Beef. There were differences in premiums for the three breed labels as well as traceability across both products, emphasizing that consumers have heterogeneous preferences for these attributes in higher vs lower-value products. Additionally, results revealed that breed and traceability labels were substitutes. This study helps to understand consumer preferences for U.S. beef products, ensuring industry leaders and stakeholders are better equipped to make more informed production decisions for U.S. Holstein and Dairy-Beef producers. Results can also be used by policymakers to inform possible support for Certified Holstein and Certified Dairy-Beef programs

This thesis is dedicated to Leila, Mommy, Daddy, the Joiner-Tyler Family, and the friends I've made in East Lansing. Thank you for all your love and support during this master's journey. This is one more step on my journey towards Secretary of Agriculture.

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INTRODUCTION

Did you know that beef can come from many different breeds of cattle? While most beef is associated with traditional cattle breeds such as Angus or Hereford, it can also come from dairy-type cattle – whether it be cull dairy cows or dairy cattle offspring not entering the herd as milking replacements or bulls. Holsteins are a prominent dairy cattle breed that also represent a significant portion of the beef supply worldwide (Shabtay et al., 2021). In the United States, for example, Holsteins make up a significant source of feedlot cattle with around 3 to 4 million calves entering the nation's beef supply annually. Beef from finished Holsteins has many desirable characteristics and provides high-quality, consistent products.[1] Additionally, there have been major strides in managing Holstein steers resulting in a relatively higher percentage of Holsteins grading Choice, according to the United States Department of Agriculture (USDA) Quality Grading Standards (Schweihofer, J, 2017). As a result, many popular mainstream American restaurant chains have even adopted Holstein beef products as part of their menu but are not labeled as such (Fabricant, 2024). Despite Holsteins making positive contributions to the U.S. beef sector, producers face challenges finding marketing opportunities for these products including discounts throughout the supply chain, limited capacity in processing facilities, as well as being overlooked in favor of traditional beef breeds such as Angus or Hereford. Because of these challenges, the dairy-beef industry is seeking ways to create more value for dairy cattle entering the beef supply. However, there have been no studies to understand consumer acceptance and willingness to pay for labeled dairy-beef products. This thesis seeks to fill this gap to help the dairy-beef industry make more informed production and marketing decisions.

Holstein cattle have been a quiet contributor to the beef industry meeting feedlots' and beef packers' needs for consistent cattle supplies and consumers' demand for beef. There are high fixed costs at the feedlot and, especially, beef packer levels of the supply chain. As such, profits increase when the average fixed cost per head is lowered. Feedlots want fast-growing, healthy cattle that can convert feed to carcass weight efficiently. Packers want as much high-quality carcass weight they can get on the hook space of their plants. If cattle numbers from traditional small-framed breeds like Angus or Hereford are low, stakeholders have to respond quickly to ensure consumer demand is met. Historically, Holsteins have been used to fill gaps in beef production when cattle inventory has been constrained *(See* Figure *1; LMIC, 2024).* Over the last decade, the beef sector has seen higher input costs, droughts in the West, delayed slaughtering of feeder cattle, and COVID-19 -related issues that have caused tighter cattle supplies (Balagtas, Cooper, 2021).

[1] Finished beef has a mature skeleton and muscle development with some fat.

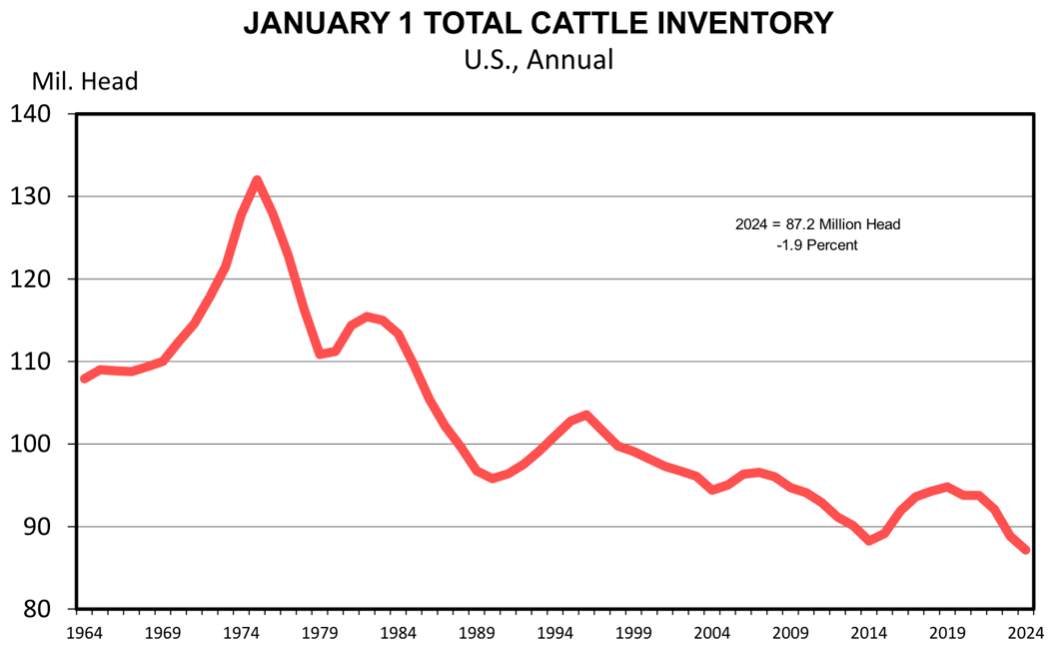

Figure 1 Cattle Inventory from 1964-2024 [2]

The dairy-beef industry has faced many challenges due to its intersectionality between both the beef and dairy industries. While there have been major strides to increase productivity across the sector, the dairy industry has seen increases in input costs, output price volatility, and a decrease in fluid milk demand over the last few years (Geuskens, 2023). Additionally, federal spending on dairy programs has declined providing less support for producers (Olson, 1993). With these changes in the production environment, the sector saw an increase in consolidation with licensed dairy farms falling by 15% from 2017 to 2019 (Frisvold, 2020). In response, stakeholders began exploring alternatives to create more value on their dairy farms.

Dairy-beef /Holstein producers do not have the same opportunities as producers of small-framed traditional beef breeds. In December 2016, Tyson Foods, Inc., one of the three largest beef packers in the U.S. and a major slaughterer in the Midwest, announced that it would no longer slaughter finished Holstein steers at their Joslin, Illinois facility (McKendree, Saitone, and Schaefer, 2020). While the Tyson plant did not shut down operations entirely, cutting off access to a major processing network acted as a plant-specific closure for Holstein steers, creating a competitive disadvantage for Holstein suppliers and an unstable market. The three market forces that contributed to this problem were the expanding traditional beef cow herd, unwieldy size of Holstein cattle that made processing more difficult, and increased demand for more specialized beef products such as Certified Angus Beef. McKendree, Saitone,

[2] Data sourced from the National Agricultural Statistics Service (NASS) and compiled by the Livestock Marketing Information Center (LMIC).

and Schaefer (2020) found that the full effects of the procurement policy change were felt in the dressed and fed Holstein markets where prices decreased by 3.5% and 5.5%, respectively, due to the shock. They also found that Holstein feeder prices dropped 22% and remained 4.8% below prices before the procurement changes in 2018, two years after the announcement. Furthermore, they estimated that the impacts on U.S. Holstein feeder operations' revenues and gross margins suffered losses totaling $610 million annually.

Given these challenges, the dairy-beef industry is seeking ways to increase profitability. To increase profits, producers can either decrease costs (e.g. production efficiencies), or increase revenue (e.g., increasing output price or output volume) (Hansen, Moland, Lenning, 2019). Most studies have focused on reducing costs, as this is more under the industry's control. Up to this point, more attention has been focused on Holsteins and dairy-beef performance on the production side with different management and feeding strategies to improve Holstein steers efficiency (Schweihofer, 2017; Carrasco et al, 2013; Martin et al, 2014; Schaefer, 2017; Pimentel-Concepción, et al., 2023; Scheffler et al., 2003). On the revenue side, Holsteins and other dairy-beef products are currently sold as generic commodities without any labels to differentiate them. There is a gap in understanding if consumers would accept a price premium or increase demand for dairy-beef products if they were labeled in the market. Understanding U.S. consumer perceptions and concerns regarding beef products could lead to more informed and accurate decision-making for industry firms (Ortez et al., 2022). Thus, it is imperative to investigate consumer attitudes toward dairy-beef and Holstein beef specifically. The main contribution of this thesis is that it is the first to look at consumer perceptions of labeled dairy-beef and Holstein beef products.

Not all beef in the U.S. is sold generically, without labels. The USDA Agriculture Marketing Service (AMS) administers several certified beef programs including breed-specific programs. There are four programs in the certified Hereford umbrella while there are 52 Angus programs (AMS, 2023). Of these breed programs, Certified Angus Beef (CAB) and Certified Hereford Beef (CHB) are the most well-known (AMS, 2023). While Certified Angus Beef is the most dominate, its market share is only a small percentage of total beef production in the U.S. (Scheffler, Carr, Scheffler, 2021). No study has looked at consumer knowledge of these different cattle breeds. This study allows us to test, "*Are consumers knowledgeable about cattle breeds?"* Furthermore, there are no third-party certified Holstein or certified dairy-beef programs. Our study uses a hypothetical Certified Holstein Beef label to understand consumer preferences for these products. As such, we can test, "A*re consumers willing to pay for a Certified Holstein Beef Label?*

Given the market shocks, there has been a recent shift towards beef x dairy crossbreeding where lower-producing dairy dams are bred to beef sires, commonly known as "beef-on-dairy" or "dairy-beef" (Foraker et al., 2022). Crossbreeding allows producers not only to not only improve their profitability but

also improve marketability of cull cattle (Quigley, 1997). Dairy-beef crossbred cattle should display similar, or even greater, consistency in many traits related to meat production compared to populations with purebred parental breeds (Gregory, Cundiff, Koch, 1995). However, there is still a gap in the literature surrounding the growth and terminal performance of crossbred dairy-beef in the U.S. beef market, especially in comparison to the growing body of literature surrounding the calf-fed Holstein market (Pimentel-Concepción et al., 2024). Additionally, it is unknow if consumers value pure-bred animals over cross-bred animals. Because crossbred animals would not fit under the purebred Holstein label, we include a broader dairy-influenced label that encompasses purebred or crossbred dairy animals. From this, we establish the research question, "*Are consumers willing to pay for a Certified Dairy-Beef Label?*"

Another attribute valued by consumers in food products is traceability (Loureiro & Umberger, 2007; Lu, Wu, Wang, and Xu, 2016; Hansstein, 2014; Vriezen, Plishka, Cranfield, 2023). Traceability could be one way for the dairy-beef industry to differentiate its products. When comparing traceability for products from beef and dairy cattle, dairy-beef has an advantage over traditional beef products (Foraker, Frink, Woerner, 2022; Arnold, 2024). This starts with differences in management strategies. Dairy producers take a more intensive individual cow approach, using precision technologies to monitor feeding behaviors, milk output, reproductive status, and overall health metrics (Penn State Extension, 2023). Alternatively, individual beef cattle performance data is difficult to maintain so beef producers commonly take a whole-herd approach to managing production needs while maintaining some individual records for health, calving, and birth information (University of Maryland Extension, 2022). There are also differences in the dairy-beef and traditional beef supply chains. Dairy cattle in the U.S. beef sector move through the supply chain 1-2 times between birth to slaughter versus beef cattle that move 3-4 times (Pennsylvania Beef Council; Dallago et al., 202; DeVries & Marcondes, 2020). Because of segmentation, regional production differences, and geographical disbursement, this complicates implementing animal traceback systems for beef cattle. Since the approach to managing dairy cattle is done on a per-cow basis, dairy producers have an advantage over beef producers implementing traceability practices, especially in prominent dairy states. Michigan requires Radio Frequency Identification (RFID) tags for both beef and dairy cattle (Braggs et al., 2024). However, this information is only for disease traceback but could be developed further for marketing purposes. Another research question is, "*Are breed and traceability complements or substitutes?*"

Our experimental study uses an online discrete choice experiment (DCE) to assess consumer preferences and attitudes toward labeled Holstein and dairy-beef products. The goal is to understand relative preferences for Breed (Certified Angus Beef, Certified Holstein Beef, Certified Dairy Beef, and No Breed Information Available), Traceability (Traceable back to the farm or origin, No traceability

information), and Price. Because cattle produce different cuts of meat, it is important to understand the premiums attached to different products, not just one cut (Moyer, 2022). As such, our study uses one high value cut – ribeye steak – and one lower value and very common cut – ground beef – to generate a more complete premium on the carcass. Using ground beef and ribeye steak, we want to know "*Does willingness to pay for breed and traceability labels differ by beef product?"* Building on past research, the study also uses a reference-price-informed (RP-informed) design adopted by Kilders & Caputo (2024) to incorporate individuals' reference prices into the choice experiment to reflect consumers' experience in the actual beef markets.

By having an increased understanding of consumer preferences for U.S. beef products, industry leaders and stakeholders are better equipped to make more informed production decisions and expand market channel opportunities for U.S. Holstein and dairy-beef producers. These results can also be used by policymakers to inform their decision making for support programs relating to potential Certified Holstein and Certified Dairy-Beef.

BACKGROUND

The following sections will provide an overview of the beef and dairy supply chains, dairy-beef production, challenges faced by Holstein producers, and food product quality labeling.

1.1 OVEVIEW OF BEEF AND DAIRY SUPPLY CHAINS

Beef and dairy cattle production lifecycles have distinct differences (*see Figure 2*). As the needs of a beef animal change through its lifecycle, cattle move to operations that specialize in different aspects of production (Farm Credit of the Virginias, 2024). This production system can be broken into three general categories. Starting at the cow-calf operations, calves are born and nursed by their mother and weaned around 6–8 months old, weighing between 500-700 pounds (ERS, 2023; New, Ward, Zook, 2020). Some of the female heifers and male bulls are retained on the operation while the remainder are sold to other producers.[3] From here, calves can be sold to stockers or backgrounders to add body weight before being sent to a feedlot where they are fed a high-grain diet to reach market weight, where most fed cattle will finish between 900-1,400 pounds.

Traditionally, the dairy-beef cattle supply chain is shorter, with the animal changing owners fewer times. Once born, calves are nursed by their mother for 24 hours before being separated to feed on milk replacers (Amaral-Phillips, Scharko, Johns, Franklin, 2006). Heifer calves will be reared to either replace milk-producing cows once they reach maturity or enter the beef supply (veal or finished beef) (Franklin & Jackson 2002). Male calves are either finished for the beef market or may be retained as breeding bulls. Dairy calves that are purchased around 2 months old, gradually introduced to a high-grain diet and fed until they are harvested at approximately 14 months of age are called “calf-fed" (Drouillard, 2018; McKendree, Saitone, Schaefer, 2020). Although the “calf-fed” model is the most common, some dairy-beef cattle may follow the traditional beef supply chain. These cattle, known as yearling feeders, are older feeder steers that weigh typically between 700-1,000 pounds are backgrounded on pasture before being put on feed 4-8 months before harvest.

Given that it takes nearly three years from the time a decision is made to breed a cow until the beef from the resultant offspring reaches the market, it can take time for the cattle market to react to information. The cattle cycle is a time period that describes cattle producers’ decision to expand or contract their herds. These decisions made by individual operations impact the size of the national herd (ERS, 2023). This cycle averages 8-12 years and is influenced by cattle prices, input costs, time needed to raise the calves to market weight as well as climate conditions (drought), all of which influence producer profitability. When inventories for traditional beef breeds such as Angus and Hereford are low but demand for beef is staying the same or even increasing, processors and retailers must find creative ways

[3] Female calves are known as heifers while male calves are bulls.

to meet these consumer needs. For example, from 2011-2016, beef cow inventory was trending downward *(See Graph 2; LMIC, 2024).* In comparison, dairy cattle inventories remained consistent. During this period, there was an increase in dairy-type carcasses from 9.9% to 16.3% within the beef supply chain (Boykin et al. 2017).

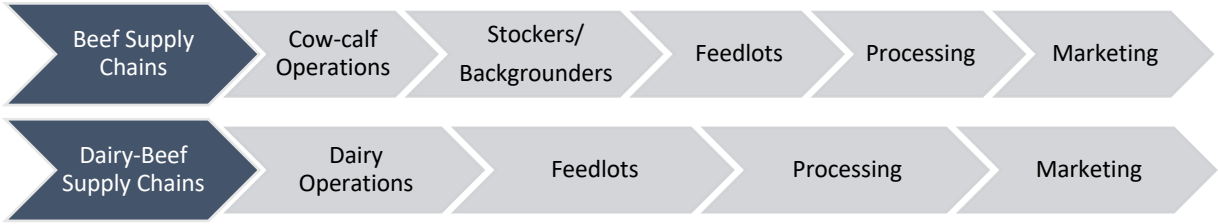

Figure 2 *Traditional Beef vs Dairy-Beef Supply Chains*

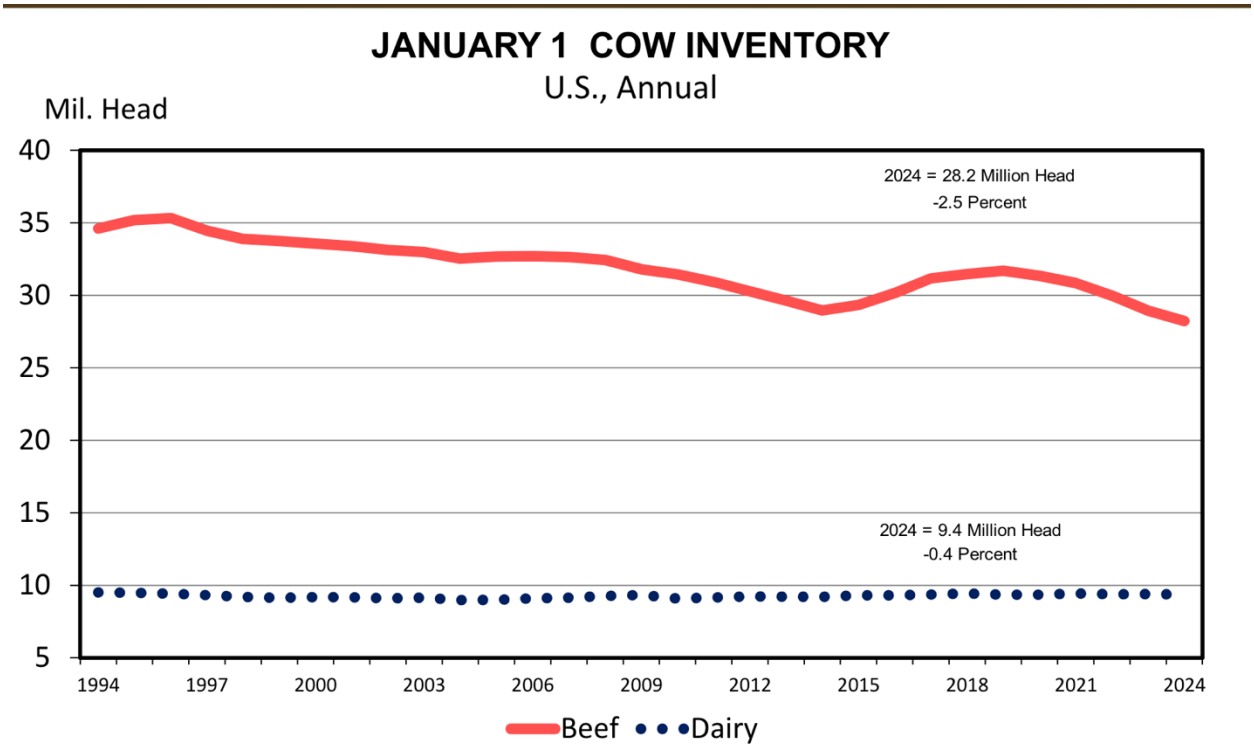

Figure 3 *Dairy vs Beef Cattle Inventory from 1994-2024* [4]

[4] Data sourced from the National Agricultural Statistics Service (NASS) and compiled by the Livestock Marketing Information Center (LMIC).

1.2 CHALLENGES IN THE DAIRY INDUSTRY

Because it is often deemed as one of the most heavily capitalized sectors of the food industry, the dairy sector is vulnerable to regulation changes, political shifts, and involvement from large agribusiness leaders (Napolitano et al., 2010; Hansen, Jervell, 2015). Milk prices have been on the decline after years of unfavorable international policies and increasing global milk supplies (Gould, 2010; Shields, 2010). While larger operations are able to improve productivity and drive down per-unit costs (i.e., milk-per-cow efficiency) in this highly regulated market, smaller farms are unable to compete (Napolitano et al., 2010; Hansen, Jervell, 2015). This creates inequities in net returns across dairy operations of varying sizes, suggesting shifts toward larger operations and smaller dairy operators exiting the industry. This has put a spotlight on the dairy industry as it has experienced widespread consolidations of small and medium-scale farms. Between 2017 and 2019, licensed dairy farms fell by 15 percent due to operations facing financial challenges with the feed cost and milk price gap narrowing, providing producers with less profit (McDonald, Law, Mosheim, 2020). While this wave of farm closures affected traditional dairy-producing states in the Midwest and Northeast regions of the United States, there has not been a dip in productivity. Compared to thirty years ago, when there were over 200,000 farms with milk cow herds of 80 or fewer, the number of dairy farms has fallen by around three-quarters, but milk production has increased over 50 percent on farms with 1,000 milk or more milking cows.

With fewer operations needed to keep up with fluid milk demand, stakeholders are trying to find unique ways to profit from their dairy cattle. Naturally, when people think about dairy, they think of one revenue source – milk. But there are two other revenue streams that become particularly important when margins are tight. The profitability a producer receives from their dairy cattle depends largely on the calf value (Moreira, Rosa, Schaefer, 2021; Hersom & Thrift, 2018) as well as the cull cow value. So, if margins for milk are tight, producers can find alternate ways to increase their revenue by focusing on cull cows, milking cows, or dairy calves. Given the recent rough years in the dairy industry, producers have focused more heavily on creating value for their calves through the beef market. Another innovation sparked by consolidations is repurposing existing dairy infrastructure (barns, feed bunks, silos) as feedlots, especially for dairy-beef in the Midwest and Northeastern U.S. (Scherer-Carlson, 2024).

1.3 CHALLENGES FOR HOLSTEIN BEEF

Funneling both dairy offspring and cull cows into the beef supply has proven to be a solution for many producers to maximize their cattle value (Berry, 2021). However, because they have been bred to support greater lactation requirements, Holstein cattle have some less desirable beef characteristics. Holsteins have shorter hair, thinner hides, and less subcutaneous fat than other beef breeds. This means they do not respond well to cold stress which makes raising Holsteins in the Midwest, where many cattle and feedlot operations are concentrated, challenging. When assessed by the U.S. Department of

Agriculture (USDA) beef quality grading system, Holsteins typically have a lower dressing percentage when compared to purebred beef steers. This is due to larger gut proportion, higher bone-to-muscle ratio, and increased liver size (Schaefer, 2005). According to USDA standards, these characteristics cause Holstein's weight gain metric to be similar, but not as efficient, as traditional breeds.

When comparing trimmed muscle cuts between finished Holstein and small-framed beef cattle, Holstein ribeye and loin muscles have been described as thinner, and triangular with a tapered shape toward the end (Shabtay et al., 2021). There is machinery that can reform this tapered look into a round shape similar to those from traditional breeds. These factors, along with Holstein steers having a heavier, more complex anatomical skeletal frame, create a challenge for Holstein producers because they have constrained marketing access and fewer processing facilities that will accept them. This has caused them to be heavily discounted historically and put producers at a competitive disadvantage (Burdine, 2003). These large carcasses also create internal challenges for the processing facility. Meat processing is a high fixed-cost industry meaning each animal coming through the facilities has a per-head cost attached to the labor, technology, and resources needed to move it through the facility (Boyer, Lambert, Martinez, Maples, 2023). The larger frame of Holsteins creates a backlog in some older production facilities because they drag from being too big for existing shorter equipment, slowing down daily output, and increasing the per-unit cost for the animals coming through the facility. The carcasses also create additional hazards for plant workers such as increased risk in knocking into sharp objects and musculoskeletal injuries from handling the larger animals (OSHA, 2024).

1.4 DAIRY BEEF CROSSBREEDING

Challenges spark innovation. In response to industry challenges, there has been a recent shift towards "beef-on-dairy" or "dairy-beef" (Carvalho, 2023). Crossbreeding combines the desirable traits of two or more different breeds to produce one hybrid. This could mean transferring genes that are superior for animal growth, feed efficiency, and dressing percentages. Typically, beef-on-dairy is breeding a beef breed sire (male bull used for breeding) on a dairy breed dam (a breeding female cow). For example, an Angus sire could be bred to a Holstein dam. Because most breeding in the dairy industry is done via artificial insemination (AI) versus live cover, crossbreeding can happen easily without major management changes (McCabe, 2023).[5] Another way beef-on-dairy crossbreeding occurs is using a beef breed clean-up bull on dairy cows that had unsuccessful AI.[6]

[5] AI allows farmers to select bulls based on their genetic traits based on the traits of their offspring. This process involves collecting semen from genetically superior bulls and evaluating the semen for specific traits based on production goals.

[6] A clean up bull is a bull used to breed cows that didn't conceive through artificial insemination.

When compared to purebred dairy cattle, dairy-beef cattle have increased efficiency through greater average daily gain and improved feed efficiency (Pimentel-Concepción et al., 2023). These cattle also meet or exceed marbling requirements for branded beef programs in the U.S. The 2022 National Quality Beef Audit confirmed the industry is trending towards beef sires being used on dairy cows finding that Holstein hide color decreased from 20% in 2016 to 12.3% in 2020 while black-hided cattle increased from 58% to 62% in the same time frame (NBQA, 2022). Studies have also indicated that products from beef x dairy crossbreds demonstrate greater tenderness and flavor than purebred cattle that do not have any dairy influence (Picard, 2016; Frink 2022; Gagaua, 2020).

Inconsistencies in the market and downstream packer logistics have limited the value dairy-beef crossbreeds have to feedlots due to the variability of acceptance at packing plants. In some cases, pricing structures at plants are only for purebred Holsteins (Basiel & Felix, 2022). Additionally, there have been concerns from industry stakeholders about the variation in visual phenotype expression for crossbred beef x dairy cattle (Jaborek, Carvalho, Felix, 2023). Because genetics, including hide color, are characteristics attributed to high-quality beef, dairy-type expressions have carried negative implications for beef production. This is due to the association with inferior meat yields, higher incidence of liver abscesses, and irregularly shaped beef products compared to traditional breeds (NBQA, 2022). Though beef x dairy crossbreds may not fully exhibit the negative consequences associated with dairy influence in beef production, variation in expression may contribute to decreased cattle value.

1.5 BEEF TRACEABILITY

There have been ongoing discussions about beef traceability for decades; however, the U.S. has not implemented a national traceability system. The COVID-19 pandemic sparked more interest in traceability as the link between food safety and resilient food systems became more apparent. In response to these shifts in market preferences, traceability technologies have become an important tool to protect both international and domestic agri-food supply chains. Food traceability refers to a system that provides a recordkeeping database that tracks food products or product attributes as they move through the supply chain. The complexity of a traceability system is determined by breadth (amount of information recorded in the system), depth (the reach the system has within the entirety of the supply chain), and precision (the accuracy for which product movement and characteristics can be identified). Traceability also strengthens the identification of safety issues and improves the efficiency of managing food safety breaches by firms. This reduces costs associated with food recalls, preserves industry reputation, protects consumers from animal disease outbreaks and foodborne illnesses, as well as emphasizes producer accountability in the eyes of the public (Loureiro, M. L., & Umberger, W. J, 2004).

Even though the U.S. has typically set the operating standard for international food handling, recent research suggests that the U.S. beef system is falling behind global competitors in terms of traceability

(Dickenson & Von Bailey, 2002). Livestock traceability has been an increasing focus of the USDA, National Cattlemen's Beef Association (NCBA), high beef-producing states and other stakeholders across the beef industry (Shear & Pendell, 2020). This is to mitigate adverse future disease outbreaks and food safety crisis as well as maintain positive perceptions of U.S. beef products for international exports. Traceability systems do, however, impose costs on producers to implement and maintain systems for increased data collection and storage costs, tracking technologies, and product separation. These added costs could impose a higher price for these traceable products versus their non-traceable competitors. Because of this, it is critical to evaluate consumer value for traceability technology to determine if the investment is worth it. The U.S. does have some existing state-level programming in prominent dairy states (i.e., Michigan) that are used for disease traceback only (MSU Extension). Given existing infrastructure, this presents an opportunity for dairy-beef producers to utilize this traceability information as a marketing tool (Braggs et al., 2024).

1.6 FOOD PRODUCT LABELING

In the U.S. food system, food product labels have historically been used to ensure fair competition between producers and inform consumers about the characteristics of products (Gao & Unterschultz, 2010; Klain, Lusk, Tonsor, and Schroeder, 2014). This has resulted in food markets relying heavily on labeling as an indicator to inform buyers of intrinsic and extrinsic cues such as nutrition, quality, and safety. Consumer evaluation of food quality is one of the most challenging aspects of studying consumer behavior since food comes in many forms (Grunert, 1997). Economists use choice experiments (CE) to elicit consumer preferences for food attributes and labels such as tenderness, country of origin, animal welfare, food safety, third-party certifications, health claims, and nutrition. Choice experiments force consumers to make choices between alternatives that differ in certain quality attributes but hold other attributes not listed as constant. One of the main goals of choice experiments is to understand consumer willingness- to-pay (WTP) for a product with attributes and attribute combinations. These studies show how consumers will respond to food labels and product differentiation and help project demand under food labeling programs (Koistinen et al., 2013). There have been several studies that highlight the heterogeneity of consumer preferences, indicating subgroups of consumers have different valuations of product characteristics (Chalakk et al., 2008, Kornelis et al., 2010, Nilsson et al., 2006, Pouta et al. 2010). These segments are often tied to socio-demographic differences but there can also be an aspect of consumer attitudes, which impact how consumers purchase products. WTP studies prevent producers and food industry stakeholders from investing blindly in product enhancements and risk the profitability of their businesses (Koistinen et al., 2013). Thus, having a clear understanding of how additional food quality attribute labels affect consumer WTP can help producers, processors, policymakers, and researchers understand the welfare analysis associated with food labeling (Gao, Schroeder, 2009).

Beef in the U.S. is often sold as a commodity, without labels that differentiate it from other products in its class. To create a competitive advantage, adding quality labels or other cues could position companies to appeal more to consumers and support informed production decisions. (Koistinen et al., 2013). In turn, there has been an increase in literature focusing on the consumer valuation of beef products (Ardeshiri, Sampson, Swait, 2019; Tedford et al., 2014; Syrengelas, DeLong, Grebitus, Nayga, 2018; Garmyn, 2020). This includes evaluating consumer preferences for different quality attributes such as food safety, quality grade, Country of Origin Labeling (COOL), grass vs grain-fed, rearing techniques, and animal welfare (Carzedda et al., 2021; Tait et al., 2019; Chen, Anders, An, 2013; Ortega, Hong, Wang, and Wu, 2016; Yang, Raper, and Lusk, 2020). These studies emphasize that since consumers are heterogeneous in their preferences, there is an inherent need to understand how premiums differ between beef attributes by groups of consumers. These studies also found that consumer knowledge and information treatments impacted willingness to pay for beef attributes. Additionally, several studies have assessed how traceability technology plays a role WTP for food products (Loureiro and Umberger, 2007; Denver, Jensen, Olsen, Christensen, 2019; Gracia, 2014; Balcombe, Bradley, Frasser, Hussein, 2016; Shew, Snell, Nayga, Lacity, 2022). These results emphasize that consumers are willing to pay a higher price for safe and guaranteed origin products. There are, however, gaps in understanding how cattle breed intersects with beef product quality.

1.7 CERTIFIED BREED PROGRAMS

While consumer willingness to pay for specific meat characteristics has a major impact on that product's demand, the influence of meat brands' advertising strategies on beef demand cannot be ignored (Zimmerman, Schroeder, 2011). The United States Department of Agriculture Marketing Service (AMS) administers several commodity-specific programs, with one category being livestock and poultry breed-certified programs (AMS, 2023). These certified beef breed programs generally include specifications for quality, yield traits, and carcass attributes (Scheffler, Carr, Carr, 2021). The programs also establish high-quality standards to maintain quality expected by consumers.

In the late 1970s, the American Angus Association (AAA) submitted a request to the Standardization Branch of AMS for a new marketing program solely for beef from Angus cattle. With the AAA phenotypic base, the Certified Angus Beef (CAB) program was introduced with 10 additional quality standards. The CAB brand grew rapidly over the late 20th century as they built relationships with major U.S. packers, restaurants and distributors who identified a need to provide consistent and high-quality beef products. In 2023, CAB sales reached 44.7 million pounds sold across retail and food service in both domestic and international markets (CAB, 2023). The success of the CAB program has influenced the creation of other, especially Angus, certified beef programs. At its peak, AMS administered 130 certified

beef programs for Angus, Herford, and Wagyu cattle (USDA, 2020). Today, there are around 71 active certified beef programs, but none for Holstein or dairy-beef cattle

METHODS

Given that Certified Holstein Beef and Certified Dairy Beef programs do not exist, we used a hypothetical choice experiment to understand the stated research questions. Choice experiments are a preferred hypothetical method to evaluate consumer choices because (1) multiple attributes can evaluate simultaneously, (2) they are consistent with random utility theory, and (3) a choice experiment simulates the actual consumer purchasing decision where a choice must be made between alternatives. Using this method decreases the risk of hypothetical bias compared to contingent valuation (CV) methods (Lusk & Schroeder, 2004).

This section first describes the online experiment implementation and then illustrates the empirical strategy followed to estimate the data.

2.1 ONLINE CHOICE EXPERIMENT & EXPERIMENTAL DESIGN

Choice experiments are widely used to understand the heterogeneous expectations of various consumer segments (Caputo & Scarpa, 2022) and help industry members predict purchasing behaviors for different products (Merlino et al., 2018). Our study used a split sample approach to design a DCE focusing on ground beef and ribeye steak selections. We selected these products because understanding the price premiums for both low and high-value products is important to inform producers (Li, 2023). Given carcass anatomy, when harvested cattle produce multiple different cuts of beef and finite amounts of each cut. Thus, it is important to understand the premiums gained from both lower and higher value products (McKendree, 2013; Scozzafava et al., 2016; Van Loo et al., 2011; Uys & Bisschoff, 2016; Gracia & de-Magistris, 2013). This project received approval from the MSU Office of Regulatory Affairs' Human Research Protection Program with study #STUDY00009823.

There is a diverse group of quality attributes that influence beef consumers' purchasing decisions (Van Loo et al., 2011). Through a detailed literature review and discussions with beef industry experts, relevant beef quality attributes and their corresponding levels were identified as the most pertinent attributes to compare consumer preferences for Holstein and Dairy-Beef products (Yong, Eskridge, Calkins, Umberger, 2010; Lusk & Fox, 2000; Loureiro & Umberger, 2007). These are breed (Certified Holstein Beef, Certified Angus Beef, Certified Dairy-Beef, and no breed information shown), traceability (traceable back to the farm of origin, no traceability information), and price (displayed in $/pound) (*see Table 1)*.[7]

[7] Labels for breed and traceability were used to indicate to the consumer if that attribute was present. Because Certified Angus Beef exists in the market already, labels for the hypothetical Certified Dairy-Beef and Certified Holstein Beef were created by the research team.

Table 1 *Choice experiment attributes descriptions*

Attribute	Attribute Definitions and Levels
Price (In U.S. Dollar Per Pound ($/lb.)	
Low Ribeye (PVA)	$7.99, $11.99, $15.99, or $19.99
High Ribeye (PVB)	$19.99, $23.99, $27.99, or 431.99
Low Ground Beef (PVC)	$2.99. $4.99, $6.99, or $8.99
High Ground Beef (PVD)	$8.99, $10.99, $12.99, or $14.99
Breed	Certified Angus Beef Certified Dairy Beef Certified Holstein Beef No Breed Information Available (Generic)
Traceability	Traceable to the Farm of Origin No Traceability Information

Breed-specific branding is the main topic of interest for the study since the research team is interested in investigating the viability of potential Certified Holstein Beef and Certified Dairy-Beef programs. Traceability was included as it could be another way for Holstein and dairy-beef to differentiate their products. However, it is not known if breed and traceability labels are substitutes or complements. If they are complements, then consumers are WTP more when both labels are included than if each label was included individually. If traceability and breed labels are substitutes, then whichever garners the highest WTP is the attribute the industry may want to focus on for differentiation.

The pricing structure for the experiment was adopted from the reference-price-informed (RP) design developed by Kilders and Caputo (2024) which incorporates individuals' reference prices into the Discrete Choice Experiment (DCE) to better reflect what consumers experience in the food market. The design was chosen because market prices fluctuate across time, locations, space, and product, meaning the reference price consumers evaluate a product against also varies due to reference price uncertainty (Caputo et al., 2018; Caputo et al., 2020). This is especially true for meat products, as shown in Kilders and Caputo (2024) and Lim and Hu (2023).

Following Kilders and Caputo (2024), participants were asked at the beginning of the survey *"What price do you expect to pay for a 1lb. ribeye steak (or ground beef) package from the grocery store you normally shop at?"* This question determined which price vector group they were assigned. Based on price expectations, participants were then sorted and shown the choice experiment with the lower or higher price vector for their respective product group. As such, there were treatment groups for the study covering the upper and lower half of the prices available in the market: 1) ribeye steak, lower price

(PVA), 2) ribeye steak, higher price (PVB), 3) ground beef, lower price (PVC), and 4) ground beef, higher price (PVD). A visual depiction of these treatments is in *Figure 4*.

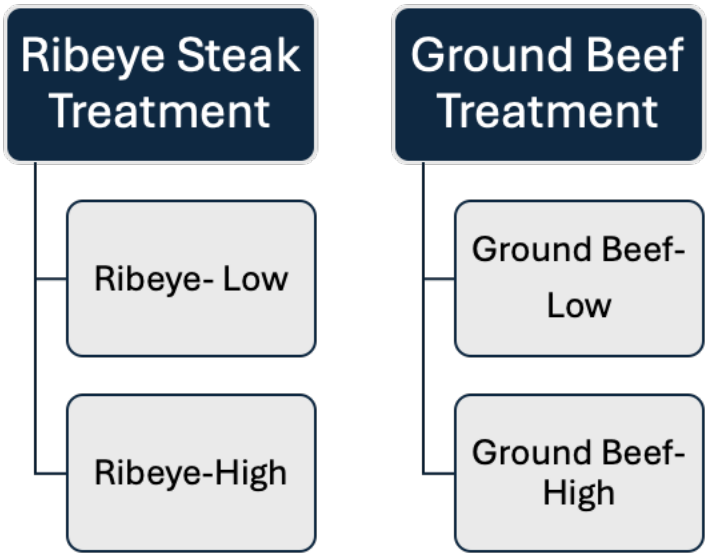

Figure 4 *Split-sample treatment groups*

Respondents with a reference price at or below $8.99 for ground beef and $19.99 for ribeye steaks were presented with four price levels covering the lower half of the prices in the choice design ($2.99, $4.99, $6.99, and $8.99 for ground beef PVC; $7.99, $11.99, $15.99, and $19.99 for ribeye steak PVA), whereas respondents with a reference price above $8.99 and $19.99 saw four price levels covering the upper half of the prices in the choice design ($8.99, $10.99, $12.99, and $14.99 for ground beef PVD; $19.99, $23.99, $27.99, and $31.99 for ribeye steaks PVB). These price levels were determined using the USDA Agriculture Marketing Service (AMS) National Beef Retail Report as well as average prices for 1lb. ground beef and ribeye steak packages at regional and national grocery store chains. Given that Certified Dairy- Beef and Certified Holstein Beef do not currently exist in the market, we matched price levels for the products to those of branded, Choice, and Prime ground beef and ribeye steaks. For the choice experiment, respondents were presented with either two different raw 1lb ribeye steak or 1lb ground beef packages plus a third "no purchase" alternative (Mørkbak, Nordström, 2009; Alfines et. al, 2006). This was done to mimic the real-world choice scenarios faced by the consumer. An example of a choice set for both the ribeye steak and ground beef products is given in *Figure 5.*The choice sets were designed using a Bayesian D-efficient design (Scarpa, Campbel, Hutchinson, 2007; Scarpa & Rose, 2008). The design was done in two main stages. The first stage was an orthogonal design that we used for the pilot study. Given that each price vector has two alternatives in the DCE, a full factorial design would require $4^2 \cdot 2^2 \cdot 4^2 = 1{,}024$ choice questions for the design with four price levels, four breed levels, and

two traceability levels. We used the Ngene software program (ChoiceMetrics, 2018) to create a simultaneous fractional factorial design to reduce the number of choice questions respondents saw to only 24 questions split into two separate blocks, so therefore each respondent saw 12 choice questions. A general design framework was applied to each price vector, only switching out the price depending on the product and if it was the high or low-price vector. The second stage involved deriving uniform efficient designs for each product and price vector using multinominal logit probability specification to estimate the coefficients used as Bayesian priors for the data collected in the first stage. The efficient designs included the original 24 choice question-2 block structure that was originally proposed in the pilot study.

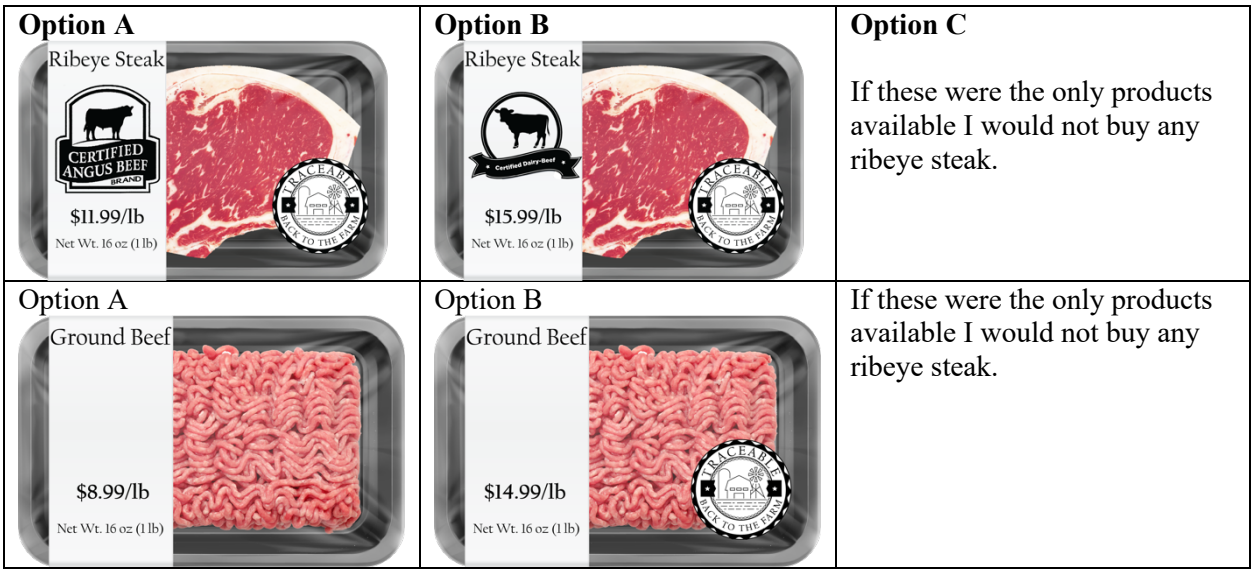

Figure 5 *Choice set example for ribeye steak and ground beef*

2.2 EMPIRICAL MODELS

Choice experiments are consistent with Random Utility Theory (Lusk and Shroeder, 2004), which state that when individuals are presented with multiple alternatives, they act rationally by selecting the alternative that gives them the highest utility among a given set of choices. Formally, the utility that an individual *n* derives from alternative *j* at choice occasion *t* can be represented as follows:

Equation 1

$$U_{njt} = V_{njt} + \varepsilon_{njt}$$

where V_{njt} is the utility that the researcher models and ε_{njt} is the random error component (McFadden, 1974). Depending on the assumptions regarding the functional form of the utility and the distribution of the error term, different econometric models can be specified.

In this study, the data was analyzed using a Random Parameters Logit (RPL) model. The RPL model assumes that the random errors are independently and identically distributed (i.i.d) across alternatives. In addition, the RPL model allows for the identification of preference heterogeneity within the population (Train, 2009), while also accounting for repeated observations taken from the respondent (Revelt & Train, 1998). Formally, consider a sequence of observed choices i by individual n the unconditional probability that individual N makes this sequence of choices can be expressed as follows:

Equation 2 $$P_{ni} = \int L_{ni}(\beta) f(\beta) d\beta$$

where $f(\beta)$ is the density of the coefficients β, while L_{ni} is the conditional probability, which can be expressed as follows: refers to the parameters of the density function. Conditional on the probability that the person makes the sequence of choices is the product of these logits:

Equation 3 $$L_{ni}(\beta) = \prod_{t=1}^{T} [\frac{e^{V_{nit}}}{\sum_j e^{V_{njt}}}]$$

casein our application, V_{njt} was specified as follows:

Equation 4

$$V_{njt} = ASC_j + \beta_1 CAB_{njt} + \beta_2 HOLSTEIN_{njt} + \beta_3 DAIRY_{njt} + \beta_4 TRACEABILITY_{njt} + \beta_5 PRICE_{njt}$$

where ASC is the alternative specific constant representing the "no buy" option, *CAB* is a dummy variable assuming the value of 1 if the choice is a Certified Angus Beef product (CHB), *HOLSTEIN* is a dummy variable assuming the value of 1 if the choice is a Certified Holstein Beef (CHB) product, *DAIRY* is a dummy variable assuming the value of 1 if the choice is a Certified Dairy Beef (CDB) product, and *TRACE* is a dummy variable assuming the value of 1if the choice has traceability information for the product. *PRICE* is a continuous variable for the price attribute, which varies depending on the reference price design in which participants were directed during the experiment. The distributions of the non-monetary attributes were specified as normally distributed, while the price coefficient was uniformly distributed.

The coefficients from the RPL model were used to compute WTP values. The WTP for the *i*th attribute is computed as the negative ratio between the coefficients of the non-monetary attributes and the price coefficient, following the Delta (Wald) Procedure.

2.3 DATA COLLECTION AND ONLINE SURVEY

The study was conducted in March 2024 using Qualtrics with a stratified sample of 1,561 U.S. consumer households. In addition to the choice experiment, the online survey consisted of consumer demographic information, basic knowledge questions on the U.S. beef industry, respondents' beef consumption/purchasing patterns, basic knowledge questions about beef labels currently in the market, and reference price-related questions. To ensure the sample was appropriately matched to the U.S. population numbers for age, gender, education, geographic region, and income, the research team integrated quotas for participants at the beginning of the survey. Respondents had to be at least 18 years or older, be one of the primary grocery shoppers in their household and had purchased either ground beef or ribeye steak within the last three (3) months. Additionally, participants had to indicate the frequency they purchased ground beef and ribeye steak. These options included "weekly", "every other week", "monthly", "every other month", "every 3 months", or "never". The participants' responses to this question would determine which product group they were sorted into. If they selected "never" for both ribeye steak and ground beef they did not move through the rest of the survey. If they only purchased one of the products, they were sorted into that product group. Those that purchased both ground beef and ribeye steak were randomly placed into the product groups

2.4 MEASURING CONSUMER KNOWLEDGE

Understanding how information impacts consumer decisions and the way this variable is measured has been a major topic of marketing literature (House et al., 2004). Consumers are often, however, overconfident and think they know more about the product than they do (Alba & Hutchinson, 2000). To measure consumer knowledge of beef production and cattle breeds we follow Park & Lessig (1981) who recommend questions about both subjective and objective knowledge. Objective knowledge questions measure how much a person thinks they know about a topic, while subjective knowledge measures how much the person actually knows about the topic. The gap between a consumer's subjective and objective knowledge occurs when the user does not accurately perceive how much or how little they know. This could impact a consumer's purchasing decision as those with higher levels of self-rated knowledge would be less likely to seek out new information about a product.

The subjective knowledge section required respondents to indicate how knowledgeable they believed they were about cattle and beef production system topics on a scale of 1-5 (no knowledge=1, minimal knowledge=2, basic knowledge=3, intermediate knowledge=4, advanced knowledge=5). The topics included: cattle breeds, USDA quality grades, Certified Angus Beef (CAB), USDA Organic, grass-fed beef, animal welfare certifications, beef traceability systems, and beef tenderness. The objective knowledge section tested the true knowledge consumers had about the beef production system topics. The first set of questions were identifying cattle breeds traditionally used for beef production and breeds

traditionally used for dairy production. This required selecting all that applied from pictures of Angus, Jersey, Hereford, and Holstein cattle as well as a “none of the above” and “I don’t know” option. The next section were true/false questions based on the topics in the subjective knowledge questions (*See Table E for full listing of questions*).

RESULTS

The survey used for the study was implemented through Qualtrics (https://www.qualtrics.com/). During the data collection period, 1,561 completed responses were collected across the two products, 1,049 from ground beef and 512 from ribeye steak.

3.1 DEMOGRAPHICS

Demographic summary statistics are shown in *Tables 2 & 3*. Across the overall sample, there were some demographic categories that were in line with the U.S. Census records. The average age in our sample (33 years) is below the national average (39 years) (U.S. Census Bureau, 2020), however our sample is comparable to other beef choice studies that imposed a minimum age requirement of 18 (e.g., Kilders & Caputo, 2024; Loureiro & Umberger, 2007; Van Wezemael et al., 2014; Schulze, Spiller, Risius, 2021). Compared to national averages, 52% of respondents identified as female (50% according to the U.S. Census Bureau, 2022) while 47% of respondents identified as male (50% according to the U.S. Census Bureau, 2022). These results align with past data that suggests women are more likely to be the primary shoppers in their households, both for those with and without children (BLS, 2016). In terms of income, 36% of the sample reported making less than $50K a year which is slightly above the national average of 34%, while 26% of the sample reported making $100K or more a year, which is below the national average of 38% (U.S. Census Bureau, 2022).

Table 2 *Socio-demographic characteristics of the sample* [8]

Socio-Demographic Characteristic	% of Total
Gender	
Male	46.74%
Female	52.34%
Non-binary/non-conforming	0.71%%
Prefer to self-describe	0.07%
Prefer not to say	0.14%
Age Group	
18-24 years	7.38%
25-34 years	20.14%
35-44 years	17.65%
45-54 years	15.03%
55-64 years	14.25%
65-74 years	18.15%
75 years or older	7.38%
Educational Status	
Less than high school	2.41%
GED	22.77%
Associates	12.27%
Some college	23.76%
Bachelor's degree	23.19%
Master's degree	10.78%
Professional degree	1.99%
Doctorate	2.84%
Ethnicity	
White	74.38%
Asian	2.49%
Hispanic	3.43%
Black/African American	12.85%
Middle Eastern	0.16%
American Indian	0.55%
South/Southeast Asian	0.47%
Native Hawaiian/Pacific Islander	0.08%
Other	0.39%

[8] Sample size (n) = 1,561

Table 3 *Household characteristics of the sample* [9]

Household characteristic	% of Total
Household Size	
One person	24.45%
Two person	37.69%
Three person	18.77%
Four person	12.07%
More than 5	7.01%
Household Members Under the Age of 12	
None	77.10%
One person	12.54%
Two person	6.70%
Three person	2.41%
Four person	0.93%
More than 5	0.31%
Average Household Income	
Less than $25,000	14.61%
$25,000 to $49,999	21.70%
$50,000 to $74,999	23.76%
$75,000 to $99,999	13.48%
$100,000 to $124,999	9.29%
$125,000 to $149,999	8.01%
$150,000 or greater	9.15%
Marital Status	
Single	33.18%
Married	44.00%
Separated	2.65%
Divorced	13.01%
Widowed	7.17%
Area Description	
Urban	24.84%
Suburban	50.62%
Rural	24.53%
Political Party Affiliation	
Democrat	35.75%
Republican	34.27%
Independent	25.93%

[9] Sample size (n) = 1,561

Table 3 *(cont'd)*

Other political affiliations	1.25%
Prefer not to say	2.80%

3.2 SUBJECTIVE AND OBJECTIVE KNOWLEDGE SECTIONS

Since cattle breed information was a main research question, it was important for the survey to ask about cattle breeds before the choice experiment to establish a level of baseline knowledge while still including a variety of beef industry topics to avoid priming the respondents. The respondents' levels of subjective knowledge for each of the beef production system topics are in *Table D*. For subjective knowledge, the top three categories that participants indicated the highest level of knowledge (levels 3, 4 or 5) were grass fed beef (60%), USDA quality grades (63%), and beef tenderness (67%). The categories consumers felt they had the lowest level of knowledge were beef traceability systems (30%), animal welfare certifications (39%), and cattle breeds (44%). Average scores ranged from 1.98 to 2.87, indicating that consumers felt they have minimum to basic knowledge levels of the beef industry topics. Consumers had the highest average score for USDA Quality Grades (2.87/5) while they had the lowest average score for beef traceability systems (1.98/5).

Table 4 *Subjective knowledge section results*

Beef Production Systems Topic	No knowledge (1)	Minimum (2)	Basic (3)	Intermediate (4)	Advanced (5)	Average Score
Cattle Breeds	23.90%	32.06%	26.38%	12.34%	5.32%	2.43
USDA Quality Grades	11.13%	25.82%	36.45%	18.30%	8.30%	2.87
Certified Angus Beef (CAB)	16.67%	28.87%	31.06%	15.39%	8.01%	2.69
USDA Organic	16.24%	29.36%	32.98%	13.33%	8.09%	2.68
Grass Fed Beef	11.42%	28.27%	34.89%	17.45%	7.87%	2.82
Animal Welfare Certifications	34.26%	26.67%	23.62%	10.35%	5.11%	2.25
Beef Traceability Systems	49.15%	21.21%	16.31%	9.50%	3.83%	1.98
Beef Tenderness	9.65%	23.05%	37.09%	21.21%	9.01%	2.97

Overall, consumers did not perform well on the objective knowledge questions (*Table E).* For the true/false section, the top three questions that were answered correctly were: according to the USDA, beef

can be classified as organic if the animal is raised in conditions allowing them to graze on pasture or be fed 100% organic feed/forage, and not be administered additional hormones or antibiotics (73% answered correctly, true), crossbreeding is a technique where two or more purebred cattle mate to produce an offspring that combines the desired traits from the parent breed (68% answered correctly, true), and the United States Department of Agriculture (USDA) provides certification of beef carcasses for several labeling programs that make claims concerning breed and carcass characteristics (56% answered correctly, true). Questions that received the lowest percentage of correct responses were: in the U.S., it is nationally mandated that all beef products are traceable back to the farm or origin (9% answered correctly, false) and cattle that qualify for the Certified Angus Beef program must have a main body that is solid black (33% answered correctly, true).

For the questions that asked respondents to select which cattle breeds were used for beef and dairy production, only 2% of respondents correctly identified all three cattle breeds that are used for beef production (Angus, Hereford, and Holstein) but 81% of respondents correctly identified Angus as a beef breed. 75% of respondents indicated Holstein as a breed used for dairy production but only 6% correctly identified the two breeds that are used in dairy production (Jersey and Holstein).The final question prompted respondents to order beef quality grades, shown randomly, from highest to lowest quality picking from USDA Prime, USDA Choice, and USDA Select. Of the responses, 41% correctly placed prime as highest quality, 72% correctly placed Choice as second highest quality, and 50% correctly placed Select as third highest quality.

Table 5 *Objective knowledge questions and responses* [10]

Question	Correct Answer	Responses
Holstein cattle can be used for both milk and beef production	True	True (50.71%) * False (10.92%) I don't know (38.37%)
The United States Department of Agriculture (USDA) provides certification of beef carcasses for several labeling programs that make claims concerning breed and carcass characteristics	True	True (55.60%) * False (7.02%) I don't know (37.38%)
In the U.S., it is nationally mandated that all beef products are traceable back to the farm or origin	False	True (67.94%) False (9.43%) * I don't know (22.62%)
According to the USDA, beef can be classified as organic if the animal is raised in conditions allowing them to graze on pasture or be fed 100% organic feed/forage, and not be administered additional hormones or antibiotics.	True	True (73.05%) * False (7.66%) I don't know (19.29%)
Crossbreeding is a technique where two or more purebred cattle mate to produce an offspring that combines the desired traits from the parent breed	True	True (67.87%) * False (9.72%) I don't know (22.41%)
Cattle that qualify for the Certified Angus Beef program must have a main body that is solid black.	True	True (33.40%) * False (23.19%) I don't know (43.40%)
There are three USDA quality grades for beef. Please reorder the following images from the highest quality grade to the lowest quality grade.	1. Prime 2. Choice 3. Select	Prime 1st (47.16%) Choice 2nd (71.56%) Select 3rd (50.00%)

3.3 RESPONDENT BUYING PATTERNS

Three buyer types were identified in line with findings from Van Loo et al. (2011): habitual buyers (weekly, every other week), occasional buyers (monthly, every other month, every three months), and non-buyers (never). Responses showed that consumers are primarily occasional buyers of ribeye steak (55%) while consumers are habitual buyers of ground beef (63%). Most participants purchased both ground beef and ribeye steak, with only 0.92% of respondents being non-buyers of ground beef and 19.08% being non-buyers for ribeye steak.

The results for the average reference prices compared to the market prices for the two products are displayed below in *Figure 8.* The average reference price for ground beef was $7.18/lb., above the

[10] * Indicates the percentage of respondents that answered the objective knowledge question correctly.

national average for ground chuck ($5.02) at the time of data collection (March/April). The average reference price for ribeye steak was $16.16/lb., above the national average for boneless ribeye steak ($10.06) at the time of data collection (March/April) (USDA AMS, 2024). Alternatively, the average lowest (highest) prices for ground beef that respondents expected to find in 90% of grocery stores was $6.10 ($9.19) and $13.11 ($19.80) for ribeye steaks.

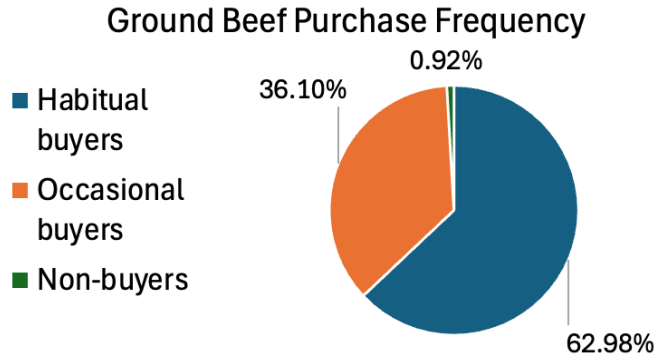

Figure 6 *Ground Beef Purchasing Frequency* [11]

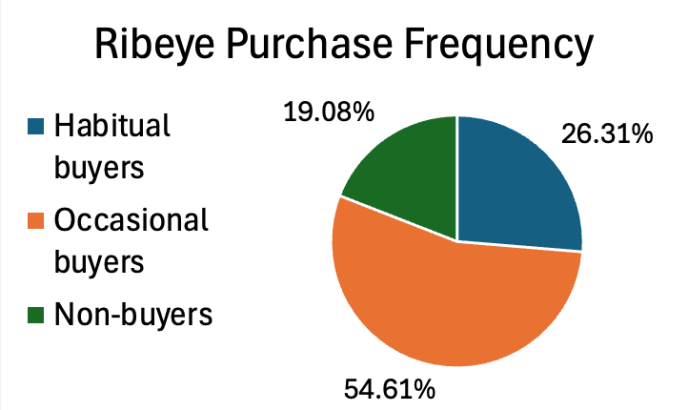

Figure 7 *Ribeye Steak Purchasing Frequency* [12]

[11] n=1,049
[12] n=512

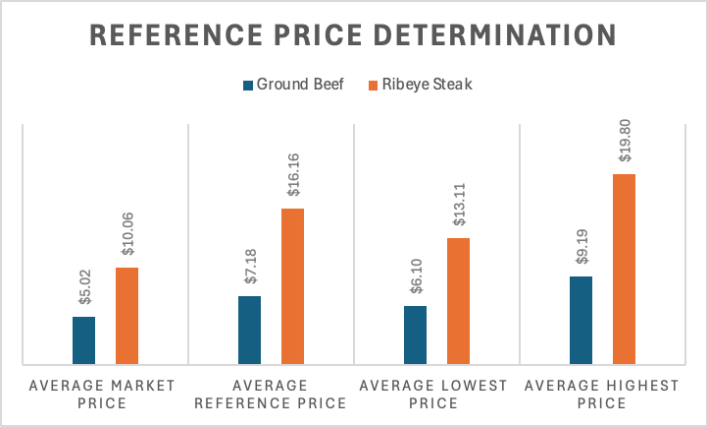

Figure 8 *Average Reference Prices vs Market Prices*

3.4 RPL MODEL RESULTS

The consumer utility functions varied across ground beef and ribeye steak. RPL coefficient results are below in *Tables 6 & 7.*[13] For ground beef, the price coefficient was negative indicating that a price increase would decrease utility for ground beef, aligning with the expected traditional utility relationship. Coefficients were positive and statistically significant for Certified Angus Beef (CAB), Certified Dairy-Beef (CDB), Certified Holstein Beef (CHB), and traceability (TRACE). This indicates that consumers place a higher utility on ground beef with either of these labels versus generic products. When looking at the interaction terms between breed and traceability, the interaction between CDB and TRACE as well as between CHB and TRACE are both negative but statistically significant meaning consumers yield a negative utility when both these breed and traceability labels are present on the ground beef packaging. The negative interaction term indicates that CHB and CDB are substitutes for TRACE. The interaction between CAB and TRACE was negative and statistically insignificant, causing no real effect on the respondent's utility. Most of the standard deviation estimates are statistically significant, indicating there is heterogeneity in consumer preferences for these attributes in ground beef.

When looking at ribeye steak, the price coefficient was negative as expected. The CAB, CHB, and TRACE coefficients were positive, similar to ground beef. However, the CDB attribute had a negative and statistically significant coefficient, indicating that consumers have a lower utility when this label is present versus no label (generic). The interactions between CAB and CHB with TRACEC were statistically insignificant. However, the interaction between CDB and TRACE was statistically significant and negative, indicating substitutes. Thus, overall, the CDB label is not highly valued by the ribeye steak consumers. All standard deviation estimates are statistically significant, indicating heterogeneity in consumer preferences for these attributes in ribeye steak.

[13] MNL Coefficients and WTP estimates are available in Appendix B.

Table 6 RPL model estimates for Ground Beef

Variable Name	Coefficient Estimates	Standard Deviations
PRICE	-0.239***	0.239***
	(0.005)	(0.005)
CERTIFIED ANGUS BEEF (CAB)	1.434***	1.202***
	(0.063)	(0.040)
CERTIFIED DAIRY BEEF (CDB)	0.821***	1.280***
	(0.069)	(0.041)
CERTIFIED HOLSTEIN BEEF (CHB)	0.823***	0.761***
	(0.057)	(0.034)
TRACEABILITY	0.786***	0.814***
	(0.060)	(0.208)
CAB x TRACEABILITY	-0.032	0.072
	(0.082)	(0.046)
CDB x TRACEABILITY	-1.111**	0.014
	(0.089)	(0.047)
CHB x TRACEABILITY	-0.398***	0.113**
	(0.078)	(0.045)
NOBUY	-1.567***	
	(0.063)	
N	12,588	
Log Likelihood	-11,237.758	

***, **, * ==> Significance at 1%, 5%, 10% level.

Table 7 *RPL model estimates for Ribeye Steak*

Variable Name	Coefficient Estimates	Standard Deviations
PRICE	-0.169***	0.169***
	(0.004)	(0.004)
CERTIFIED ANGUS BEEF (CAB)	1.334***	0.545***
	(0.237)	(0.052)
CERTIFIED DAIRY BEEF (CDB)	-0.272***	0.785***
	(0.091)	(0.052)
CERTIFIED HOLSTEIN BEEF (CHB)	0.471***	0.532***
	(0.075)	(.046)
TRACEABILITY	0.404***	0.558***
	(0.080)	(0.041)
CAB x TRACEABILITY	-0.443	1.554***
	(0.118)	(0.088)
CDB x TRACEABILITY	-0.262**	0.120*
	(0.127)	(0.068)
CHB x TRACEABILITY	0.090	0.766***
	(0.115)	(0.075)
NOBUY	-3.148***	
	(0.102)	
N	*6,144*	
Log Likelihood	*-5,411.624*	

***, **, * ==> Significance at 1%, 5%, 10% level.

3.5 WTP ESTIMATES

RPL coefficients were used to calculate WTP estimates (*Table 8)*. The ground beef responses showed positive price premiums for CAB ($5.99/lb.), CHB ($3.44/lb.), CDB ($3.43/lb.), and TRACE ($3.28/lb.) while the ribeye steak responses showed positive price premiums for CAB ($7.91/lb.), CHB ($2.79/lb.), and TRACE ($2.39/lb.). Across both products, respondents were willing to pay more for CAB label compared to the other attributes in the study. These positive WTP for CAB and TRACE are consistent with findings from other studies (Loureiro & Umberger, 2007; Lim, Hu, Maynard, Goodard, 2013; Meyerding, Gentz, Altmann, Meier-Dinkel, 2018). Consumers were unwilling to pay for the CDB

label, with a negative premium, in ribeye steaks. Looking across products, the WTP for CAB was higher in ribeye steak than ground beef. However, the opposite is true for CHB, CDB, and TRACE attributes with these WTP values being higher for ground beef than ribeye steak. This is interesting as the relative price of ribeye is higher than ground beef.

Table 8 *Mean and standard error of WTP estimates from the RPL model ($/lb.)*

	Estimates	
Variable Name	**Ground Beef**	**Ribeye Steak**
CERTIFIED ANGUS BEEF	5.992*** (0.282)	7.912*** (0.546)
CERTIFIED DAIRY BEEF	3.433*** (0.294)	-1.612*** (0.539)
CERTIFIED HOLSTEIN BEEF	3.440*** (0.250)	2.792** (0.449)
TRACEABILITY	3.285*** (0.260)	2.396*** (0.482)

***, **, * ==> Significance at 1%, 5%, 10% level

3.6 POST CHOICE EXPERIMENT ATTRIBUTES

After the choice experiment, respondents were asked to identify how they perceive different aspects of the beef industry and beef quality. The first section asked how respondents perceived beef from Angus, Holstein, and Dairy-crossbred cattle. The vast majority (85.36%) of respondents indicated Angus beef as high-quality, while very few respondents perceived Holstein (30.14%) and Dairy-Beef (15.50%) as high-quality. Respondents were also presented with beef product options to indicate which of the three breed certifications they would be willing to purchase products with these labels. These options included: sirloin steak, ribeye steak, skirt steak, ground beef, beef roast, stew beef, and deli sliced beef. For each product, Certified Angus Beef gained the most interest in potential product purchases versus Certified Holstein and Certified Dairy-Beef. However, there was still some interest in both certifications. Products labeled Certified Holstein Beef had the most interest from consumers with stew beef, ground beef, and beef roast. Consumers purchasing products with the Certified Dairy-Beef label had the most interest in stew beef, ground beef, and deli sliced beef. Products perceived as having a higher price point did not gain as much interest as potential Certified Holstein or Certified Dairy-Beef products.

Because one of the attributes in the choice experiment was traceability information, it was important to understand consumer perceptions on the topic. Respondents were asked to indicate how strongly they

agreed with statements on food traceability systems in the beef sector. A scale from 1 (strongly agree) to 5 (strongly disagree) was used to capture how they felt about the presented statements with an “I don’t know” option at the end of the scale. Combining the agree and strongly agree results, results show 83.02% of consumers believe that food traceability systems can increase product safety, 80.04% believe they can protect consumer health, and 79.83% believe they can increase consumer confidence in the agriculture industry. When asked if they intended to purchase products from companies that implement food traceability technologies, 56.85% of respondents indicated they agreed or strongly agreed with the statement.

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IMPLICATIONS AND CONCLUSIONS

4.1 IMPLICATIONS

Even with a growing body of literature pointing to how beef quality is important for consumers to make purchasing decisions, beef in the U.S. is typically marketed as a "generic" product with little done to differentiate quality among products. Past WTP studies have focused on other beef quality attributes, such as guaranteed tenderness, quality grades, and production conditions, but have not applied these attributes to products from dairy-type cattle. This study is the first research to assess marketing opportunities for Holstein and dairy-beef, evaluating two new potential certified dairy-beef programs, the existing CAB program, and a traceability label.

Consumers were willing to pay the highest premium for Certified Angus Beef, aligning with past studies (Feldkamp, Lusk, Shroeder, 2003; Claborn et al., 2011; Henchion, McCarthy, Resconi, 2017). This is not surprising as this program is well established in the market and consumers better understand CAB product quality. While this was an expected outcome of the study, it should not discourage creating other breed-branded beef programs. Overall, there was more support for a Certified Holstein Beef label than a Certified Dairy-Beef label. A Certified Holstein Beef program creates benefits for both consumers and producers. Since labels are an important method to communicate cues linked to meat quality (Aboah & Lees, 2020), the Certified Holstein Beef label is a way to inform consumers of the high quality, consistent product they are receiving. Additionally, the program provides a way for producers to differentiate their products and potentially increase their bottom line.

Without understanding how consumers value quality attributes between different beef cuts from the same animal, producers could potentially improperly invest in credence attributes and lose economic gains. Findings from the study point to consumers accepting products with Certified Holstein labels for both ground beef and ribeye steak; however, consumers were only willing to pay for Certified Dairy-Beef labels on ground beef. Because ribeye is a higher-value product, consumers may be more selective (more risk averse) than when purchasing a lower-value product such as ground beef (less risk averse). There is also preference heterogeneity between products, with many WTP values being higher per pound in ground beef than ribeye.

Results also showed consumers were willing to pay more for both ground beef and ribeye steaks with traceability labels. Several studies have suggested that U.S. consumers value traceability systems for beef products (Dickinson, Von Bailey, 2015; Snell, Nayga, Lacity, 2021). While there is not a national animal identification (ID) program, there have been some recent changes to U.S. animal traceability requirements. The final rule announced by the USDA Animal Plant Health Inspection Service (APHIS) on April 26, 2024, revises the 2013 policy by requiring producers shipping certain types of cattle and bison across state lines to use electronic tags as official identification (APHIS, 2024). The new national

radio frequency identification (RFID) requirements will take effect November 5, 2024, but it will take time to see the intended benefits. Opportunely, the dairy industry is in a key position to lead the cattle industry in traceability. Michigan, a prominent dairy and dairy-beef state, was the only state before the rule change that had mandatory RFID requirements for cattle (Braggs et al., 2024). This information has only been used for disease traceback. Given that Michigan already has the infrastructure, they could be a first mover here and utilize the RFID tags as a baseline for a marketable traceability system. One interesting finding was that consumers were willing to pay a higher premium for the traceability label on ground beef versus ribeye steak. Unfortunately, given current technology levels, muscle cuts are physically easier, and thus less expensive, to trace than ground products. A key next step is continuing research on implementing traceability systems in the beef supply chain and on technology that would allow ground products to be traceable back to the farm of origin.

When looking at the WTP for products with both breed and traceability, results reveal that the two attributes are substitutes. Thus, there is no evidence to support including both breed and traceability labels on the same product. Combining this with more support for the CHB label than the CDB label, pure bred Holstein beef and beef from crossbred cattle could have different optimal labeling programs. Because there is existing infrastructure in the dairy industry to support disease traceback, dairy-beef producers can focus on traceability labeling. Since consumers indicated higher WTP values for the purebred Holstein products, breed labels could be a way for producers to capture those premiums. Additionally, although we find evidence of positive price premiums, understanding costs of implementation is outside the project scope. Stakeholders would need to do a cost-benefit analysis to see which program creates the best industry investment.

One issue dairy-beef has faced historically is access to line space at beef packing facilities, especially due to large frame sizes. This issue would need to be resolved for certification programs with dairy-beef cattle to be sustainable. Post-pandemic, state and federal policy makers are pushing to increase meat processing capacity to improve manufacturing practices and adapt to changing industry conditions (Gwin, Thiboumery, Stillman, 2013). Over the last few decades, beef carcass weights have continuously gotten heavier and wider, narrowing the size difference between beef and dairy type cattle (Dijmsa, 2022). It is extremely challenging for beef processing facilities to chill carcasses with differing sizes at a uniformed temperature with current equipment. Variability in carcass size can influence the rate it is chilled, which can cause issues with beef tenderness and color. These new initiatives to improve production capacity would enhance technology for processing plants to accommodate larger framed cattle, expanding opportunities for more dairy-type cattle processing.

There is a need for education and outreach for both consumers and producers. Consumers surveyed were not knowledgeable about cattle breeds. This information asymmetry can negatively impact

purchasing decisions. Thus, there is a need for more informational materials targeted at consumers to inform them about the desirable attributes from Holstein and dairy-beef. Additionally, producers will also need readily available, easily interpretable materials about marketing dairy-beef. This can be through on-farm demonstrations, online materials, or other extension resources offered through state agricultural agencies, the U.S. Department of Agriculture, and Land Grant Universities (USDA NIFA, 2024). Without a platform to distribute information on the work being done surrounding dairy-beef, producers and supply chain stakeholders would be at a disadvantage when making operational decisions.

4.2 CONCLUSIONS AND FUTURE RESEARCH

To remain competitive in the U.S. beef market, it is important to understand consumer perceptions of beef attributes. Holsteins and other dairy-type cattle make contributions to the beef sector; however, little is known about consumer acceptance of these products. We conducted a hypothetical online discrete choice experiment to evaluate relative preferences for traceability, Certified Angus Beef, Certified Holstein Beef, and Certified Dairy-Beef attributes applied to ground beef and ribeye steaks. External validity of the study is improved by implementing a reference-price informed design (RP) as adopted by Kilders & Caputo (2024). Coefficient estimates were obtained using a random parameters logit (RPL) model to calculate willingness-to-pay estimates. Respondents were willing to pay more for products with Certified Angus Beef labeling across both ground beef and ribeye steak followed by Certified Holstein Beef, Traceability, and Certified Dairy-Beef. Differences in premiums for the three breeds and traceability labels existed between ground beef and ribeye steak, showing consumers have heterogeneous preferences for these attributes in higher vs lower-value products. Additionally, breed and traceability labels were substitutes. Potentially, Holstein beef producers could consider a Certified Holstein Beef label, while crossbred dairy-beef producers could differentiate using a traceability label.

While we were able to complete a robust economic study, we did encounter some limitations. The main limitation was that we were unable to include an information treatment to compare how that affected consumer preferences for the Certified Holstein and Certified Dairy-Beef products. Given the low levels of subjective and objective knowledge about the beef industry, future research should focus on the impact of messaging and product positioning for beef. Including information about Holsteins in the form of infographics, short videos, written descriptions or other mediums would be a way to communicate the differences between products to consumers. Thus, we encourage future studies to utilize between-sample information treatments that assess how information on Holstein and Dairy-Beef products impacts WTP values. This study also only considered three product attributes. Beef has several factors that define the perceived consumer quality (Santos et al., 2021). While dairy-beef has some similar qualities as beef products from traditional beef cattle, it is important to highlight where beef from dairy-type cattle standout. This includes greater feed efficiency, better marbling scores, more tender cuts, and increased

volumes grading Prime and high-Choice (Henderson, 2023). Future studies should include these other attributes where Holstein and dairy-beef excel.

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APPENDIX A: INTRODUCTION TO DISCRETE CHOICE EXPERIMENT

BRIEF SUMMARY

You are being asked to participate in a research study. Researchers are required to provide a consent form to inform you about the research study, to convey that participation is voluntary, to explain the risks and benefits of participation including why you might or might not want to participate, and to empower you to make an informed decision. Please ask the researchers any questions you may have.

You are being asked to participate in a research study of consumer preferences. Your participation in this study will take about 20 minutes. The questions in this survey will ask about your preferences for food in addition to questions about your food expenditure. We will also ask you some basic demographic questions. This research will help anticipate the demand for branded beef products.

The most likely risks of participating in this study are minimal. The risks are no greater than those ordinarily encountered in daily life. Moreover, you can stop the survey at any time.

You will not directly benefit from your participation in this study. However, your participation in this study may contribute to the understanding of future food policy and marketing strategies.

PURPOSE OF RESEARCH

The purpose of this research study is to understand consumers' preferences for branded beef products.

POTENTIAL BENEFITS

You will not benefit personally from being in this study. However, we hope that, in the future, other people might benefit from this study. Your responses will help us develop a deeper understanding of future marketing strategies.

POTENTIAL RISKS

There are no foreseeable potential risks outside of that which you would expect in everyday life.

PRIVACY AND CONFIDENTIALITY

No identifying data will be maintained, nor will any information be released outside of aggregated, anonymized responses.

YOUR RIGHTS TO PARTICIPATE, SAY NO, OR WITHDRAW

You have the right to say no to participating in the research. You can stop at any time after it has already started without penalty.

COSTS AND COMPENSATION FOR BEING IN THE STUDY

There are no costs or compensations associated with your participation in this study.

If you have questions or concerns about your role and rights as a research participant, would like to obtain information or offer input, or would like to register a complaint about this study, you may contact, anonymously if you wish, the Michigan State University's Human Research Protection Program at 517-

355-2180, Fax 517-432-4503, or e-mail irb@msu.edu or regular mail at 4000 Collins Rd, Suite 136, Lansing, MI 48910.

I have read and fully understand the consent form. I understand that my participation is voluntary. By clicking **yes** below, I am indicating that I freely and voluntarily agree to participate in this study, and I also acknowledge that I am at least 18 years old and live in the United States.

- o Yes
- o No

Which of the following best describes how involved you are in grocery shopping for your household?

- o I typically do not do any grocery shopping
- o I typically do some, but less than one-half of the grocery shopping
- o I typically do at least one-half of the grocery shopping
- o I am solely or primarily responsible for grocery shopping
- o Don't know or not sure

How often have you **purchased** the following beef products in the past three(3) months?

	Weekly	Every Other Week	Monthly	Every Other Month	Every 3 Months	Never
Ground Beef	o	o	o	o	o	o
Ribeye Steak	o	o	o	o	o	o

Please complete the following demographic questions.

What gender do you identify as?

- o Female
- o Male
- o Non-binary or non-conforming
- o Prefer to self-describe
- o Prefer not to say

What is your age?

▼ Under 18 ... 75 or older

What is your annual household income?

- o Less than $25,000
- o $25,000 - $49,999
- o $50,000 - $74,999
- o $75,000 - $99,999
- o $100,000 - $124,999
- o $125,000 - $149,999
- o $150,000 or greater

What is the highest level of education you have completed?

- o Less than high school diploma
- o High school diploma/GED
- o Some college (no degree)
- o 2-year college degree (Associates)
- o 4-year college degree (BS, BA)
- o Master's degree (MS, MA)
- o Professional Degree (MBA)
- o Doctorate Degree (JD, MD, PhD, etc.)

What U.S. state do you live in?

▼ Alabama ... Wyoming

In the next section, you will answer questions about your knowledge of cattle and beef production.

How would you rate your level of knowledge on the following topics?

	No Knowledge	Minimal Knowledge	Basic Knowledge	Intermediate Knowledge	Advanced Knowledge
Cattle Breeds	o	o	o	o	o
USDA Quality Grades	o	o	o	o	o
Certified Angus Beef (CAB)	o	o	o	o	o
USDA Organic Beef	o	o	o	o	o
Grass-Fed Beef	o	o	o	o	o
Animal Welfare Certifications	o	o	o	o	o
Beef Traceability Systems	o	o	o	o	o
Beef Tenderness	o	o	o	o	o

Which of the following cattle breeds are **primarily** used to produce **beef** in the U.S.? (select all that apply)

- ▢ Angus
- ▢ Jersey
- ▢ Hereford
- ▢ Holstein
- ▢ ⊗None of these
- ▢ ⊗I don't know

Which of the following cattle breeds are **primarily** used to produce **milk/dairy products** in the U.S.? (select all that apply)

- ▢ Angus
- ▢ Jersey
- ▢ Hereford
- ▢ Holstein
- ▢ ⊗None of these
- ▢ ⊗I don't know

In this section, please indicate whether you believe the questions about cattle and beef production are true or false.

Holstein cattle can be used for both milk and beef production.

- o True
- o False
- o I don't know

The United States Department of Agriculture (USDA) provides certification of beef carcasses for several labeling programs that make claims concerning breed and carcass characteristics.

- o True
- o False
- o I don't know

In the U.S., it is nationally mandated that all beef products are traceable back to their farm of origin.

- o True
- o False
- o I don't know

According to the USDA, beef can be classified as organic if the animal is raised in conditions allowing them to graze pasture or be fed 100% organic feed/ forage, and not be administered additional hormones or antibiotics.

- o True
- o False
- o I don't know

Crossbreeding is a technique where two or more purebred cattle mate to produce an offspring that combines the desired traits from the parent breeds.

- o True
- o False
- o I don't know

Cattle that qualify for the Certified Angus Beef program must have a main body that is solid black.

- o True
- o False
- o I don't know

In this section, please rank the objects in order from highest to lowest quality.

There are three USDA quality grades for beef. Please reorder the following images from the highest quality grade to the lowest quality grade.

_____ USDA Choice
_____ USDA Prime
_____ USDA Select

If the true/false and ranking questions you just answered about cattle and beef were on a test, how would you score yourself?

Use the graphic slider to grade yourself where **"A"** corresponds to answering all questions correctly and **"F"** corresponds to answering no questions correctly.

1
2
3
4
5

This section of the survey asks about your household's <u>RIBEYE STEAK</u> purchases.

Which of the following best describes where you primarily **purchase** ribeye steak?

- o Grocery Store (e.g., Kroger, Safeway, Publix, Sprouts)
- o Mass Merchandiser (e.g., Target, Wal-Mart)
- o Club Store (e.g., Costco, Sam's Club)
- o Farmers Market or Direct-from-Producer Sales Channels
- o Butcher Shop or Meat Market
- o Meal Kits (e.g., Blue Apron, Hello Fresh)
- o Prepared Meal Delivery Service (e.g., Factor, Green Chef)
- o Online Retailer and Delivered to Your Home (e.g., Amazon)
- o Other (Please Describe) _____

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

- o Less than $50
- o $50 - $150
- o $151 - $250
- o $251 - $350
- o $351 - $450
- o More than $450

On average, how much of your weekly grocery food budget do you expect to spend on **beef**?

- o Less than 5%
- o 5-10%
- o 11-15%
- o 16-20%
- o More than 20%

How much **ribeye steak** did your household purchase in the last 3 months?

▼ I did not purchase ribeye steak ... 17 lbs. or more

On average, how many meals a week does your household **consume** ribeye steak?

▼ 0... More than 10

What price do you expect to pay for a 1lb. **ribeye steak** package from the grocery store you normally shop at?

In the box below, please write the price in dollars.

_____

What is the lowest price you expect to pay for a 1lb. **ribeye steak** in 90% of grocery stores?

In the box below, please write the price in dollars.

_____

What is the highest price you expect to pay for a 1lb. **ribeye steak** in 90% of grocery stores?

In the box below, please write the price in dollars.

_____

This section of the survey asks about your household's <u>GROUND BEEF</u> purchases.

Which of the following best describes where you primarily **purchase** ground beef?

- o Grocery Store (e.g., Kroger, Safeway, Publix, Sprouts)
- o Mass Merchandiser (e.g., Target, Wal-Mart)
- o Club Store (e.g., Costco, Sam's Club)
- o Farmers Market or Direct-from-Producer Sales Channels
- o Butcher Shop or Meat Market
- o Meal Kits (e.g., Blue Apron, Hello Fresh)
- o Prepared Meal Delivery Service (e.g., Factor, Green Chef)
- o Online Retailer and Delivered to Your Home (e.g., Amazon)
- o Other (Please Describe) _____

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

- o Less than $50
- o $50 - $150
- o $151 - $250
- o $251 - $350
- o $351 - $450
- o More than $450

On average, how much of your weekly grocery food budget do you expect to spend on **beef**?

- o Less than 5%
- o 5-10%
- o 11-15%
- o 16-20%
- o More than 20%

How much **ground beef** did your household purchase in the last 3 months?

▼ I did not purchase ground beef ... 17 lbs. or more

On average, how many meals a week does your household **consume** ground beef?

▼ 0 ... More than 10

What price do you expect to pay for a 1lb. **ground beef** package from the grocery store you normally shop at?

In the box below, please write the price in dollars.

_____

What is the lowest price you expect to pay for a 1lb. **ground beef** package in 90% of grocery stores?

In the box below, please write the price in dollars.

_____

What is the highest price you expect to pay for a 1lb. **ground beef** package in 90% of grocery stores?

In the box below, please write the price in dollars.

_____

Choice Experiment Instructions- Price Vector A

You are about to answer twelve (12) choice questions. **Each question presents two (2) different 1lb ribeye steak packages and a no-purchase option.**

For each 1lb ribeye steak package you will see information about **Price**, **Traceability**, and **Cattle breeds.**

Price
The price shown is expressed in dollars per pound ($/lb). The four prices are **$7.99, $11.99, $15.99, and $19.99**.

Traceability
Food traceability is following the movements of a food product and its ingredients through the production, processing, and distribution aspects of the agri-food chain.

Beef products with this traceability label guarantee that the meat can be traced back to the farm of origin.

Breed
There are different types of cattle. Cattle breeds have similar traits (i.e., color markings, size, body shape, muscle, horns) that are passed along through generations. Some cattle breeds are recognized for their high-quality beef, efficient milk production, and some are recognized for both. You have likely consumed beef from different cattle breeds but did not know it or it was not labeled. You will see **three (3)** breed labels in the choice questions:

Angus cattle are traditionally associated with being raised for high-quality beef. Cattle in this program must be of the Angus breed with solid black hides.

Holstein cattle are traditionally associated with dairy production, but also produce high-quality beef. Cattle in this program must be of the Holstein breed with black and white hides.

Dairy-Beef cattle are a cross between a dairy breed and a beef breed, which produce high-quality beef. Cattle in this program must be a Dairy-Beef cross with black, or black and white hides.

Cattle in all three programs must pass the "10 Specifications for Quality" standards. These specifications include requirements for muscling, young cattle age, and sufficient marbling to grade USDA (United States Department of Agriculture) Average Choice, High Choice, or Prime.

Before we proceed with the choice questions, we would like to make sure the instructions we provided to you were properly displayed and covered. Based on the instructions, please select which of the following labels will be shown to you in the choice questions, **select all that apply.**

- ▢ Holstein
- ▢ Organic
- ▢ Grassfed
- ▢ Traceability

Now you are ready to answer the choice questions. In each question, you will see pictures of two ribeye steak packages that are the same except for the labels shown. For each question, please choose the 1lb ribeye steak package you would prefer to purchase or if you would not purchase either product select the "I would not purchase either" option.

While these questions are hypothetical, that is, you will not actually have to pay for the product, it is important that you answer as if you were actually faced with buying the product at a grocery retailer. Thus, before making your selection, consider whether you would actually be willing to pay the listed price, meaning that you would no longer have that money available for other purchases.

The results of this survey will be available to farmers/ranchers, retailers, and policymakers, as well as to the wider general public of consumers. This means that this survey could affect the decisions of farmers/ranchers, retailers, and policymakers.

Choice Experiment Instructions- Price Vector B

You are about to answer twelve (12) choice questions. **Each question presents two (2) different 1lb ribeye steak packages and a no-purchase option.**

For each 1lb ribeye steak package you will see information about **Price**, **Traceability**, and **Cattle breeds.**

Price
The price shown is expressed in dollars per pound ($/lb). The four prices are **$19.99, $23.99, $27.99, and $31.99**.

Traceability
Food traceability is following the movements of a food product and its ingredients through the production, processing, and distribution aspects of the agri-food chain.

Beef products with this traceability label guarantee that the meat can be traced back to the farm of origin.

Breed
There are different types of cattle. Cattle breeds have similar traits (i.e., color markings, size, body shape, muscle, horns) that are passed along through generations. Some cattle breeds are recognized for their high-quality beef, efficient milk production, and some are recognized for both. You have likely consumed beef from different cattle breeds but did not know it or it was not labeled. You will see **three (3)** breed labels in the choice questions:

Angus cattle are traditionally associated with being raised for high-quality beef. Cattle in this program must be of the Angus breed with solid black hides.

Holstein cattle are traditionally associated with dairy production, but also produce high-quality beef. Cattle in this program must be of the Holstein breed with black and white hides.

Dairy-Beef cattle are a cross between a dairy breed and a beef breed, which produce high-quality beef. Cattle in this program must be a Dairy-Beef cross with black, or black and white hides.

Cattle in all three programs must pass the “10 Specifications for Quality” standards. These specifications include requirements for muscling, young cattle age, and sufficient marbling to grade USDA (United States Department of Agriculture) Average Choice, High Choice, or Prime.

Before we proceed with the choice questions, we would like to make sure the instructions we provided to you were properly displayed and covered. Based on the instructions, please select which of the following labels will be shown to you in the choice questions, **select all that apply.**

- ☐ Holstein
- ☐ Organic
- ☐ Grassfed
- ☐ Traceability

Now you are ready to answer the choice questions. In each question, you will see pictures of two ribeye steak packages that are the same except for the labels shown. For each question, please choose the 1lb ribeye steak package you would prefer to purchase or if you would not purchase either product select the "I would not purchase either" option.

While these questions are hypothetical, that is, you will not actually have to pay for the product, it is important that you answer as if you were actually faced with buying the product at a grocery retailer. Thus, before making your selection, consider whether you would actually be willing to pay the listed price, meaning that you would no longer have that money available for other purchases.

The results of this survey will be available to farmers/ranchers, retailers, and policymakers, as well as to the wider general public of consumers. This means that this survey could affect the decisions of farmers/ranchers, retailers, and policymakers.

Choice Experiment Instructions- Price Vector C

You are about to answer twelve (12) choice questions. **Each question presents two (2) different 1lb ground beef packages and a no-purchase option.**

For each 1lb. ground beef package you will see information about **Price**, **Traceability**, and **Cattle breeds.**

Price
The price shown is expressed in dollars per pound ($/lb). The four prices are **$2.99, $4.99, $6.99, and $8.99**.

Traceability
Food traceability is following the movements of a food product and its ingredients through the production, processing, and distribution aspects of the agri-food chain.

Beef products with this traceability label guarantee that the meat can be traced back to the farm of origin.

Breed

There are different types of cattle. Cattle breeds have similar traits (i.e., color markings, size, body shape, muscle, horns) that are passed along through generations. Some cattle breeds are recognized for their high-quality beef, efficient milk production, and some are recognized for both. You have likely consumed beef from different cattle breeds but did not know it or it was not labeled. You will see **three (3)** breed labels in the choice questions:

Angus cattle are traditionally associated with being raised for high-quality beef. Cattle in this program must be of the Angus breed with solid black hides.

Holstein cattle are traditionally associated with dairy production, but also produce high-quality beef. Cattle in this program must be of the Holstein breed with black and white hides.

Dairy-Beef cattle are a cross between a dairy breed and a beef breed, which produce high-quality beef. Cattle in this program must be a Dairy-Beef cross with black, or black and white hides.

Cattle in all three programs must pass the “10 Specifications for Quality” standards. These specifications include requirements for muscling, young cattle age, and sufficient marbling to grade USDA (United States Department of Agriculture) Average Choice, High Choice, or Prime.

Before we proceed with the choice questions, we would like to make sure the instructions we provided to you were properly displayed and covered. Based on the instructions, please select which of the following labels will be shown to you in the choice questions, **select all that apply.**

- ☐ Holstein
- ☐ Organic
- ☐ Grassfed
- ☐ Traceability

Now you are ready to answer the choice questions. In each question, you will see pictures of two ribeye steak packages that are the same except for the labels shown. For each question, please choose the 1lb ribeye steak package you would prefer to purchase or if you would not purchase either product select the "I would not purchase either" option.

While these questions are hypothetical, that is, you will not actually have to pay for the product, it is important that you answer as if you were actually faced with buying the product at a grocery retailer. Thus, before making your selection, consider whether you would actually be willing to pay the listed price, meaning that you would no longer have that money available for other purchases.

The results of this survey will be available to farmers/ranchers, retailers, and policymakers, as well as to the wider general public of consumers. This means that this survey could affect the decisions of farmers/ranchers, retailers, and policymakers.

Choice Experiment Instructions- Price Vector D

You are about to answer twelve (12) choice questions. **Each question presents two (2) different 1lb ground beef packages and a no-purchase option.**

For each 1lb. ground beef package you will see information about **Price**, **Traceability**, and **Cattle breeds.**

Price
The price shown is expressed in dollars per pound ($/lb). The four prices are **$8.99, $10.99, $12.99, and $14.99**.

Traceability
Food traceability is following the movements of a food product and its ingredients through the production, processing, and distribution aspects of the agri-food chain.

Beef products with this traceability label guarantee that the meat can be traced back to the farm of origin.

Breed
There are different types of cattle. Cattle breeds have similar traits (i.e., color markings, size, body shape, muscle, horns) that are passed along through generations. Some cattle breeds are recognized for their high-quality beef, efficient milk production, and some are recognized for both. You have likely consumed beef from different cattle breeds but did not know it or it was not labeled. You will see **three (3)** breed labels in the choice questions:

Angus cattle are traditionally associated with being raised for high-quality beef. Cattle in this program must be of the Angus breed with solid black hides.

Holstein cattle are traditionally associated with dairy production, but also produce high-quality beef. Cattle in this program must be of the Holstein breed with black and white hides.

Dairy-Beef cattle are a cross between a dairy breed and a beef breed, which produce high-quality beef. Cattle in this program must be a Dairy-Beef cross with black, or black and white hides.

Cattle in all three programs must pass the “10 Specifications for Quality” standards. These specifications include requirements for muscling, young cattle age, and sufficient marbling to grade USDA (United States Department of Agriculture) Average Choice, High Choice, or Prime.

Before we proceed with the choice questions, we would like to make sure the instructions we provided to you were properly displayed and covered. Based on the instructions, please select which of the following labels will be shown to you in the choice questions, **select all that apply.**

- ☐ Holstein
- ☐ Organic
- ☐ Grassfed
- ☐ Traceability

Now you are ready to answer the choice questions. In each question, you will see pictures of two ribeye steak packages that are the same except for the labels shown. For each question, please choose the 1lb ribeye steak package you would prefer to purchase or if you would not purchase either product select the "I would not purchase either" option.

While these questions are hypothetical, that is, you will not actually have to pay for the product, it is important that you answer as if you were actually faced with buying the product at a grocery retailer. Thus, before making your selection, consider whether you would actually be willing to pay the listed price, meaning that you would no longer have that money available for other purchases.

The results of this survey will be available to farmers/ranchers, retailers, and policymakers, as well as to the wider general public of consumers. This means that this survey could affect the decisions of farmers/ranchers, retailers, and policymakers.

Thank you for completing the choice questions.

Questions in this section will ask you to identify how you perceive both beef quality and the U.S. beef industry.

How do you perceive beef from the following cattle breeds?

	High Quality	Mid Quality	Low Quality	I do not perceive the breed's quality
Angus	o	o	o	o
Holstein	o	o	o	o
Dairy-Beef Crossbred	o	o	o	o

I would be willing to purchase the following products (select all that apply):

	Certified Angus Beef	Certified Holstein Beef	Certified Dairy-Beef	I would not purchase any of these products
Sirloin Steak	▢	▢	▢	▢
Ribeye Steak	▢	▢	▢	▢
Skirt Steak	▢	▢	▢	▢
Ground Beef	▢	▢	▢	▢
Beef Roast	▢	▢	▢	▢
Stew Beef	▢	▢	▢	▢
Deli Sliced Beef	▢	▢	▢	▢

Please indicate how strongly you agree with the following statements

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree	I do not know
A food traceability system can increase product safety	o	o	o	o	o	o
A food traceability system can	o	o	o	o	o	o

protect consumer health						
A food traceability system can increase consumer confidence in the agriculture industry	o	o	o	o	o	o
I intend to purchase products from companies that implement food traceability systems	o	o	o	o	o	o

In this section, you will answer questions about your household's general characteristics.

How many people (including yourself) live in the household that you shop for?
- o 1
- o 2
- o 3
- o 4
- o 5 or more

How many members of your household are under the age of 12?
- o None
- o 1
- o 2
- o 3
- o 4
- o 5 or more

How would you describe the current area you live in?
- o Urban (1)
- o Suburban (2)
- o Rural (3)

Which of the following best describes you? Select all that apply.
- ▢ White (ex: German, Irish, English, Italian, Polish, French, etc.)
- ▢ Asian (ex: Chinese, Korean, Japanese, etc.)
- ▢ Hispanic, Latino or Spanish (ex: Mexican or Mexican American, Puerto Rican, Cuban, Salvadoran, Dominican, Colombian, etc.)
- ▢ Black or African American (ex: African American, Jamaican, Haitian, Nigerian, Ethiopian, Somalian, etc.)
- ▢ Middle Eastern or North African (ex: Lebanese, Iranian, Egyptian, Syrian, Moroccan, Algerian, etc.)
- ▢ American Indian or Alaskan Native (ex: Navajo Nation, Blackfeet Tribe, Mayan, Aztec, Native Village or Barrow Inupiat Traditional Government, Nome Eskimo Community, etc.)
- ▢ South or Southeast Asian (ex: Indian, Pakistani, Filipino, Vietnamese, Malaysian, etc.)
- ▢ Native Hawaiian or Other Pacific Islander (ex: Native Hawaiian, Samoan, Chamorro, Tongan, Fijian, etc.)
- ▢ Other. Please specify _____

What is your current marital status?
- o Single, never married
- o Married
- o Separated
- o Divorced
- o Widowed

Which U.S. political party do you most identify with?
- o Democratic
- o Republican

- o I am an independent
- o Other. Please specify _____
- o Prefer Not to Say

APPENDIX B: MNL COEFFICENTS

Table 9 *MNL model estimates for Ground Beef*

Variable Name	Estimates
PRICE	-0.065***
	(0.004)
CERTIFIED ANGUS BEEF (CAB)	1.277***
	(0.055)
CERTIFIED DAIRY BEEF (CDB)	0.766***
	(0.061)
CERTIFIED HOLSTEIN BEEF (CHB)	0.831***
	(0.051)
TRACEABILITY	0.758***
	(0.054)
CAB x TRACEABILITY	-0.280***
	(0.071)
CDB x TRACEABILITY	-0.773***
	(0.077)
CHB x TRACEABILITY	-0.505***
	(0.070)
NOBUY	-0.497**
	(0.057)
N 12588	
Log Likelihood -12023.404	

***, **, * ==> Significance at 1%, 5%, 10% level.

Table 10 *MNL model estimates for Ribeye Steak*

Variable Name	**Estimates**
PRICE	-0.169***
	(0.004)
CERTIFIED ANGUS BEEF (CAB)	1.334***
	(0.237)
CERTIFIED DAIRY BEEF (CDB)	-0.272***
	(0.091)
CERTIFIED HOLSTEIN BEEF (CHB)	0.471***
	(0.075)
TRACEABILITY	0.404***
	(0.080)
CAB x TRACEABILITY	-0.443
	(0.322)
CDB x TRACEABILITY	-0.262**
	(0.127)
CHB x TRACEABILITY	0.090
	(0.115)
NOBUY	-3.148***
	(0.102)
N	*6144*
Log Likelihood	*-5411.624*

***, **, * ==> Significance at 1%, 5%, 10% level.