DISSERTATION

BENCHMARK OF LAMB QUALITY IN U.S. RETAIL AND FOODSERVICE MARKETS

Submitted by

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ABSTRACT

BENCHMARK OF LAMB QUALITY IN U.S. RETAIL AND FOODSERVICE MARKETS

Quality is an accumulation of attributes that satisfy customer preferences and expectations. Lamb quality is a moving target that means different things to the supply chain and sheep/lamb industry stakeholders. The objectives of this research were to determine the rank, definition, relative preference, and willingness to pay (WTP) for seven quality attributes and quantify product attributes of lamb at U.S. retail markets. Structured interviews of retail and foodservice respondents were conducted from May 2014 to March 2015 via face-to-face or telephone with lamb/protein purchaser representatives of retail (n = 60), foodservice (n = 45), and purveyor (n = 15) marketing sectors.

Shares of preference (relative percentage of preference) in best/worst evaluation for all interviews indicated that eating satisfaction (38.9%) was the most important attribute. Shares of preference for all seven specified quality attributes were statistically different from each other ($P < 0.05$). Credence attributes of origin (17.2%) and sheep raising practices (13.6%) ranked second and third overall, respectively. Physical product characteristic traits of product appearance/composition (10.5%) and weight/size (8.5%) were ranked fourth and fifth in shares of preference, respectively. Nutrition/wholesomeness (7.1%) ranked sixth and product convenience/form (4.2%) ranked seventh in the overall ranking across all sectors of retailer, foodservice, and purveyor interview respondents.

In WTP analyses, origin (25.8%) and sheep raising practices (20.0%) had the greatest likelihood of being a non-negotiable requirement for lamb purchasers. Eating satisfaction was

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the trait most likely to receive a premium (71.7%) from buyers, and product assurance of eating satisfaction generated the greatest average WTP premium (18.6%). This research indicated, across all sectors, eating satisfaction, defined as lamb flavor/taste, was the most important quality trait to those who purchase lamb.

In-store evaluations of retail lamb labels showed that lamb shoulder and loin chops originating from the U.S. garnered the greatest price premiums compared to either New Zealand or Australian lamb ($P < 0.05$). Lamb was merchandised to American consumers at specialty type stores at an increased price per kg premium than either locally owned or national grocery chains ($P < 0.05$). Lamb shoulder prices at retail were merchandised with the greatest premium for product of U.S. origin from a specialty store packaged in modified atmosphere packaging and labeled with local (+ $5.42/kg) and natural (+ $5.40/kg) claims ($P < 0.05$). Lamb loin prices at retail were merchandised with the greatest premium for product of U.S. origin from a specialty store merchandised in a full service case or modified atmosphere packaged and labeled with a source verified and branded (+ $7.21/kg) label claim ($P < 0.05$). Shoulder and loin chop prices analyzed via hedonic modeling were not different for store location (East, Central, and West) nor USDA process verified Never-Ever 3 claim ($P > 0.05$).

Additionally, this research indicated that lamb loin and rib chops purchased at U.S. retail markets originating from U.S. lamb were the most muscular. Loin eye area of loin chops from U.S. origin were greater (19.55 cm^2) than Australian chops (16.77 cm^2), and chops from New Zealand (14.52 cm^2) were the least muscular ($P < 0.05$). Also, Australian lamb (0.64 cm) had a trimness advantage of external fat of loin chops compared to lamb originating from either the U.S (0.84 cm) or New Zealand (0.86 cm; $P < 0.05$).

Lamb producers should strive to place a strategic emphasis on quality attributes identified in this research to ensure eating satisfaction and lamb flavor are optimized for American Lamb, and to produce lamb with product authenticity attributes requested by retail and foodservice sectors, and inevitably American lamb consumers.

An important application of the research included the development of an American lamb quality mission to: improve the consistency of quality, cutability, and marketability of American lamb with a consumer driven focus. The final phase of this project was a sheep/lamb industry strategy workshop that identified goals to: 1) Address factors contributing to lamb flavor, their impact on consumer satisfaction, and align flavor characteristics with target markets; 2) Improve lamb management to hit market-ready targets for product size, composition, and eating satisfaction while reducing production costs; and 3) Identify and capitalize on market opportunities for American lamb. A continuous improvement mentality is essential to lamb quality management throughout the supply chain in order to maintain (and increase) market share and demand for American lamb.

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CHAPTER I

INTRODUCTION

A broad genetic base of sheep, production management systems that incorporate various

diets, and inconsistency of animal slaughter endpoints contribute to product variability and create

a challenge for U.S. lamb quality. Also, animal age, body composition, and target market of end

product affect lamb quality. In general, lamb quality influences eating satisfaction in measures

of tenderness, juiciness, and flavor. Lamb is expensive comparatively to other protein options,

and it is important to provide quality and meet consumer expectations. It is challenging for

sheep producers and the industry to make continuous improvement in production efficiencies and

quality management without benchmarking where the industry is and measuring what it should

do to define success. Variation in sheep age, genetics, nutrition, and management regimens as

well as inherent seasonality of production and the inability to control timely harvest in relation to

lamb demand has led to product inconsistency (weight, fatness, and flavor) in American lamb

merchandised to consumers at foodservice and retail outlets.

Quality may be defined as the satisfaction of the customer, yet an accumulation of quality

attributes (while differing) are necessary to provide any product that meets and exceeds

expectations. Consumers' decisions may be impacted when purchasing lamb at retail by a price-

value relationship of a lamb product that is comparatively expensive to red meat alternatives in

both retail and foodservice. Consequently, an understanding of the preferences of the most

important quality attributes at the retail and foodservice sectors can provide a roadmap to reduce

quality outliers in a fragmented supply chain and identify the traits that most greatly impact

customer satisfaction. Lamb products merchandised at retail are multi-attribute goods, and further understanding of the implicit value of specified product traits and labeling claims can provide insight into consumer preferences and future marketing of lamb.

The objectives of the study discussed in Chapter III, funded by the American Lamb Board, were to determine U.S. lamb retail and foodservice rank, definition, and relative preference for seven quality attributes. Best-worst scaling, shares of preference, and a willingness to pay (WTP) assessment can provide a rank and quantification of attribute preference, the likelihood of "must have" quality attributes for purchase, and an estimation of percent increased value of lamb products when a quality attribute was guaranteed for lamb.

The objectives of the research discussed in Chapter IV were to document any product quality-related or financial items of concern to retail lamb customers and quantify their importance for lamb products available for sale at the U.S. retail marketplace. Also, researchers were to collect price and product characteristic data to determine the differential value of retail lamb attributes for cuts presented at retail stores through hedonic pricing model.

Additionally, sheep producers need guidance on how to produce lamb with credence attributes desired by retail and foodservice sectors, and American lamb consumers. Incorporation of a Total Quality Management strategies should be utilized to ensure the implementation of best practices that provide eating satisfaction. Future steps should include an action plan that targets production management effects on lamb quality attributes—primarily flavor and composition—with a focus to identify and eliminate practices that contribute to negative lamb flavor attributes. Research summarized in this dissertation can be incorporated to improve the consistency of quality, cutability, and marketability of American Lamb with a consumer driven focus.

CHAPTER II

REVIEW OF LITERATURE

SHEEP SAFETY & QUALITY ASSURANCE PROGRAM

Consumers are concerned about the safety of the foods they eat as well as the quality and consistency of the products they purchase at the marketplace (Redmond and Griffith, 2004). This consumer awareness is very important to recognize, and added emphasis on supply chain management, on-farm production practices, and product assurances are necessary to consistently deliver meat that will satisfy consumer demands for quality and eating experience (Pethick et al., 2011). Lamb and wool products are imported and exported throughout the world. Global lamb producers need to be cognizant of international competitors and position themselves to be competitive in an ever-changing market by producing products desired by consumers (Pethick et al., 2014). Schroeder et al. (2001) concluded that understanding the major determinants of, and trends in, consumer demand are critical in developing production and management strategies.

The American Sheep Industry Association (ASI) began development of an industry wide quality assurance program in 1991. In 1992 through 1993, ASI, in conjunction with the United States Department of Agriculture (USDA), sponsored a quality audit to ascertain the frequency of quality defects resulting from management practices inclusive of all phases of the production of sheep and of the generation of lamb, mutton, wool, pelts, milk, and lanolin. The audit traced each product from its origin on the farm or ranch through processing (in animal-harvesting plants and mills) to the consumer.

In the final report of the 1992 audit, industry problem areas were identified, including bruising, excess fat trim, mud/manure, and wool contaminants. Subsequent preventative management strategies, in the form of SSQA criteria, were developed to assist in the reduction of quality challenges (Cunningham and LeValley, 1992). Several deviations from acceptable product quality could be managed through implementation of quality assurance programs at the farm, ranch, and feedlot to ultimately yield safe, high quality sheep products.

The ASI, in cooperation with Colorado State University and other universities, revised the nation-wide Sheep Safety and Quality Assurance program. Production management topics affecting end product quality and safety included feeding management, sanitation, facilities, handling and transportation, shearing, and flock health; these were introduced in the "Producing High Quality Consumer Products from Sheep," released by ASI in 1995. This was the initial manual adopted for producer education for American sheep producers.

Additional lessons learned throughout implementation of the SSQA program were addressed, compiled, and summarized into six identified criterion -- feedstuffs and sources, feed additives and medications, animal health treatments, carcass and wool quality, care and husbandry, and record keeping -- addressed via a total of 40 procedural objectives. This approach was released in the 2001 publication of "Producing Consumer Products from Sheep: The Sheep Safety and Quality Assurance Program" (Roeber et al., 2001). Subsequent training of industry leaders promoted the program and allowed regional access to SSQA trainers throughout critical regions of the United States.

Further promotion of the SSQA program implementation would need to be addressed in order to reach American lamb and wool producers. The necessity of a more stream-lined, producer-friendly approach to the material also was critical in application of SSQA principles.

The SSQA program was re-evaluated, and the manual and criteria were again revised in 2004. These criteria summarized production practices into ten criteria affecting product safety and six criteria addressing lamb and wool quality (Hoffman et al., 2004). The SSQA program reflected over 20 years of efforts to address management concerns in every sector of the sheep industry regarding care and safety of products marketed.

In order to more effectively implement the SSQA program nationwide, trainers and reviewers need to be familiarized with and trained to implement critical components of a quality assurance program for a production unit. Trained individuals will be more likely to successfully convey standardized methods associated with the SSQA program to sheep producers throughout the country.

With the revised criteria of the SSQA program, a SSQA Train-the-Trainer seminar was advertised nationally and held in Ft. Collins, CO on October 12-14, 2004. The seminar provided hands-on instruction in SSQA program development on-farm to knowledgeable individuals, and a platform from which to, in turn, instruct producers in SSQA principles. Eleven new SSQA trainers from California to Minnesota to Maryland successfully completed the two-day train-the-trainer course at Colorado State University; they also participated in an additional day of on-farm reviewer training with a private auditing specialist contracted to provide training for this purpose. Education in SSQA implementation has been promoted by the American Sheep Industry Association (ASI), educational events at producer groups throughout the country, and the development of supporting educational materials.

LeValley et al. (2007) conducted a National Sheep and Lamb Quality Audit to ascertain an industry benchmark of quality attribute improvements and challenges. This research provided an update of industry dynamics related to product safety, quality, and value. A revised SSQA

manual, "Producing Consumer Products from Sheep: The Sheep Safety & Quality Assurance Program" was completed in 2009 and distributed by the American Sheep Industry Association (ASI) to its members. In 2010, the ASI initiated an online SSQA program allowing accessibility to sheep producers from across the country to the nationwide program.

In 2014, Colorado State University and Ohio State University initiated a research project entitled "Preference and Complaints associated with American Lamb Quality in Retail and Foodservice Markets." This research and findings partly provided in this dissertation will serve beneficial for defining the criterion of focus that retail and foodservice deem essential to U.S. lamb quality and are most willing to pay for (Hoffman et al., 2015). This research will assist with the direction for the future of the SSQA program that is focused on continuous improvement and works to ensure maximum consumer confidence in the production of safe, high quality lamb and wool products.

LAMB QUALITY AT RETAIL AND FOODSERVICE

Consumer preferences for purchasing decisions, and perceptions vary on a magnitude of appearance, sensory, and marketing factors (Font i Furnols et al., 2014). Garrigus (1967) stated that a majority of consumers prefer to have lamb regularly available which is relatively lean, tender, juicy, mild in flavor, and preferably priced competitively. Nearly fifty years later, we can expect that consumer preferences have not strayed far from the aforementioned suggestions of lamb quality. Thus management and nutrition factors which influence the degree of fatness, tenderness, and flavor of lamb should be considered in U.S. lamb production (Garrigus, 1967). The protein industry is global, and each protein sector will (or already has) faced the decision of either branding product via global meat marketing or by the localized marketing alternative

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(Belk et al., 2014). Product differentiation and building of a fresh, homegrown American Lamb brand will be important for future success in the U.S. retail and foodservice sectors.

In 1945, the average per capita consumption of lamb reached 3.4 kg, yet since 1975 consumption has remained below 1 kg per person per year. Most recent data (2008-2014) has remained steady between 0.4 to 0.5 kg per person per year in the United States (USDA-ERS, 2015). Despite the low consumption per capita, there is a trend for increased menu featuring for lamb in American restaurants. U.S. production of lamb has been stagnant from 2012 to 2014 (73 million kg). However, imported product has increased yearly from 2012 to 2014 and now accounts for over 15 million kg more than domestic production. Reversing the precipitous decline since 1945, per capita disappearance of lamb has shown a promising trend upward since 2011 (USDA-ERS, 2015).

Lamb is a nutrient dense, protein-rich food that provides versatility for either at-home or restaurant dining options as part of a healthy lifestyle. The USDA-ARS National Nutrient Database for Standard Reference reports that a composite of raw, 1/4" fat trimmed retail cuts of domestic lamb provides only 5.2 grams of total fat, 133 Kcal, and over 20 grams of protein per 100 gram serving on a separable lean basis. A 100 gram serving of lamb provides an excellent source of protein (43%), Vitamin B_{12} (100%), zinc (20%), and selenium (37%) for the daily recommended allowances for an individual. Additionally, a 100 gram serving of lamb is a good source of niacin (18%), riboflavin (16%), and iron (11%; USDA-ARS, 2015). Ikem et al. (2015) estimated the essential and non-essential elements of U.S. and New Zealand lamb *Longissimus* muscle. The daily intake levels, in order, for U.S. lamb loins were potassium, phosphorus, sodium, magnesium, calcium, zinc, and iron; only magnesium and calcium levels changed in the comparative New Zealand lamb (Ikem et al., 2015).

Due to the lighter carcass weight compared to beef or pork, retail lamb cuts are inherently smaller in size. However, compared to other proteins of beef, pork, or chicken, lamb is an expensive option at either retail or foodservice entities. Little research has been conducted that characterizes lamb in the U.S. retail case. A national market basket study for lamb evaluated retail cases in six U.S. cities in 1990. An average fat thickness across all lamb cuts was 0.35 cm, and researchers concluded high ratings for all retail lamb through sensory analysis (Harris et al., 1990). The aforementioned benchmark of retail lamb only reported 1% of lamb as imported (New Zealand) product (Harris et al., 1990). The amount of imported retail product from both Australia and New Zealand are dramatically greater (over 50%) in today's marketplace (USDA-ERS, 2015).

The only other published lamb retail audit to date was conducted in Australia. Safari et al. (2002) determined that 20.3% of loins sampled from supermarkets and retail butcher shops had a shear force measurements over a 5 kg threshold value. A threshold value of 4.4 kg is often used in scientific literature as the value in which there is a 50% chance that consumers will rate lamb as acceptable for tenderness (Carvalho-Neto et al., 2011). Researchers suggested a need for improvement of lamb tenderness originating from Australia through a lamb eating quality assurance system to ensure high eating quality for lamb (Safari et al., 2002).

Consumer sensory panel and instrumental measurement data can be used in combination to decipher the consumer's response and acceptance of American lamb meat. Carvalho-Neto et al. (2011) conducted a study to determine consumer sensory panel ratings and to establish baseline tenderness for American lamb meat. Carvalho-Neto et al. (2011) found that values did not differ for Warner-Bratzler Shear Force (WBSF) tenderness analysis between lamb loin samples from USDA Quality Grade Prime and Choice carcasses. It should be noted that the

Longissimus muscle from lamb aged for 15 days post-mortem was extremely tender relative to competitive proteins. A mean WBSF value of 2.01 kg across all treatment levels was observed. The proportion of consumers that "liked" lamb tenderness was 94%, flavor was 81%, and overall acceptance was 88%. Results further demonstrated that American lamb meat has an overall acceptability rate of 83% or higher among consumers that at least periodically purchase lamb at retail (Carvalho-Neto et. al., 2011). Consumer ratings for American lamb loin chops did not differ for tenderness, flavor, or overall acceptability by Quality Grade or by seasonal period of production. American lamb of USDA Prime and Choice grades is extremely tender and should be marketed appropriately.

A consumer acceptability analysis of grilled lamb loin chops identified eating quality attributes of tenderness, roast lamb flavor, sweet flavor, meaty aftertaste, and roast lamb aftertaste as positively influencing consumer acceptability (Oltra et al., 2015). Negative descriptors included rubbery, bitter flavor, and bitter aftertaste. Oltra et al. (2015) found glucose, glucose-6-phosphate, inosine, inosine monophosphate and adenosine monophosphate contributed to preferred flavor profiles.

A model developed by Bueno et al. (2014) explained 74% of the aroma/odor variation among grilled lamb loins through an analysis of 32 aroma-active chemical compounds. Negative aroma of lamb meat has been attributed to branched-chain fatty acids, including 4-methyloctanoic and 4-ethyloctanoic acids related to a mutton off-flavor (Watkins et al., 2014). The fatty acid prevalence of skatole (3-methylindole) and indole have been associated with the pastoral flavor of lamb and increasing levels of these compounds are negatively perceived as intense lamb odor and flavor (Prescott et al., 2001; Devincenzi et al., 2014). Also, carbonyl compounds of hepan-2-one and oct-1-en-3-one have been associated with lamb flavor (Resconi

et al., 2010). Font i Furnols et al. (2009) suggested that consumers from Spain, Germany, United Kingdom, and France preferred meat from lamb fed with either a concentrate or combination of concentrate and pasture than meat from lamb only fed on pasture. However, flavor intensity preferences for lamb may differ based on past experiences, lamb flavor familiarity, flavor intensity preferences, and cultural backgrounds.

A WTP contingent valuation was completed with 800 consumers in Sydney, Australia that quantified the value of muscle and fat cutability of lamb loin chops at the retail case. Researchers determined consumers were unwilling to pay a premium for greater red meat area of lamb loin chops, but lamb chops with greater fat cover would be purchased at a discounted price (Mullen and Wohlgenant, 1991).

An in-home consumer evaluation was conducted by Maddock et al. (2004) to define acceptable eating characteristics of at-home consumption of lamb. Consumers preferred rib and loin chop palatability over blade and leg cuts for overall like, tenderness, juiciness, and flavor desirability (Maddock et al., 2004). Consumers tended to prefer pan-broiled/pan-fried to grilled lamb, and increased degree of doneness decreased juiciness of lamb chop (Maddock et al., 2004).

Research conducted by Nayga (1993) identified potential for increased market share in the U.S. foodservice sector for lamb originating from Australia and New Zealand. Employed males with an increased age and income were more prone to eat lamb away from home, and a negative correlation existed for lamb consumed by larger family size. Additionally, ethnic consumers were more likely to consume lamb away from the home compared to Caucasians or African Americans (Nayga, 1993). Imported product has increased in the U.S., yet current production levels domestically are not able to suffice demand, and consequently, the market will continue to merchandise both domestic and imported lamb (USDA-ERS, 2015).

TOTAL QUALITY MANAGEMENT FOR LAMB

A top priority for the success of the lamb industry relies on its ability to deliver products that satisfy consumers' expectations. More specifically, it is essential for the American lamb industry to produce a product that meets most consumers' expectations and demands. Description, evaluation, and production of "consumer-preferred" lamb carcasses are defined differently by sectors of the industry (Carpenter, 1966). A supply chain management approach should be considered to create product quality through product specifications, optimized yield, and a balance of optimal product price and the premium quality for the consumer (Kristensen et al., 2014). Information relative to physiological growth, genetic antagonisms, palatability, heritability and merchandising would undoubtedly lead to changes in the specifications for the lamb carcass that would be most desirable for all segments of the industry, including the consumer (Carpenter, 1966).

Kristensen et al. (2014) identified meat quality management as a key area of future focus. Meat and Livestock Australia has been at the forefront of whole supply chain quality management of sheep and lamb meat. Consumer acceptability of lamb can be monitored with critical control points from conception to consumption. Russell et al. (2005) reiterated that the most preferred evaluation of lamb quality was untrained consumer panelist evaluations. An Australian implementation of eating quality assurance programs was meant to more ably meet the eating quality requirements of lamb for consumers and provide appropriate industry feedback to enable continuous improvement of quality (Russell et al., 2005).

Australian sheep operations were historically focused on wool, but economic pressures redirected a focus to lamb meat that strive for production efficiency and larger lamb carcasses. However, a survey reported that 45% of retailers and supermarket butchers would not purchase

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large lamb carcasses due to primal and cut sizes (Channon, 1990). Since then, the Australian sheep industry has seen improvements with genetics, farm management, and marketing. Genetic improvement has emphasized increased carcass weight and muscle, and a reduction in fatness of lamb (Pethick et al., 2006).

Mullen and Alston (1994) noted that profitability of sheep production was not just dependent on production and processing costs, but also required a demand shift of consumers. A premium and willingness to pay for large lean lambs would be required for increased profitability (Mullen and Alston, 1994). However, consumer preference for leanness were not reflected in prices at traditional auction markets (Mullen, 1995). An increase in retail carcass value was associated with an increase in percent of retail leg, and a decrease of external fat over the loin eye (Carpenter et al., 1964). This research also indicated that an objective measurement of loin eye fat accounted for 65% of the variation in lamb carcass value. Hufton et al. (2009) observed that premiums and discounts based on carcass weight were inconsistent in the lamb Australian market. Fifteen years after Mullen and Alston's research, the stated preference of consumers for larger lambs was still not evident in Australia live lamb and lamb carcass prices (Hufton et al., 2009). Lamb carcass value can be attributed to conformation (muscling), fat depth, and meat color, and Farrell and Hopkins (2007) suggested that these three characteristics should be incorporated into carcass grading models in Australia.

Lamb product fatness was considered the primary negative challenge for retail markets, but a combination of fatness, conformation, and weight comprise lamb specifications (Kilkenny, 1990). Even with a focus on cutability, changes in nutrient density of Australian lamb cuts represented a less than 5% change per 100 g of edible portion based on recommended dietary intake from previous research (Hoke et al., 1999). Cobiac et al. (2003) determined that

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decreasing the external fat level on lamb at retail can result in a protein with decreased separable fat. Research stated that Australian loin chops had a mean of 4.9 mm of external fat, but a comparison of external fat width of < 2, 5, and 8 mm external fat for loin chops identified significantly less total separable fat of 29.8, 36.5, and 42.6%, respectively (Cobiac et al., 2003). No difference of total fat content was found from the separable lean across raw retail lamb cuts (Duysen et al., 2014). Consequently, the consumable fat from various lamb cuts can be mostly attributed to the level of external fat. An overall average of separable fat (16.51%) from lamb purchased at U.S. retail markets (99% U.S. origin) was substantially lower than previous Australian research (Harris et al., 1990; Cobiac et al., 2003). An evaluation of the nutritional composition for lamb of U.S. origin is in progress to update the USDA National Nutrient Database for Standard Reference.

Beerman et al. (1995) reported that less than 30% of lambs slaughtered in the U.S. met muscling and leanness requirements for the Certified Fresh American Lamb program. Production of lamb in the 1990's was hindered by producing carcasses with excessive fat, and it can be argued that, in 2015, we face a similar challenge (Beerman et al., 1995). Beerman et al. (1995) suggested that the industry should incorporate large framed terminal sires, feed intact males, feed rumen-escape dietary protein, and slaughter at compositionally appropriate weights to improve sheep production efficiency and create solutions for lamb composition challenges.

In the U.S., the most recent research evaluating sheep production management was conducted by the National Animal Health Monitoring System with a series of documents to quantify issues associated with animal health. Improvements in biosecurity practices were found, and an evaluation of antibiotic usage was quantified, but factors critical to end product cutability or quality were not addressed in this research (NAHMS, 2011).

Corner-Thomas et al. (2015) evaluated the adoption of farm management tools by New Zealand sheep operations. Only a small percentage of farmers were incorporating management practices for improvements in farm profitability. Demographics of farm size, farmer age, and education level were found to be linked with increased management, yet opportunity existed for greater uptake of management tools (Corner-Thomas et al., 2015).

While meat quality traits are generally moderately heritable, sheep breeding objectives can be refined and impact fresh meat redness, retail meat redness, and iron content (Mortimer et al., 2014). Research conducted in Australia has shifted the mentality of sheep producers to selection not only on growth and yield, but additionally addressing a more balanced approach to total quality management and emphasizing future consumer needs (Pethick et al., 2014). Post-harvest interventions for quality also include adoption of carcass electrical stimulation in 14 harvest facilities that represent over 70% of the slaughter capacity in Australia (Hopkins et al., 2008).

Pethick et al. (2011) identified lean meat yield, eating quality, and human nutritive value as the three most important quality criteria for lamb meat quality. The Australian lamb industry should be a model for comprehensive continuous improvement of animal management to produce sheep and lamb that are mutually beneficial to the sheep industry and the lamb consumer (Pethick et al. 2011). With regard to total quality management of lamb, the United States is significantly behind the quantification and progress currently accomplished within the Australian sheep supply chain. Further, both Australia and New Zealand lamb have had an increasing market penetration in the U.S. retail and foodservice markets (USDA-ERS, 2015). A rejuvenation of the total quality management approach among the U.S. sheep industry supply chain is imperative to ensure production of lamb that meets and exceeds consumer expectations.

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CHAPTER III

PREFERENCES ASSOCIATED WITH AMERICAN LAMB QUALITY IN RETAIL &
FOODSERVICE MARKETS

INTRODUCTION

Customers' needs and expectations are continually changing, and lamb quality is a

moving target that has different meanings to sheep/lamb industry stakeholders throughout the

supply chain. The National Lamb Quality Audit benchmarked the current status of lamb quality

preferences and complaints for U.S. retail and foodservice markets (Hoffman et al., 2015). Dr.

W. Edwards Deming, often considered the father of Total Quality Management, believed in

process control in the quest for continuous improvement and that people, not products, were the

ultimate determinant of quality.

Quality audits previously conducted in the beef, pork, and lamb industries were used to

determine goals and objectives for livestock producers to implement and improve the quality,

consistency, value, and competitiveness of protein products. At the request of the American

Sheep Industry Association (ASI), an industry wide quality assurance program was developed in

1991. The mission of the Sheep Safety and Quality Assurance (SSQA) program is to maximize

consumer confidence in, and acceptance of, sheep products by using research and education to

improve management of the production of sheep products (Hoffman et al., 2004). The first

National Lamb Quality Audit (NLQA) was conducted in 1992 (Cunningham and LeValley,

1992). The final report of the 1992 audit focused on lamb and wool quality attributes and

identified carcass bruising and excessive fat trim as product defects and the greatest industry

meat quality challenges (Cunningham and LeValley, 1992). The 2007 NLQA, conducted by

Colorado State University, evaluated the sheep supply chain from producer to harvest and noted prominent industry quality concerns of seasonal supply, feeder lamb genetics and health, and needed improvement of overall muscling and ribeye area of lamb carcasses (LeValley et al., 2007).

While previous audits evaluated product quality from production to harvest, the U.S. lamb industry cannot expect improvements in prices offered or quantity demanded for its products when "quality" does not warrant such increases. Without adjusting philosophy of production practices, and given reduced demand for lamb that has manifested during the past 30 years, it is not possible to be optimistic about the future of lamb markets in the United States unless changes are made to emphasize lamb quality strengths, and identify and then correct shortcomings necessary for improved demand.

Lamb has a reputation as a high end protein. However, product cost for the consumer at retail and foodservice necessitates high quality American Lamb to fulfill the customer value proposition. It is unclear if development and deployment of the SSQA program, as a strategy to address opportunities for improvement that were identified in previous audits, has had an impact—particularly on perception of lamb quality at retail and foodservice levels of the industry.

MATERIALS AND METHODS

For the first time in a NLQA, perceptions regarding lamb quality via structured interviews were quantified with state-of-the-art data collection technology and design. Interviews and questionnaires, along with sophisticated experimental design and analytical techniques, were utilized most recently in a 2010 evaluation of U.S. Pork Quality in Asia and Mexico and the

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2011 NBQA. Researchers conducted interviews, and results identified quality concerns, benchmarked management practices and product quality attributes, quantified improvements influenced by production, and identified next steps to improve product marketability and consumer demand (Igo et al., 2013; Murphy et al., 2015).

Structured Interview Protocol

A dynamic-routing, standardized electronic software was utilized to administer structured interviews with lamb/protein purchasers at the retail, foodservice, and purveyor sectors of the supply chain. A software package (Qualtrics®) was customized to develop a structured order of questions and interviews that were administered and recorded with an Apple iPad®. Company demographic information, a rank and definition of seven quality attributes and their associated WTP, and answers to open-ended questions were collected from interview respondents (N = 120). Structured interviews averaged about 40 minutes in length, and were primarily face-to-face (or via telephone if logistics did not permit) to gather spontaneous (with no forethought) reaction and input on Lamb Quality. Interviews were conducted from May 2014 to March 2015. Interviews were administered to buying personnel at retail (n = 31 supermarkets, n = 11 butcher's markets, and n = 18 direct/farmer's markets), foodservice (n = 23 fine dining, n = 22 casual dining), and provision/purveyor (n = 15) companies. Questions were formulated to obtain information regarding: problems at the retailer/foodservice level, improvements that can be made, opportunities that may exist, and consumer demand for lamb.

Previous quality audits evaluating the sheep and lamb industry did not address the consumer and consequently we asked the sectors closest to consumer to quantify and benchmark attributes of importance for development of a Deming-like philosophy to production control and lamb quality of American Lamb. Interviews with protein purchasing representatives provided

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information unbiased definitions for "What is Lamb Quality?" In order to determine a customer's WTP premium for lamb quality attributes, it was necessary to first determine what quality "means" to each interviewee. This set of questions addressed the question: "What is 'quality' and what quality factors drive the company's purchasing decisions?" The "gut" reactions and "top of mind" answers regarding what the category means to them allowed for unbiased interpretation of a specified definition for each respondent.

Respondents were asked whether or not they would pay a given percentage premium for all seven quality attribute categories. The WTP values were quantified using an unstructured line scale from a 0% to 30% increase of premium if a specified quality attribute could be assured. If a quality category was deemed "must have before I will purchase", then percent premium increase was not quantified, as that attribute was considered to be a non-negotiable requirement for the lamb purchase. If a quality category was not deemed to be a "must-have before I will purchase" trait, then respondents were asked if the trait warranted a zero value premium increase. Respondents that answered yes to "would you purchase the product at a premium percent increase of dollar value if this trait could be guaranteed?", then utilized the unstructured line scale to create a continuous variable of percent increase (range: 0% to 30%) of premium. The attribute percent increase was aggregated for an average WTP for each quality attribute and reported within each attribute and sector.

Maximum difference or best/worst scaling questions were included following administration of WTP questions to measure the importance of the seven quality attributes and compare the true rank of importance with WTP responses. Interview respondents were asked to rank the most and least important trait of the seven specified quality attributes through several choice rank sets to determine shares of preference for quality attributes. Best/worst scaling was

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shown to be a more accurate predictor of attribute importance and consumer preferences of beef attributes than a standard direct ranking approach (Lagerkvist, 2013).

The calculated shares of preference sums to one across all attributes, and determined a probability for each quality attribute when chosen as more important in each comparison. For example, if shares of preference for "attribute A" were twice as large as "attribute B", then "A" would be twice as preferred as "B" in relative importance (Lusk and Briggeman, 2009). Similarly to how strategic planning systems operate, these response data allowed—for the first time—true objective best/worst ranking of individual quality categories based on unbiased perceptions, as well as shares of preference value, or the relative percentage of preference for each of the seven quality attributes.

Upon completion of data collection, probabilities for traits being essential, for willingness to pay a premium, and the customer's WTP value was computed. By conducting the interviews in this manner, we were able to quantitatively rank seven quality attributes, define the true meaning of each quality attribute, and determine WTP premiums for each identified attribute across retail sectors of the lamb marketing chain.

Lamb Quality Strategy Workshop

The American Lamb Board hosted a Strategy Workshop pertinent to American Lamb Quality in June 2015. A twenty-five person focus group represented all sectors of the lamb supply chain to develop goals, a vision, and an action plan from findings of this project. Researchers from Colorado State University and The Ohio State University presented results to strategy workshop attendees. Participants engaged in a day and a half discussion on identifying the current status of American Lamb Quality, including current strengths, deficiencies, and

determining necessary steps for future improvements critical to maintaining and increasing American Lamb market share.

DATA ANALYSIS

Open ended responses for definitions of lamb quality were sorted into one of the seven quality attribute categories identified and narrowed in terms of description to define what each of these generic quality classifications "means" to each company interviewed. Definitions of quality were evaluated qualitatively to determine the likelihood of central themes for each quality attribute. Additionally, addressing up front issues associated with economic/financial concerns first allowed for interviewees to answer regarding quality traits of interest instead of financial concerns.

Through this interview methodology, perceptions regarding relative importance of lamb quality were ranked, seven quality attributes were defined by interviewees, and WTP estimates quantified the perceived value for specified lamb quality attributes. Researchers conducted data analysis, and quantified perceptions of seven specified quality attributes: (1) eating satisfaction; (2) origin; (3) sheep raising practices; (4) product appearance/composition; (5) weight/size; (6) nutrition/wholesomeness; and (7) product convenience/form, to estimate contingent valuation WTP by retail and foodservice customers, and established a Best/Worst (B/W) ranking of the importance of the specified quality categories.

Multinomial logit (MNL) models in SAS® (SAS Inst. Inc., ver. 9.4, Cary, NC) MDC were used to calculate shares of preference. Lusk and Briggeman (2009) define a share of preference as the forecasted probability in which a question is preferred as most important and can be estimated in the following equation: shares of preference for attribute $j = e^{\lambda_j} / \sum_{k=1}^{j} e^{\lambda_j}$.

To test whether the shares of preferences were statistically different from one another, a distribution of each coefficient was generated via Monte Carlo simulation and combinational test were conducted on all pairwise combinations (Poe, Giraud, and Loomis, 2005). Specifically, using the coefficients and variance terms from the MNL models, 1,000 observations were drawn from a multivariate normal distribution. The simulated coefficients were then used to test for statistical differences in the shares of preference ($\alpha = 0.05$).

RESULTS AND DISCUSSION

Representatives of the retail, foodservice, and purveyor sectors of the lamb industry were asked to "define lamb." The gut reaction, or initial impression, answer was split between descriptions of a young sheep animal and the red meat protein on the plate. Central themes for the definition of lamb included a probability of being described as: 1) young sheep (32%); 2) red meat alternative (25%); 3) delicious and flavorful attributes (20%); 4) delicacy, high end meat (9%); 5) healthy protein (7%); and 6) other (7%). The predominant answer was "young sheep"; and while the definition of lamb varied by respondent in foodservice, retail, and purveyor sectors of the industry, lamb was most commonly defined as a young sheep less than 12 months of age.

Lamb was identified as both a retail and foodservice alternative to beef, pork, and chicken. Often, lamb versatility and description of a unique flavor that is slight to mildly gamey resulted in menu flexibility and alternatives on menus at restaurants. A common response was "lamb is delicious!" Another interviewee stated that lamb was "in one word, delicious. Exotic and flavorful. Lamb is like taking a vacation, it is out of the norm and really wonderful all at the same time." Negative connotations were expressed on occasion with both the anthropomorphism of lamb and the mental connection with a baby animal, as well as a recurring negative image of

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older sheep and the term mutton. Also, an additional term that described lamb was "terroir", meaning that much like wine, lamb flavor is a representation of specific location and raising practice. Respondents indicated that lamb currently has the stigma of only being a high end, niche market meat option, and that currently faces the struggle of being considered an everyday protein. Lamb was also described as a healthy, lean meat protein. Furthermore, there is an important perceived connection between sheep and the environment. One interview respondent reiterated that the "beauty of lamb is that it is as close to the earth as possible. If you choose to do the right things, the right way, you can get less expensive in production with lamb on grass and it is great for the environment." Lastly, while flavor perceptions of lamb differed, numerous respondents indicated that lamb lovers enjoy lamb and seek it out, but a proportion of consumers are hesitant to try lamb and abstain from lamb purchasing for a myriad of reasons.

Quality, in general, is a more ambiguous term to define. Interview responses for "define quality" show a variety of answers for supermarket, butcher, direct/farmer's market, fine dining, casual dining, and purveyor representatives of the lamb industry. Per the Deming philosophy and the quest for continuous improvement the people comprising the supply chain are integral to end product quality. Quality may be defined as the satisfaction of the customer, yet an accumulation of quality attributes (while differing) in relation to dollars are necessary to provide any product that meets and exceeds expectations. The customer value proposition encourages a quest for the highest quality lamb to meet the value expected for the price of a comparatively expensive lamb product to red meat alternatives in both retail and foodservice. Consequently, an understanding of the preferences and complaints associated with most important quality attributes at the retail and foodservice sectors can provide a roadmap to reduce quality outliers in a fragmented supply chain and identify the trait(s) that most greatly impact customer satisfaction.

Economic Considerations

To insure that quality was the central focus of this research, it was critical to first discuss the economic considerations important to lamb/protein purchasers. People in charge of protein purchase at retail and foodservice make decisions daily that financially impact their respective business. Lamb purchasing decisions related to pricing can range from a white table cloth restaurant that always offers lamb menu options because of customer demands to a price sensitive large grocery chain that simply offers only lamb shoulder and shank at the retail case because of their customer demographics. Interview respondents from both retail and foodservice answered a question regarding the economic concerns that play a role in whether or not their business purchases lamb. Lamb purchase price was most frequently cited as having the greatest impact from the financial perspective by supermarkets, butchers, fine dining, and purveyors. Customer preferences and advertisement features ranked in the top three conditions as affecting lamb purchasing for both supermarkets and butchers. Price consistency for direct marketers and menu price affordability for casual dining were mentioned as a result of price volatility in the lamb marketplace. However, the importance of quality lamb surpassed price as an issue for 39% of fine dining establishments and 17% of farmer's markets. Also, the volatility of price and overall cost did not impact lamb purchasing decisions for 27% of butchers, 19% of supermarkets, and 14% of casual dining restaurants. Addressing financial concerns early in each interview allowed for all remaining questions of the structured interview to focus on the quality traits of interest.

Shares of Preference

Best/Worst scaling questions of the structured interviews quantified the importance of seven quality categories via seven comparisons of three traits; choosing the most important and

least important. A final comparison asked interviewees to identify only the most important and least important of all seven quality categories in a single contrast. The ranking of the seven specified quality attributes as related to their importance to lamb quality for the accumulated interviews of retail, foodservice, and purveyor sectors (N = 120) are summarized in Table 3.1. Eating satisfaction was the most important ($P < 0.05$) quality attribute for interviewed protein purchasers across all sectors in this research. The total shares of preference (relative percentage of preference) for all interviews for eating satisfaction in this study was 38.9%. The emphasis on eating satisfaction was apparent for U.S. lamb industry stakeholders as the consumer-focused attribute was more than double the next closest quality attribute.

This current study differed from recent beef and pork audits that identified food safety as the most important attribute (Igo et al., 2013; Murphy et al., 2015). Food safety was not perceived as an issue for lamb due to rare occurrences associated with foodborne illness compared to competitive proteins. The Center for Disease Control and Prevention (CDC) published The Food Outbreak Online Database (FOOD) that had identified only five individual disease outbreaks associated with lamb and lamb products from 1998 to 2014 (CDC, 2014). Two cases of *E. coli* O157:H7, one in Washington (2004) and one in Ohio (2006) were reported, and *Salmonella enterica* was confirmed as the foodborne pathogen associated with three incidences of disease, two in New York (2002; 2009) and one in Massachusetts (2007), potentially originating from lamb consumption. Lamb has by some margin the lowest rate of incidence causing foodborne illness of all major proteins (Hoffman et al., 2014).

Research indicated that consumers with limited expertise in meat purchasing were more prone to associate over-arching themes of food safety such as disease control and farm hygiene to lamb quality than older, more experienced lamb purchasers (Sepulveda et al., 2011).

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Consumer demographics, food safety knowledge, and socio-economic classifications impacted

consumer attitudes focused on food safety (Wilcock et al., 2004). Duffy et al. (2001) determined

that lamb carcass contamination was low for *Salmonella* spp. (1.5% positive) and *Escherichia*

coli (Aerobic Plate Count: 4.4; Total Coliform Count: 1.2; and Generic *E. coli* Count: 0.70 log

CFU/cm^2) incidence in U.S. lamb packing plants. Lamb has not been identified as the source of

a multi-state or national foodborne disease outbreak in the past 15 years. Consequently, food

safety/wholesomeness concerns of lamb were of limited importance for lamb, and attributes such

as eating satisfaction had increased shares of preference compared to previous research with beef

and pork.

Eating satisfaction ranked as the second most important quality trait in the 2011 National

Beef Quality Audit (NBQA) for U.S. beef industry sectors including packers, retailers, and

foodservice, distributors, and further processors. Comparatively, the retailer sector in the NBQA

resulted in a 10% lower shares of preference (29.2%) value for eating satisfaction than lamb

quality interview respondents. Eating quality ranked third overall in the evaluation of U.S. pork

for importing countries and only rated second for Hong Kong/China and Japan (Murphy et al.,

2015).

Credence attributes and production management traits of origin (17.2%) and sheep

raising practices (13.6%) ranked second and third overall, respectively ($P < 0.05$).

Comparatively in the 2011 NBQA, how and where the cattle were raised ranked third (10.0%)

among retailers and fourth (9.6%) for foodservice, distributor, and further processor purchasers

of beef (Igo et al., 2013). The emphasis of local, regional, and domestic origin of lamb was

important to interviewees. Sheep raising practices and the potential for specific labeling claims

of lamb at retail and on restaurant menus resulted in greater shares of preference for production

history than either of the other studies that evaluated beef and pork quality. Sepulveda et al. (2011) identified that origin of production and animal feeding were important for lamb consumers in Spain, and that factors of lesser importance include animal welfare and environmental concerns. Yet, a segment of consumers (more commonly younger age) make purchasing decisions on credence attributes such as animal well-being and production effects on the environment (Sepulveda et al., 2011).

Physical product characteristic traits of product appearance/composition (10.5%) and weight/size (8.5%) were ranked fourth and fifth in the shares of preference, respectively ($P < 0.05$). These results mirrored findings from the 2011 NBQA that reported visual characteristics, weight and size, and lean, fat, and bone attributes from third to sixth in importance for retailer and foodservice sectors. Consequently, this study showed that product appearance/composition and weight and size were not as important to overall lamb quality as either eating satisfaction or the aforementioned credence attributes.

Nutrition/wholesomeness (7.1%) ranked sixth in the overall ranking of shares of preference ($P < 0.05$). Lamb was considered a nutrient rich protein and red meat was determined important for people to add to their diet for essential nutrients (Hoke et al., 1999; Binnie et al., 2014). Interviewees reported that lamb has a clean food safety record compared to competitive proteins, and interviewees also stated that lamb quality was driven by factors other than nutritional basis. Product convenience/form (4.2%) ranked seventh, and this rank was consistent across all sectors of retailer, foodservice, and purveyor interview respondents.

Preference and overall rank of quality attributes varied within sectors (Table 3.2; Table 3.3). Across all sectors interviewed, eating satisfaction was the highest ranking quality attribute. Furthermore, product convenience/form consistently ranked seventh among all sectors

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interviewed in the lamb supply chain. Supermarket interview respondents in the B/W scaling identified the trait of eating satisfaction as most important (39.2%), and origin ranked second (18.2%) at the retail level. Along with purveyors, supermarkets were the only other sector to have product appearance/composition in the top three quality attributes (16.5% for both sectors). Weight/size ranked fourth for supermarkets, and the quality trait that was lower in importance for supermarket interviews was sheep raising practices, ranked as the fifth most important quality attribute. Sheep raising practices for supermarkets had the lowest preference value (7.0%) across all sectors interviewed. This decrease in relative importance of sheep raising practices for supermarkets indicated that end consumers may not value production management practices and associated labeling claims compared to other retail and foodservice sectors.

Interview respondents representing butchers quantified an increase of 6% greater and 5% greater shares of preference value than the mean across all sectors for origin and sheep raising practices, respectively. In fact, origin was the greatest preference for butchers (23.4%) compared to all other sectors, and reiterated the importance of locally raised to interviewed butchers. Also, weight/size surpassed product appearance/composition in the butchers' ranking, but both were lower than the mean value because of the increased emphasis on credence attributes for butchers to sell protein at their marketplace. Butchers rated product appearance/composition (5.2%), nutrition/wholesomeness (5.1%), and product convenience/form (1.3%) lowest among the six sectors.

Interview respondents that represented either direct market lamb merchandisers or farmer's market merchandisers indicated the greatest shares of preference values for both sheep raising practices (22.4%) and nutrition/wholesomeness (8.4%). Also, sheep raising practices and origin were 5% and 8% greater for shares of preference than the mean, respectively, for this

sector. Direct marketers of lamb were the only sector to rank nutrition/wholesomeness in the top four specified quality traits. While eating satisfaction was the highest ranked quality attribute for direct/farmer's markets, they reported the lowest value for eating satisfaction shares of preference (27.8%). The preferred attributes of sheep raising practices and nutrition/wholesomeness related to the trust built on farmer and customer interaction. The documented production history of sheep production and the perceived health/safety benefits were of greater importance for direct marketers of lamb than other sectors.

Fine dining interview respondents identified eating satisfaction (48.8%) as over twice as important as any other quality attribute. The shares of preference for sheep raising practices was second only in value to direct/farmers markets, and 12% greater than shares of preference for origin of product for fine dining establishments. This showed an increased preference for how an animal was raised than the origin of production for the fine dining sector. Nutrition/wholesomeness ranked over weight/size in the fine dining sector. Also, the quality attribute of weight/size was rated the lowest (4.0%) for all retail market sectors evaluated in this study.

Interview respondents representing the casual dining segment reported the greatest SOP value for eating satisfaction (54.3%) compared to all other sectors. Sheep raising practices passed origin for rank of preference in casual dining entities. Origin received the lowest shares of preference (12.1%) for casual dining compared to any other retail marketing sector. The importance of eating satisfaction for the casual dining sector reinforced the critical need to boost lamb consumption for both new and returning consumers.

The purveyor sector emphasized the product characteristics of weight/size (20.4%), product appearance/composition (16.5%), and product convenience/form (5.5%) more than any

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other sector. Purveyors were the only industry segment that ranked weight/size second and the relative preference was over twice that of any other sector's value. Supermarkets were the only other retail marketing sector to have product appearance/composition rated in the top three attributes. An apparent emphasis on product characteristics stressed the significance of meeting product specifications and physical quality attributes.

An analysis of shares of preference was conducted for small (< 45 kg per week; n = 37), medium (45 to 454 kg per week; n = 46), and large (> 454 kg per week; n = 37) retail, foodservice, and purveyor entities. Large merchandisers placed emphasis on product appearance and composition and weight and size compared to either small or medium merchandisers of lamb. Also, as expected, lamb industry representatives that marketed U.S. lamb product returned greater shares of preference for the origin quality attribute than those that imported lamb.

Moreover, a comparison of companies that purchase either branded or un-branded lamb showed that a shares of preference for branded lamb resulted in nine percent greater emphasis on origin and a four percent preference for sheep raising practices. Sheep raising practices that ensure production of high quality lamb and a known, traceable origin result in added marketing capability for lamb at retail and foodservice markets.

Interview respondents provided designated specifications and requirements for lamb cuts and carcasses merchandised for enrolled branded lamb programs. Prominent requirements for lamb merchandised in branded lamb programs included local origin, grass-fed management practices, and domestic, or American, origin of lamb. Also, when interviewees were asked "What is the most important attribute or specification to a branded lamb program?" the locally raised requirement was rated the most commonly described attribute for branded lamb.

Definition of Quality Attributes

The seven pre-determined quality attribute groupings of origin, sheep raising practices, eating satisfaction, weight and size, product appearance and composition, product convenience and form, and nutrition and wholesomeness resulted in different meanings from interview respondents of retail and foodservice sectors. The aggregated and categorized responses from interviewed companies defining what seven quality attributes mean to their company as it relates to lamb are reported in Table 3.4. The results were analyzed qualitatively and reported with respect to each sector of the industry interviewed to determine priority of meaning and the most important descriptors of specified traits associated with lamb quality (Table 3.5; Table 3.6).

Eating Satisfaction

Eating satisfaction was clearly defined as lamb flavor and/or taste (75.8%). Lamb flavor was the primary response to what is important to eating satisfaction for supermarkets, butchers, fine dining, casual dining, and purveyors. Tenderness of lamb ranked as the second most frequent response among interview respondents. In general, tenderness of lamb was considered a strength for the industry, and rarely a detriment to overall eating satisfaction (Carvalho-Neto, 2011). A broader definition of customer satisfaction rated highest for direct/farmer's market respondents, followed secondly by lamb flavor. Various other descriptors included, to a lesser extent, marbling, texture/mouthfeel, and fat content. Results from this present study indicated that lamb flavor and taste were the primary definition and of greatest importance to lamb eating satisfaction and lamb quality.

Origin

The most common definition for the term (category) origin by retail and foodservice representatives was locally raised (44.2%), or a designation of local. Local classification ranked

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first for butchers, fine dining, casual dining, and purveyors. An expectation of tastier and higher quality products were associated with a local food label (Feldmann and Hamm, 2015). American (25.0%) was the second most common way to define origin and the most frequent term for supermarket respondents. A geographical description of regionality of product, region/state (20.0%), ranked third. Origin was most often defined by direct/farmer's market interviewee as traceable to the ranch. Overall, retailers and foodservice companies (sectors closest to the consumer) identified that origin of lamb is a future marketing opportunity due to the expansion of farmer's markets, opportunity for direct marketing, and product branding on the label at retail and on the restaurant menu.

Sheep Raising Practices

Sheep raising practices was most commonly defined by industry interview respondents as grass-fed (37.5%). Humanely raised (21.7%), or synonyms of humane treatment, rated second in frequency of responses to define sheep raising practices. Feeding regime (15.8%) and animal well-being (15.8%) tied for third, were descriptions that are very close to the initial two mentioned production practices. A variety of responses also related to a connection with the farmer as well as production practices that are considered "natural" such as "no added hormones" and "no antibiotics." Overall, retailer and foodservice entities reinforced the importance of diet of an animal as it was related to lamb quality. Sepulveda et al. (2011) found that Spanish consumers considered animal feeding the most important quality aspect related to animal production and lamb quality. A portion of industry respondents in this current research were aware that diet impacts lamb flavor profile, but preferences for grass fed and grain fed lamb were variable on perceived preferences. According to responses from "What is the image of American Lamb?" retail and foodservice companies envision sheep being raised on lush green

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pastures, or in wide open spaces and grazing on mountainside terrain in the American West.

Sepulveda et al. (2011) documented that more frequent consumers of lamb in Spain emphasize

feeding regimes and animal breed more so than environmentally friendly production methods at

purchase. However, based on industry responses conducted in U.S. interviews, a preference

toward grass-fed and pasture-raised descriptions of sheep production are important to companies

closest to the consumer, and the potential for marketing lamb with an emphasis on animal diet

currently exists among retail and foodservice buyers.

Product Appearance/Composition

The quality attribute of product appearance and composition was commonly described as

lean to fat ratio (39.2%), fresh lamb color (31.7%), freshness (21.7%), and attractive appearance

(20.8%). Definitions most commonly summarized as lean to fat ratio or an indication of lamb

cutability ranked highest for supermarkets, casual dining, and purveyors, and was in the top three

for the remaining interviewed sectors. Butchers most commonly defined product appearance and

composition as fresh lamb color as the most important attribute for appearance of lamb. The

direct marketer focused on an overall attractiveness and eye appeal of the lamb product, followed

by lean to fat ratio, and packaging ranked third. Fresh color was not as important to direct

marketers because lamb at a farmer's market was often merchandised frozen. Overall

presentation of lamb inherently differed between retail and foodservice sectors. Purchasers of

lamb at retail, foodservice, and purveyor sectors emphasize cutability by considering overall

trimness important to how product appearance/composition related to lamb quality. Freshness

was the most common descriptor of appearance for fine dining industry respondents. A fresh,

attractive appearance with an eye appealing red color was most important at retail, and a

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consistent, fresh product was preferred with a reasonable fat trim level at the foodservice and purveyor sectors.

Weight/Size

The weight and size quality attribute was primarily influenced by consistency and uniformity of lamb product. Consistent cut size and consistent cut weight were of greatest importance for fine dining and casual dining companies. The consistency of product that "comes in the door" at restaurants was very critical to their business as plate costs and visual uniformity of lamb served to customers was considered dependent on product weight and size. While consistency ranked high with retailers, live weight of animal for the direct marketer, and carcass weight specifications for supermarkets and butchers were of the greatest importance for lamb weight and size quality attribute. A disconnect existed on preferred size of lamb carcasses and cuts between sectors. A total of 40% of purveyors preferred bigger lamb cuts as they operated a margin business and also catered to restaurants requesting larger sized middle meats. However, carcass and cut size were considered too big (38.7%) for lamb purchasers representing supermarkets and was noted by 22.2% of direct marketers. This challenge is not new and, in fact, the industry can be commended for finding avenues of sale for all sizes and shapes of lambs produced in the United States. A purveyor respondent stated, "We need to produce shoulder and legs from lambs with a small hot carcass weight, and the rack and loin from lambs with a large hot carcass weight." Thus, different markets exist for different sized products, but as consistency and uniformity are also very important, a question remains of how to ensure weight and size specifications for retail, foodservice, and end-user customers.

Nutrition/Wholesomeness

The safety of and healthfulness of lamb was categorized together as a quality attribute in this current study. Healthy was most often used to describe nutrition/wholesomeness for fine dining (26.8%) and casual dining (27.3%), and was rated second for butcher (27.3%) and direct lamb marketers (27.8%). Lean was another term used to describe lamb and was the most common answer for butchers (27.3%). Feeding regime, or a description of what the animal ate, was mentioned by all sectors except purveyor. A connection exists with retail and foodservice representatives that what the sheep eats plays a factor with overall lamb product nutrition. In fact, supermarket interview respondents identified grass-fed (16.1%) and all-natural (16.1%) as the first impression of what lamb nutrition/wholesomeness means to them. Cabrera and Saadoun (2014) concluded that different contents of fatty acids, vitamins, and minerals occurred in both lamb and beef produced from differing diets and production management in South American countries. Also, lamb purchasers from fine dining (21.7%) and purveyor (20.0%) sectors indicated that consumers do not eat lamb for health or nutrition; instead, consumers were more focused on eating satisfaction. Food safety was considered a strength for lamb, and should be considering the clean food safety record compared to other foods. Food safety has been acknowledged as an important quality attribute, and consumers can be categorized as either price sensitive or safety sensitive in their purchasing decisions (Rohr et al., 2005). Food safety was most often mentioned by purveyors (26.7%), and occasionally by supermarket (9.7%) representatives. Overall, lamb was considered a wholesome product, and was considered a healthy red meat option for consumption. Additionally, the sheep raising practices of an animal have been associated with end product healthfulness and further consideration of ways to capitalize on this connection may be advantageous.

Product Convenience/Form

An increased demand for convenience food products were identified as trends for food purchasing decisions (Botonaki and Mattas, 2010; Brunner et al., 2010). The quality trait of Product Convenience/Form for lamb was most frequently described by availability, packaging, and product specifications. Availability was the most mentioned definition for butchers, direct marketers, and purveyors. These sectors indicated that convenience of the product can be limited by the ability to purchase/merchandise lamb throughout the year. The interview respondents representing the supermarket and casual dining segments of the industry highlighted the need for cut specifications of lamb that fit their company preferences. Additionally, packaging types and methods including vacuum packaged (29.0%) and pre-packaged cuts (29.0%) were important in the supermarket sector. Portion size uniformity (30.4%) was the most prominent answer for fine dining respondents to characterize a company's first impression related to product convenience and form. Uniformity of product specifications, proper and attractive packaging, and overall availability of lamb were all identified as critical to lamb quality.

Willingness to Pay

The probability of a non-negotiable requirement, or a result of either no premium or a potential premium, as well as a WTP for seven quality attributes for lamb are reported in Table 3.7. The scenario for determining WTP for a specified attribute was first dependent if the trait was a non-negotiable requirement, meaning that under no circumstances would the business be interested in purchasing lamb without that assurance of that specific trait being provided. Next, the interview respondents answered whether they were willing to pay a premium, and average premium percentages within sector were calculated and recorded.

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The likelihood of an attribute being a non-negotiable requirement was the most frequent for credence attributes of origin (25.8%) and sheep raising practices (20.0%). Butchers identified that the characteristics of origin was a non-negotiable requirement, or a "must have", 45% of the time which was greater than casual dining (9.0%) and purveyors (7.0%). Also, supermarket representatives considered origin (39.0%) a must have more than casual dining. Butchers (45.0%) considered sheep raising practices a non-negotiable requirement at the greatest probability. Due to purveyors often carrying both domestic and imported lamb product, purveyor interview respondents most commonly (40.0%) chose not to offer a premium for origin. Further analysis showed that purveyors (53%) were the least likely for willingness to pay a premium for sheep raising practices. Due to portion size uniformity and menu decisions at fine dining, fine dining establishments were the most willing (57%) to offer a premium for uniform weight and size, specifically compared to either supermarkets (23%) or direct/farmer's markets (17%).

Butchers (23.2%), supermarkets (18.0%), and purveyors (11.0%) were willing to pay the greatest premium percent for the product appearance/composition quality attribute. This reinforced the importance for these sectors to not only provide an attractive package for a retail case, but also have a reasonable (trimmed) amount of external fat on product that was merchandised within these sectors. Interview respondents from casual dining, fine dining, casual dining, and direct farmer's market emphasized the importance of eating satisfaction as their most important quality attribute and highest percent premiums with an average willingness to pay if eating satisfaction could be assured at 24.8%, 19.7%, and 15.8%, respectively. This reiterated that eating satisfaction, most commonly defined as lamb flavor, was of the utmost importance to lamb industry representatives that focused on foodservice consumption of lamb.

Within each sector of the industry, the quality attribute that garnered the least potential premium for butchers was origin (12.1%), and if supermarkets and direct/farmer's markets were willing to pay a premium for an attribute, it was the lowest for weight and size with premiums of 10.6% and 6.4%, respectively. Additionally, product convenience and form had the lowest average willing to pay premium (12.6%) among those buyers that wished to assure that quality trait compared to all traits, and fine dining (12.0%), casual dining (8.6%), and purveyors (5.6%) indicated the lowest average percent willingness to pay for quality traits that were characterized for product convenience/form.

Eating satisfaction (71.7%) easily resulted in the greatest percent of respondents willing to pay a premium if quality could be assured, and the greatest percent premium (18.6%). Across all segments of the lamb industry interviewed, sheep raising practices (52.5%), product appearance/composition (52.5%), origin (51.7%), and nutrition/wholesomeness (47.5%) were similar for being willing to pay a premium for a specific quality attribute. Product convenience/form (38.3%) and weight/size (34.2%) quality attributes resulted in the least likelihood of a company being willing to pay a premium for the specified quality attribute.

For each respective quality attribute it also was important to evaluate which segment of the industry would have the greatest willingness to pay for each respective quality attribute described in this study. Fine dining establishments were willing to pay the greatest premium when compared to other sectors for eating satisfaction (24.8%), sheep raising practices (20.3%), origin (19.4%), and nutrition/wholesomeness (18.5%). These results also indicated that consumers of fine dining establishments that purchase lamb would be willing to absorb the menu price increase and purchase a quality lamb product if they could be assured of receiving the aforementioned quality traits. The traits that were most often defined by the fine dining sector

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for these attributes included lamb flavor, grass-fed and no antibiotics, locally raised, and healthy. Butcher's markets were willing to pay the greatest premiums when compared to other sectors for product appearance/composition (23.2%) and weight/size (16.8%) attributes of lamb quality. These results showed that product composition related to fresh lamb color, product attractiveness, reasonable fat trim level, carcass weight specifications, and consistent cut size and weight were of the most value to butchers in the lamb supply chain. Supermarket interview respondents identified the importance of vacuum packaging and pre-packaged cuts along with correct cut specifications as having the greatest potential value and WTP premium for the product convenience and form (17.4%) quality attribute.

With all interview respondents (N = 120), not only did eating satisfaction receive the greatest percent willing to pay a premium, but also had the greatest average WTP (18.6%) premium, more than three percentage points greater than all other attributes. The order of WTP premiums offered by interview respondents to assure specific quality attributes were: product appearance/composition (14.9%), origin (14.2%), sheep raising practices (14.2%), weight/size (13.8%), nutrition/wholeness (13.6%), and product convenience/form (12.7%). With an aggregated premium percent if all attributes could be assured, the order of greatest willingness to pay in descending order was: 1) fine dining (81.4%); 2) butcher (65.6%); 3) casual dining (57.6%); 4) supermarket (41.0%); direct/farmer's market (39.2%); and purveyor (26.5%). This indicated that fine dining restaurants were willing to provide the greatest economic incentives for producers and the supply chain to assure quality attributes of lamb. Additionally, customers at fine dining establishments expected the highest quality lamb, and were willing to pay for it. As an executive chef of a high end steakhouse stated, "We provide celebrations in life. Lamb is part of that celebration."

Lamb Quality Strategy Workshop

A Strategy Workshop was conducted by Colorado State University, The Ohio State University, and the American Lamb Board to present results to all lamb supply chain stakeholders. The attendees developed goals, a vision, and an action plan from findings of the aforementioned research project. The proposed mission was to: Improve the consistency of quality, cutability, and marketability of American Lamb with a consumer driven focus. With a consumer-centric goal for American Lamb, three strategic goals were created to drive the future progress associated with the quality of lamb produced in the U.S. including:

1) Address factors contributing to lamb flavor, their impact on consumer satisfaction, and align flavor characteristics with target markets.

2) Improve lamb management to hit market-ready targets for product size, composition, and eating satisfaction while reducing production costs.

3) Identify and capitalize on market opportunities for American Lamb.

A twenty-five person focus group that represented all sectors of the lamb supply chain attended the Strategy Workshop. A total of 64% of workshop participants ranked the primary goal as added emphasis on lamb flavor and its impact on consumer satisfaction. A resulting action plan was to: develop a Total Quality Management approach for lamb flavor. This management strategy should be utilized to identify and eliminate practices that contribute to negative lamb flavor attributes and insure the utilization of best practices that provide eating satisfaction. Also, an assessment to determine current diversity in lamb flavor and define consumer flavor preferences and expectations in the market place for American Lamb would assist to identify our target. Lastly, the industry planned to develop rapid, processing plant-based tools to identify flavor attributes and compounds, segregate current lamb product supply into

groups that fit market channels, and implement value-based marketing that delivers predictable flavor.

The second goal to address future improvement in American Lamb Quality was focused on actual lamb management with targets for product size, composition, and eating satisfaction. The continued importance of value-based marketing was considered essential to deliver market signals for premium quality and appropriate size and composition. Inherent industry challenges of seasonal supply and demand create a challenge of excess fat that must be addressed. An action plan was created to identify and communicate the cost of fat to each segment (producer to consumer) of the lamb industry, and identify market factors that lead to compositional challenges, and strive to reduce the YG 4s and YG 5s. Lastly, the industry should communicate best management practices on the sheep/lamb supply chain and decisions that affect end product lamb quality through an all-encompassing, brief, and interactive approach.

The third goal as determined by Strategy Workshop participants was to identify and capitalize on market opportunities for American Lamb. Producers that wish to direct market as well as retailers can identify and capitalize on market opportunities (e.g. local, sheep raising practices, SSQA, etc.). The U.S. sheep and lamb industry should continue to promote the lamb story at the point of purchase (story lamb, source verified, market claims, environment, etc.).

Lastly, an opportunity exists to mirror the farmer's market and local trends that verify and locally source lamb to be branded and differentiated in the market place. The Strategy Workshop provided opportunity for industry participants to create a direction for future action in the quest for continuous improvement of quality, cutability, and marketability of American Lamb.

CONCLUSIONS

This research can be used to determine goals and objectives for producers to implement to improve the quality, consistency, value, and competitiveness of lamb. Information from this research provided a rank and quantification of quality attribute preference, the likelihood of "must have" quality attributes for purchase, and an estimate of percent increased value of lamb products when a quality attribute was guaranteed for lamb.

Most importantly from this study, market sectors closest to consumers placed a continued emphasis on eating satisfaction, primarily described as lamb flavor. Eating satisfaction garnered the greatest shares of preference, greatest likelihood to pay a premium, and the greatest dollar value premium offered if the quality trait could be assured.

When asked to define quality in open-ended questions, over one-third of respondents (45 out of 120) identified lamb flavor and/or taste as part of their definition of quality. The most frequent responses were simply "flavor or taste" (n = 23); six respondents answered "good flavor" and another six respondents noted "flavorful" as a definition of quality. Few interview respondents actually chose to describe lamb flavor, reinforcing the vague interpretation of lamb eating satisfaction, yet most common descriptors included "rich flavor" and "mild or medium flavor." Open-ended questions warranted responses that lamb flavor of American lamb was mentioned 34 times as a strength, 14 times as a weakness, 21 times as an opportunity, and 11 times as a threat to the industry. When lamb industry respondents closest to the consumer were asked what is the image of American lamb, respondents identified lamb as having "good flavor" (n = 5), "milder flavor" (n = 4), flavorful (n = 3), and "different than grass flavor" (n = 3). Responses regarding the image of imported lamb resulted in lamb described as "less flavorful" (n = 6), "gamey flavor" (n = 5), "different flavor" (n = 5), "stronger flavor" (n = 4), and "consistent

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flavor" (n = 3). According to the retail and foodservice interviewed, an overall perception of

American lamb (that is primarily grain-fed) induced an overall milder, and more approachable

flavor for American consumers. Yet, a perception that a majority of lamb in the U.S. are grass-

fed existed among those closest to the consumer.

Compared to the 2011 NBQA, where food safety ranked first in importance, interview

respondents in the present study only ranked the combination of product wholesomeness and

nutrition as sixth in importance (Igo et al., 2013). Previous experience suggests that most sheep

producers believe that product composition is the primary detrimental characteristic causing loss

in consumer demand. Results of the present study indicated that cutability, or lean to fat ratio,

was top of mind for interview respondents followed by color, attractiveness, and freshness to

those that display lamb at retail. Overall lean to fat challenges of the industry can be partially

mitigated at the processing fabrication floor and a combination of freshness and cutability are

important to lamb quality.

The image of American lamb was strong with a majority of retail and foodservice

markets. A predominant image was of sheep grazing in the Mountain West, or lambs frolicking

in lush, green pastures. The sheep/lamb industry has an advantage compared to competing

proteins as interview respondents indicated that environmental stewardship of the American

sheep rancher/farmer resulted in a perceived greater sustainability marketing angle.

Credence attributes of origin and sheep raising practices also proved important to retail

and foodservice sectors of the lamb supply chain. A segment of consumers hold an allegiance to

American lamb, yet origin was most commonly defined by industry respondents as local or

locally raised. A recurring theme of this study was a request for locally- and regionally-

produced lamb for the retail case and restaurant menus. Nearly one-third of respondents

indicated that an American Certified Lamb program would not be a good idea for a variety of reasons, and there was little agreement on what traits, if any, would be preferred or required. Respondents suggested that a Certified American Lamb program would not benefit the industry because either the program would be too broad and incorporate all American lamb, or potentially too specified based on selection criteria. The specified quality attribute of sheep raising practices was most commonly defined as grass-fed by retail and foodservice sectors of the industry. An evident disparity in preferences for sheep raising practices existed between current for U.S. grain-finishing management versus grass-finishing of lamb.

A strategic emphasis on quality attributes identified in this research should strive to ensure that eating satisfaction and lamb flavor are optimized for American lamb, and to produce lamb with credence attributes that may be valuable for sheep producers and requested by retail and foodservice sectors, and inevitably American lamb consumers. Results from this study can be used to identify areas within each sector, as well as across all sectors, that the sheep and lamb industry needs to focus on to achieve continuous improvement and to increase demand for American lamb.

Table 3.1. Coefficient estimates (SE) and shares of preference [SD] for all interview respondents (N = 120) relative to Product Convenience/Form.

Quality Attribute[1]	Econometric Estimates MNL	Shares of Preference (%) MNL
Eating Satisfaction	2.221*	38.9[2a]
	(0.102)	[1.8]
Origin	1.406*	17.2[b]
	(0.095)	[1.0]
Sheep Raising Practices	1.165*	13.5[c]
	(0.093)	[0.9]
Product Appearance/ Composition	0.912*	10.5[d]
	(0.083)	[0.6]
Weight/Size	0.694*	8.5[e]
	(0.090)	[0.6]
Nutrition/Wholesomeness	0.524*	7.1[f]
	(0.089)	[0.5]
Product Convenience/Form	0.000	4.2[g]
	(0.000)	[0.3]
N individuals	120	
N Choices	1080	
Log likelihood	-1764	
Pseudo R^2	0.1867	

[1] Seven quality attributes were compared and reported with economic parameter estimate and shares of preference after Monte Carlo simulation.

[2] Mean of simulated shares of preference of 1,000 observations drawn from a multivariate normal distribution parameterized by using the coefficients and variance-covariance terms estimated by the MNL models in SAS® MDC.

* Implies that the mean importance of the coefficient estimate is different from product convenience/ form when ($P < 0.05$).

[a,b,c,d,e,f,g] Percentages in the same column lacking a common superscript differ ($P < 0.05$).

Table 3.2. Shares of preference probabilities of seven quality attributes for supermarket, butcher, and direct/farmer's market sectors.

Supermarket		Butcher		Direct/Farmer's Market	
SOP[1]	Quality Category	SOP	Quality Category	SOP	Quality Category
39.2%	Eating Satisfaction	38.6%	Eating Satisfaction	27.8%	Eating Satisfaction
18.2%	Origin	23.4%	Origin	22.4%	Sheep Raising Practices
16.5%	Product Appearance/ Composition	19.0%	Sheep Raising Practices	21.2%	Origin
8.2%	Weight/Size	7.4%	Weight/Size	8.4%	Product Appearance/ Composition
7.0%	Sheep Raising Practices	5.2%	Product Appearance/ Composition	8.4%	Nutrition/ Wholesomeness
6.0%	Nutrition/ Wholesomeness	5.1%	Nutrition/ Wholesomeness	7.8%	Weight/Size
4.9%	Product Convenience/ Form	1.3%	Product Convenience/ Form	4.1%	Product Convenience/ Form

[1]SOP = shares of preference. Response data were evaluated as the number of times that interviewees in each market sector identified the category as most important.

Table 3.3. Shares of preference probabilities of seven quality attributes for fine dining, casual dining, and purveyor sectors.

Fine Dining		Casual Dining		Purveyor	
SOP[1]	Quality Category	SOP	Quality Category	SOP	Quality Category
48.8%	Eating Satisfaction	54.3%	Eating Satisfaction	27.9%	Eating Satisfaction
20.5%	Sheep Raising Practices	13.7%	Sheep Raising Practices	20.4%	Weight/Size
12.7%	Origin	12.1%	Origin	16.5%	Product Appearance/ Composition
6.4%	Product Appearance/ Composition	5.6%	Product Appearance/ Composition	14.3%	Origin
5.5%	Nutrition/ Wholesomeness	5.4%	Weight/Size	7.7%	Nutrition/ Wholesomeness
4.0%	Weight/Size	5.3%	Nutrition/ Wholesomeness	7.7%	Sheep Raising Practices
2.2%	Product Convenience/ Form	3.6%	Product Convenience/ Form	5.5%	Product Convenience/ Form

[1]SOP = shares of preference. Response data were evaluated as the number of times that interviewees in each market sector identified the category as most important.

Table 3.4. Categorized responses from interviewed companies defining what seven quality attributes mean to their company as it relates to lamb. Response with a frequency of equal to or greater than 10% are reported.

Eating Satisfaction		Origin		Sheep Raising Practices		Product Appearance/ Composition		Weight/Size		Nutrition/ Wholesomeness		Product Convenience/ Form	
Definition[1]	Freq.[2]	Definition	Freq.	Definition	Freq.	Definition	Freq.	Definition	Freq.	Definition	Freq.	Definition	Freq.
Lamb Flavor/ Taste	75.8%	Locally Raised	44.2%	Grass-Fed	37.5%	Lean to fat ratio	39.2%	Consistent Cut Size	32.5%	Healthy	19.2%	Availability	20.8%
Tenderness	32.5%	American	25.0%	Humanely Raised	21.7%	Fresh Lamb Color	31.7%	Consistent Cut Weight	24.2%	Lean	14.2%	Cut Specifications	15.8%
Customer Satisfaction	31.7%	Region/ State	20.0%	Feeding Regime	15.8%	Freshness	21.7%	Carcass Weight	20.0%	Nutritious	10.0%	Pre-Packaged Cuts	14.2%
Consistency	10.0%	Traceable Product	19.2%	Animal Well-Being	15.8%	Attractive Appearance	20.8%	Cut Specifications	16.7%			Portion Cut/ Uniformity	14.2%
Product Quality	10.0%	Colorado	10.0%	Antibiotic Free	15.0%	Product Quality	15.8%	Carcass/Cuts Too Big	14.2%			Vacuum Packaged	12.5%
				No Added Hormones	12.5%								

[1] Definition = the interview response for the definition or description of seven quality attributes.
[2] Freq. = Most frequent responses (=/> 10.0%) in descending order. Response data were evaluated as the number of times that interviewees in each market sector identified the attribute as a definition or description of the given category divided by the total number of responses (N = 120).

Table 3.5. Frequency of responses for the definition of eating satisfaction quality attribute for three classifications of the retail sector.

Category		Supermarket (n = 31)			Butcher (n = 11)			Direct/Farmer Market (n = 18)	
		Definition	Freq.		Definition	Freq.		Definition	Freq.
Eating Satisfaction	1	Lamb Flavor/Taste	80.6%	1	Lamb Flavor/ Taste	100.0%	1	Customer Satisfaction	50.0%
	2	Tenderness	38.7%	2	Tenderness	63.6%	2	Lamb Flavor/Taste	44.4%
	3	Customer Satisfaction	35.5%	3	Product Quality	27.3%	3	Tenderness	16.7%
Origin	1	American	48.4%	1	Locally Raised	63.6%	1	Traceable to Ranch	72.2%
	2	Locally Raised	38.7%	2	American	27.3%	2	Locally Raised	50.0%
	3	Region/State	25.8%	3	Traceable	18.2%	3	Know the Farmer	16.7%
				3	Region/State	18.2%			
Sheep Raising Practices	1	Grass-Fed/Pasture Raised	41.9%	1	Grass-Fed	45.5%	1	Grass-Fed	33.3%
	2	Humanely Raised	25.8%	2	Grain-Fed	36.4%	2	Breed	22.2%
	3	Animal Well-Being	22.6%	3	Family Farmer	27.3%	2	How they are raised	22.2%
				3	Environment	27.3%	2	Humanely Raised	22.2%
				3	Humanely Raised	27.3%			
Product Appearance/ Composition	1	Lean to Fat Ratio	54.9%	1	Fresh Lamb Color	45.5%	1	Attractive/Eye Appeal	44.4%
	2	Fresh Lamb Color	51.6%	2	Attractive/Eye Appeal	27.3%	2	Lean to Fat Ratio	33.3%
	3	Freshness	32.3%	2	Lean to Fat Ratio	27.3%	3	Packaging	22.2%
Weight/Size	1	Carcass/Cuts Too Big	38.7%	1	Carcass Weight	36.4%	1	Live Weight	44.4%
	2	Consistent Cut Size	38.7%	2	Consistent Cut Size	27.3%	2	Carcass Weight	27.8%
	3	Consistent Cut Weight	19.4%	2	Consistent Cut Weight	27.3%	3	Carcass too big	22.2%
	3	Carcass Weight	19.4%				3	Consistent Cut Weight	22.2%
Nutrition/ Wholesomeness	1	Grass-Fed	16.1%	1	Lean	27.3%	1	Protein	27.8%
	1	All-Natural	16.1%	1	Healthy	27.3%	1	Healthy	27.8%
	3	Nutritious	12.9%	3	Grain-Fed	18.2%	3	Nutritious	22.2%
	3	Feeding Regime	12.9%	3	Customer Satisfaction	18.2%			
				3	Chemical Free	18.2%			
Product Convenience/ Form	1	Cut Specifications	32.3%	1	Availability	27.3%	1	Availability	33.3%
	2	Vacuum Packaged	29.0%	2	Inaccessible	18.2%	2	Portion Uniformity	27.8%
	2	Pre-Packaged Cuts	29.0%	2	Service/Delivery	18.2%	3	Packaging	16.7%
							3	Further Processed	16.7%

Table 3.6. Frequency of responses for the definition of eating satisfaction quality attribute for three classifications of the foodservice sector.

Category		Fine Dining (n = 23)			Casual Dining (n = 22)			Purveyor (n = 15)	
		Definition	Freq.		Definition	Freq.		Definition	Freq.
Eating Satisfaction	1	Lamb Flavor/ Taste	82.6%	1	Lamb Flavor/ Taste	77.3%	1	Lamb Flavor/Taste	73.3%
	2	Texture/ Mouthfeel	26.1%	2	Customer Satisfaction	40.9%	2	Tenderness	46.7%
	2	Fat Content	26.1%	3	Tenderness	22.7%	3	Customer Satisfaction	40.0%
Origin	1	Locally Raised	39.1%	1	Locally Raised	50.0%	1	Locally Raised	33.0%
	2	Colorado	26.1%	2	Traceable source	31.8%	1	Where They Are Raised	33.0%
	3	Region/State	21.7%	3	Region/State	27.3%	3	Region/State	20.0%
							3	Australia	20.0%
							3	New Zealand	20.0%
Sheep Raising Practices	1	Grass-Fed	21.7%	1	Grass-Fed	63.6%	1	Animal Well-Being	40.0%
	1	Antibiotic Free	21.7%	2	Feeding Regime	22.7%	2	Feeding Regime	20.0%
	3	Know your Farmer	17.4%	3	No Added Hormones	18.2%	2	Humanely Raised	20.0%
	3	Animal Care	17.4%	3	No Antibiotics	18.2%	2	Antibiotic Free	20.0%
	3	Humane Treatment	17.4%	3	Humanely Raised	18.2%			
	3	No Added Hormones	17.4%						
Product Appearance/ Composition	1	Freshness	39.1%	1	Lean to Fat Ratio	31.8%	1	Lean to Fat Ratio	60.0%
	2	Product Quality	34.8%	2	Consistent	18.2%	2	Fresh Lamb Color	33.3%
	3	Lean to Fat Ratio	30.4%	3	Fresh Lamb Color	13.6%	3	Muscling	26.7%
	4	Uniform Size	26.1%	3	Freshness	13.6%			
				3	Butchery	13.6%			
Weight/Size	1	Consistent Cut Size	39.1%	1	Consistent Cut Weight	36.4%	1	Cut Specifications	46.7%
	2	Consistent Cut Weight	30.4%	2	Consistent Cut Size	31.8%	2	Consistent Cut Size	40.0%
	3	Carcass Weight	13.0%	3	Cut Specifications	22.7%	2	Bigger Cut Preferred	40.0%
Nutrition/ Wholesomeness	1	Healthy	26.8%	1	Healthy	27.3%	1	Food Safety	26.7%
	2	Feeding Regime	21.7%	2	Lean	22.7%	2	Don't Eat Lamb For Nutrition	20.0%
	2	Lean	21.7%	3	Feeding Regime	18.2%	3	USDA Inspected	13.3%
	2	Eating Satisfaction	21.7%				3	All-Natural	13.3%
	2	Don't Eat Lamb For Health	21.7%				3	Customer Satisfaction	13.3%
Product Convenience/ Form	1	Portion Size Uniformity	30.4%	1	Cut Specifications	31.8%	1	Availability	33.3%
	2	Pre-Packaged Cuts	21.7%	2	Trimmed Product	13.6%	2	Packaging	26.7%
	3	Availability	13.0%	2	Consistency	13.6%	3	Vacuum Packaged	13.3%
	3	Timely	13.0%	2	Packaging	13.6%	3	Frenched Product	13.3%
							3	Boneless Cuts	13.3%

Table 3.7. Probability (in percent) of non-negotiable requirement, no premium, and premium, and willingness to pay for quality attributes across retail, foodservice, and purveyor sectors.

Location	WTP[1]	Eating Satisfaction	Origin	Sheep Raising Practices	Product Appearance/ Composition	Weight/ Size	Nutrition/ Wholesomeness	Product Convenience/ Form
Supermarkets	Reqt.	13%	39%	23%	19%	16%	6%	13%
	No Prem.	29%	23%	32%	35%	61%	52%	52%
	Premium	58%	39%	45%	45%	23%	42%	35%
	Premium, %	15.63%	13.24%	10.95%	18.04%	10.64%	12.18%	17.37%
Butchers	Reqt.	0%	45%	45%	9%	19%	0%	0%
	No Prem.	9%	18%	18%	36%	36%	45%	55%
	Premium	91%	36%	36%	55%	45%	55%	45%
	Premium, %	21.27%	12.12%	15.83%	23.18%	16.76%	18.43%	12.64%
Direct/Farmers Market	Reqt.	0%	28%	22%	0%	33%	0%	6%
	No Prem.	22%	22%	11%	44%	50%	61%	56%
	Premium	78%	50%	67%	56%	17%	39%	39%
	Premium, %	15.84%	9.89%	10.77%	8.46%	6.40%	8.60%	14.54%
Fine Dining	Reqt.	13%	26%	22%	4%	0%	0%	4%
	No Prem.	9%	9%	13%	43%	43%	35%	48%
	Premium	78%	65%	65%	52%	57%	65%	48%
	Premium, %	24.83%	19.43%	20.29%	17.08%	16.65%	18.45%	11.99%
Casual Dining	Reqt.	14%	9%	9%	5%	5%	0%	5%
	No Prem.	9%	27%	36%	27%	59%	55%	55%
	Premium	77%	64%	55%	68%	36%	45%	41%
	Premium, %	19.72%	15.64%	15.99%	12.55%	14.95%	13.59%	8.61%
Purveyors	Reqt.	7%	7%	7%	13%	13%	0%	0%
	No Prem.	33%	40%	53%	47%	53%	60%	80%
	Premium	60%	53%	40%	40%	33%	40%	20%
	Premium, %	11.24%	9.00%	8.42%	11.33%	10.58%	5.97%	5.57%
ALL Interviews	Reqt.	9.17%	25.83%	20.00%	9.17%	13.33%	1.67%	5.83%
	No Prem.	19.17%	22.50%	27.50%	38.33%	52.50%	50.83%	55.83%
	Willing to Pay a Premium (SE)	71.67% (4.1)	51.67% (4.6)	52.50% (4.6)	52.50% (4.6)	34.17% (4.3)	47.50% (4.6)	38.33% (4.5)
	Average WTP Premium	18.59% (n = 86)	14.17% (n = 62)	14.17% (n = 63)	14.88% (n=63)	13.82% (n = 41)	13.64% (n = 57)	12.66% (n =46)

[1] Requirement = odds of category identified as a non-negotiable requirement; No Premium = odds a sector would not be willing to pay a premium; Premium = odds a sector would be willing to pay a premium; Premium, % = average percent premium WTP.

CHAPTER IV

PRODUCT ATTRIBUTES AND VALUE OF BRANDING FOR LAMB IN U.S. RETAIL
MARKETS

INTRODUCTION

Product sales for lamb are the result of demand at retail and foodservice market venues.

Lamb merchandised at foodservice as a center of the plate protein is commonly associated with

white table cloth restaurants and a high-end dining experience. Conversely, supermarkets,

butchers, and farmer's markets sell a greater variety of cuts of lamb at retail and have a greater

disparity of price point per kg. Lamb merchandised at retail can be explained through a

collection of attributes, and specified characteristics can be measured through economic analysis

and hedonic modeling to quantify an expected value to customers. Previous research conducted

by Ward et al. (2008) evaluated the value that consumers place on identifiable attributes of fresh

beef (ground beef and steaks/roasts) products from 66 grocery stores in 3 cities. Fundamental

factors that influenced beef price included cut type and USDA quality grade, while

demographics of store location, product packaging presentation, branding, and labeling claims

further explained price differences of beef steaks and roasts (Ward et al., 2008).

Researchers evaluated preferences for lamb with consumers from Spain, France, and

United Kingdom regarding country of origin, feeding systems, and price levels and determined

that country of origin of meat had the greatest influence for purchasing decisions for European

lamb consumers (Font i Furnols et al., 2011). Consumer preferences of red meat protein in the

American marketplace has focused more on beef than lamb. Research conducted by Mennecke

et al. (2007) indicated that the ideal beef steak is locally produced, traceable to the farm of

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origin, USDA Choice, Angus, and fed a mixture of grass and grain. Franken et al. (2011) evaluated beef purchasing decisions and identified quality attributes in descending order of importance: U.S produced, all-natural, grass-fed/lean, locally produced, nature friendly, organic, and low carbon footprint. An understanding of the target for lamb production, packaging, and labeling would provide insight to implicit value of product attributes.

The theory of hedonic price modeling allows for the predicted quantification of a consumer's value for a specified set of product attributes. The demand for a specific trait or label claim can be measured by the magnitude and sign of numerical coefficients calculated from hedonic price regressions. The opportunity to collect retail information through store scanner data and incorporate hedonic price modeling exists, and may provide information on consumer purchasing habits (Martinez-Garmendia, 2010). An evaluation of the value of beef steak brands and product attributes was conducted through retail scanner data and showed that brands that included breed specification, store specification, regional location, and special labels with production claims garnered an increased premium (Schulz et al., 2010). Availability of retail scanner data of lamb is limited, and a price comparison of different products and labeling claims would be challenging. Consequently, this research provided a snapshot of the U.S. marketplace for lamb available for purchase at retail through actual product transactions. The objectives of this research included: a) document any product quality-related or financial items of concern to retail lamb customers and quantify their importance; b) collect price and product characteristic data for lamb products available for sale at the U.S. retail marketplace; and c) determine the value of retail lamb attributes for cuts presented at retail stores through hedonic pricing model.

MATERIALS AND METHODS

Fresh, retail lamb cuts were purchased from retail stores in 12 locations in 11 states: California (San Francisco and Los Angeles), Colorado, Florida, Georgia, Illinois, New York, Ohio, Texas, Utah, Washington, and Wisconsin. Shoulder chops (N = 148) were collected from 46 stores in 10 states. As shoulder chops were abundantly available at a cross-section of retail markets with customers from low, medium, and high socioeconomic status, and because shoulder chops were most often offered in self-service, it portrayed the best representation of price comparison at the retail level. Loin (N = 567) and rib (N = 114) chops were collected from 62 stores in 11 states to characterize the lamb merchandised at U.S. retail markets. Loin chops were purchased and evaluated because of the importance and prevalence in the retail sector for the lamb industry.

A minimum of 4 retail chain stores were sampled in each metropolitan area. Product was obtained from prominent stores in the area, as well as from local butcher markets and farmer's markets. Lamb product was kept fresh, and was chilled during shipment. Previous research from Howard et al. (2013) indicated that tenderness evaluations for beef could be improved with frozen shipment, but logistics in this study required fresh shipment. Lamb products were shipped in insulated shipping containers with ice, with priority overnight delivery to Colorado State University and The Ohio State University. Lamb was vacuum packaged and frozen for further analysis. Products were identified with purchase location, store code, and individual identification number. Price per unit and total price were collected as well as all branded lamb product specifications. Resulting data were evaluated to characterize the current fresh lamb supply at retail and current lamb quality that represent the U.S., Australia, and New Zealand lamb products that were available at retail for consumers.

A digital image of each steak was captured for each cut surface area; muscle dimensions, external fat thickness, and total area were recorded with standardized grid evaluation and computer software. Each image was assigned a unique identification number including purchase location, store code, and individual identification number. Product attribute comparisons were completed blinded, and subsequent comparisons were paired with lamb product specifications, branded label claims, and respective price for analysis. Products from the rack and loin were vacuum packaged for further shear force analysis the day of arrival at the respective meat laboratories. Warner-Bratzler Shear Force was conducted for rack and loin chops of the *longissimus* muscle. Analysis of visual physical attributes were compared by country of origin (U.S., Australia, and New Zealand) and from label claim indication (grass-fed vs. grain-fed) production management practices. Resulting data were evaluated to characterize the current fresh lamb supply at retail and current lamb quality that represent the U.S., Australia, and New Zealand lamb products available at retail for consumers.

DATA ANALYSIS

Labeling information for lamb shoulder and loin chops purchased at retail were collected and analyzed. Retail price per kg was compared and analyzed for effects of country of origin (U.S., Australia, and New Zealand), store location (West, Central, and East), store type (National, Local, and Specialty), and packaging type (overwrap, vacuum packaged, rollstock, modified atmosphere packaging, and full-service). Shoulder and loin chops were analyzed by price per kg at retail compared to specific labeling claims found on packaging, including branded program (Source/Store/None), local designation (Y/N), production management type (Grass-fed/Grain fed), No Hormone/No Antibiotic (Y/N), and Natural (Y/N). The no hormone and no

antibiotic label designation also included no animal by-products, and was commonly referred to as "Never-Ever 3" (i.e., a USDA-AMS process verified product).

Comparisons of lamb product price was conducted that evaluated least squares means of lamb shoulder and loin chops of specified retail lamb attributes. A hedonic pricing model was utilized to determine implicit value of country of origin, store type/location, packaging type, and labeling claims of lamb at U.S. retail markets. Means comparisons only evaluate one attribute at a time, while hedonic price modeling allows for the incorporation of all product attribute data to be evaluated aggregately and truly determine the financial impact on lamb pricing. Statistical analysis was conducted in SAS PROC MIXED as well as with an Ordinary Least Squares Regression; least squares means were calculated and separated at $\alpha = 0.05$.

RESULTS AND DISCUSSION

Lamb Shoulder Retail Comparison

A retail price per kg comparison of lamb shoulder chop purchased at U.S. retail markets based on cut type, country of origin, store location, store type, and packaging type are reported in Table 4.1. Shoulder chop classification of either blade ($16.87/kg) or arm chop ($17.04/kg) did not differ ($P > 0.05$) for retail price per kg, and were analyzed together for the remainder of comparisons. Country of origin of lamb indicated U.S. product ($18.45/kg) was merchandised at the greatest price at retail, while lamb of New Zealand origin ($16.98/kg) was greater in price than lamb of Australian origin ($12.66/kg; $P < 0.05$).

Lamb shoulder chops purchased in East and Central locations cost more per kg than lamb in the West region of the U.S. ($P < 0.05$). However, further evaluation showed that a greater proportion of product purchased from the West region was Australian and consequently lower in

price. Origin of product and store type sampling distribution differences were accounted for, and a true comparison of similar (origin and store type) products, predicted that the mean retail price per kg for product from the East was $18.06/kg, and greater than both product available at retail in the Central ($15.77/kg) and West ($15.77/kg; $P < 0.05$). Lamb shoulder chops purchased at specialty stores (e.g., high end grocers, butcher shops, and farmer's markets) were merchandised ($21.23/kg) at over $4/kg greater price than either lamb sold at national chain stores ($16.80/kg) or locally owned retail stores ($15.77/kg; $P < 0.05$).

Packaging types of lamb shoulders presented in the retail case varied between stores, and twenty blade chops were purchased from the full-service counter. Lamb shoulder chops packaged in modified atmosphere packaging (MAP; $22.14/kg), or a sealed tray with a combination of CO, CO_2, and O_2 in the package, were priced highest, and was more than full-service counter ($19.34/kg), rollstock ($18.94/kg), and overwrap packaging ($14.24/kg; $P < 0.05$). People associate fresh lamb color with quality at the retail case (Khliji et al., 2010). Modified atmosphere packaging allowed attractive color at retail, yet retailers commented on the price of packaging being greater, and certainly some cost appeared to be passed on to the consumer.

However, it should be further noted though that source verified and branded product was more prone to be packaged with MAP technology. Lamb product with overwrap packaging ($14.24/kg) was merchandised at the lowest price point among offerings available to U.S. consumers at retail. While overwrap was the most common packaging of shoulder chops, sparse production and labeling claims on the package accompanied the product compared to other packaging types. Supermarkets previously indicated vacuum packaging as important to lamb convenience, yet popularity of vacuum packaged and rollstock (package absent of oxygen with a

firm underlying tray) could continue to grow if consumers accept the absence of the fresh lamb color that they are accustomed to purchasing at retail.

While geographic and store demographics influenced lamb pricing, sheep producers may be more interested in the associated label claims that are of greater value in today's marketplace. A price comparison of lamb shoulder chops purchased at U.S. retail markets based on branded program, origin, production type, and management and natural claims is shown in Table 4.2. Lamb products that were source verified and branded ($20.02/kg) were worth more at retail than store branded ($15.96/kg) or non-branded ($15.74/kg; $P < 0.05$). At the 46 stores, only 16 of the 148 purchased shoulder chops exhibiting a "local" designation on the package. Yet, those with a local classification ($20.31/kg) were priced at more than a $3.50/kg premium to non-local branded product ($16.58/kg; $P < 0.05$). There was a limited number (n = 24) of shoulder chops classified as grass-fed at retail; however, grass-fed shoulder chops ($19.05/kg) were marketed at over a $2/kg premium over shoulder chops of grain fed origin ($16.58/kg; $P < 0.05$). Consumer perception of the definition of "natural" is vague at best, but from a labeling perspective we quantified retail price difference of two labeling claims: "Never-Ever 3", (no added hormones, no antibiotics, and no animal by-products) and "All-Natural" or "Natural", (minimally processed, no artificial ingredients). Slight numerical differences existed with lamb shoulder price; however, products labeled with either USDA-AMS process verified Never-Ever 3 or uncertified All-Natural/Natural in the U.S. retail case showed no statistical difference of retail price per kg ($P > 0.05$). While there was an evident price premium for source branded, local, and grass-fed products, the proportion available to U.S. consumers currently at retail may be below market saturation, and opportunity exists for future marketing and increased sale of these production authenticity traits.

Lamb Shoulder Hedonic Pricing Model

Evaluation of lamb shoulder cuts and coefficients for hedonic modeling of price per kg are reported in Table 4.3. Specific results for attributes are discussed further to describe the positive/negative association with price. The magnitude of the coefficients indicate lesser or greater marginal effects for attributes on retail lamb value.

Country of Origin

Australian lamb was used as the base comparison because it resulted in the lowest price. Compared to lamb shoulders of Australian origin, product from New Zealand and the U.S. generated a $4.10/kg and $6.00/kg ($P < 0.05$) premium, respectively. The OLS regression identified that even when all store demographics, packaging, and label claims are accounted for, American lamb was worth more than the primary import competitor, Australian product.

Chop Type and Store Location

The range of price for lamb shoulder chops was $8.80/kg to $35.26/kg (mean = $16.98/kg). Price of blade and arm chop did not differ ($P > 0.05$), and consequently was pooled together in analysis. Additionally, the lamb purchased from the West (base) had numerically the greatest coefficient, yet not statistically significant ($P > 0.05$) which was different from the mean retail price analysis where West was the lowest ($P < 0.05$). Region of the country was not an important predictor of price per kg of lamb shoulder chops when store type and product label claims were accounted for in the model.

Store Type

Store type evaluated in the retail price analysis in PROC MIXED showed that national and local store types were not different ($P > 0.05$), but both differed from specialty stores ($P < 0.05$). Hedonic modeling coefficients identified that local stores and specialty stores were worth

$3.70/kg and $10.67/kg premiums ($P < 0.05$), respectively, when compared to national stores. A greater proportion of lamb shoulders were available at national stores (43%) compared to loin chops (32%) indicating a potential price point challenge for shoppers of large chain stores. Lamb purchased at specialty markets may have more credence attribute labeling claims (i.e., grass-fed, local). The demographic of the consumer may play a role in the greater retail prices when analyzed with hedonic modeling for lamb shoulder chops at retail specialty stores.

Packaging Type

Overwrap was the most common packaging type, and this showed that customers were most accustomed to the bright red meat, and white fat color at the retail setting. Regression results showed that overwrap was not different from product available at full-service ($P > 0.05$), but other packaging types were of premium value. Packaging types that are impermeable to oxygen and allow for extended shelflife of product include vacuum packaging and rollstock were worth an extra $6.90/kg or $7.23/kg ($P < 0.05$), respectively, when compared to overwrap product. Modified atmosphere packaging creates a fresh lamb color and ease of product preparation at retail (Khliji et al., 2010). Even though companies stated that there was an increase in cost, products sold with modified atmosphere packaging technology were merchandised at an increase of $12.28/kg more than overwrapped lamb shoulder chops. It is interesting that the value of modified atmosphere packaging remained at such a high magnitude of premium. Researchers predicted the value of this type of packaging to be partly accounted for by other quality and labeling attributes that may create a product with more credence attributes. Apparently, irrespective of additional label claims, retail markets charge more and consumers pay more for the presentation of modified atmosphere packaging, specifically when compared to overwrap product presentation.

Product Label Claims: Branded Product

Comparisons of the two statistical analysis methods to determine the changes in value of brand as a labeling claim showed differing results. The PROC MIXED evaluation in SAS showed that source branded product was worth $4.28/kg more ($P < 0.05$) when compared to having no brand label. A base of no brand was compared with store brand and source brand product labels by OLS regression. Un-branded lamb was not different from store brand with hedonic modeling analysis. Source branded product was different with a decrease of $8.62/kg ($P < 0.05$) from un-branded, yet surprisingly in an opposite direction. Ward et al. (2008) indicated that, on occasion, the sign and magnitude of specific traits in a hedonic pricing models may be counterintuitive, and with the current analysis, an explanation of the discrepancy does not exist.

Product Label Claims: Grass-Fed, Natural, No Hormone/No Antibiotic, Local

A statistical analysis and evaluation of least squares means comparisons of product label claims indicated that local designation ($3.73/kg) and grass-fed ($2.47/kg) label claims were of value at U.S. retail markets ($P < 0.05$). Feldmann and Hamm (2015) evaluated consumer attitudes that affect food purchasing and summarized that taste is the predominant reason for purchasing decisions, but that local origin is also of premium value. Consumers believe that local food is healthier, and there is a perceived advantage in trust of the supply chain (Feldmann and Hamm, 2015). However, lamb shoulders with no hormone/no antibiotic and/or natural claims were not worth a premium ($P > 0.05$) at retail. The hedonic model comparison mirrored results for local designation with a $5.42/kg premium ($P < 0.05$) for local or locally raised label claims, and also the no added hormones/no antibiotics label claim was not worth ($P > 0.05$) an incentive for retail customers. No difference was found in the means comparison (Table 4.2) for natural (minimally processed, no added ingredients) lamb products. However, results that

account for all product attributes via hedonic modeling showed a different outcome and that the natural claim was worth $5.40/kg ($P < 0.05$) at retail. Interestingly, the hedonic model results also contrast the expectation for lamb that was merchandised as grass-fed because it indicated that a grass-fed labeling claim would be worth a $3.37/kg discount.

Lamb Loin Retail Comparison

Lamb loin chops were available for purchase in a variety of retail markets both in self-service and full-service cases and are a common purchase for grocery shoppers. A retail price per kg comparison of lamb loin chops purchased at U.S. retail markets based on cut type, country of origin, store location, store type, and packaging type are reported in Table 4.4.

Analysis of loin chop labeling was compared by store ($N = 62$), not chop, because of the variability in number of chops available/purchased at selected stores. Purchased lamb loin chops originated from the U.S. (66%), Australia (23%), and New Zealand (11%). A comparison of country of origin of lamb determined U.S. product ($34.35/kg; $P < 0.05$) was merchandised at the greatest price, and a $5.88/kg premium over New Zealand loin chops. Lamb from New Zealand origin ($28.47/kg) was sold at numerically a $5.80/kg advantage over Australian loin chops, yet the price was not statistically different than lamb of Australian origin ($22.67/kg; $P > 0.05$).

Lamb loin chops available at retail were not different ($P > 0.05$) based on region of country (i.e., East, Central, and West). While lamb purchased from stores in the West had a numerically greater price, this can partly be attributed to an increase of purchased lamb from specialty stores. Store type resulted in the greatest disparity of price for loin chops than any individual labeling claim. Lamb loin chops purchased at specialty stores (e.g., high end grocers, butcher markets, and farmer's markets) were merchandised ($37.75/kg) with an over $5/kg

premium price over local retail stores ($32.26/kg; $P < 0.05$). Local and regional owned retail

stores sold lamb loin chops at an additional $5.87/kg than national chain stores ($26.39; $P <$

0.05).

Packaging types of lamb loin chops were most commonly presented in overwrap (44%),

followed by merchandised through a full-service counter (24%). Lamb loin chops sold in full-

service ($37.22/kg) were greater than overwrap packaged ($27.56/kg; $P < 0.05$). Loin chops

packaged in MAP ($35.26/kg), rollstock ($32.79/kg), and vacuum packaging ($32.06/kg) were

not different ($P > 0.05$) from one another. As lamb loin chops are considered a high-end protein,

featuring them in the full-service retail case was associated with an increase of price compared to

the other forms of packaging, yet this was most common for the specialty type stores.

Labeling claims of lamb and a retail price comparison were compared at U.S. retail

markets based on branded program, origin, production type, and management and natural claims

is shown in Table 4.5. Understanding the value of production practices and the potential for

increased premiums can provide insight for sheep producers and lamb marketing. Source

branded ($36.40/kg) lamb was worth more at retail than either store branded ($30.74/kg; $P <$

0.05) or non-branded ($27.21/kg; $P < 0.05$) lamb loin chops. Lamb loin chops labeled with a

local designation occurred at only 8 of the 62 locations and locally raised ($34.91/kg) was not

different from a non-local branded product ($31.22/kg; $P > 0.05$). This was different from

shoulder chops where premiums for both local and grass-fed labeling claims existed. A total of

13 stores merchandised lamb with a grass-fed label, but lamb derived from grain finishing and

not labeled as grass-fed ($31.82/kg) was not different than grass-fed ($31.24/kg; $P > 0.05$)

designation. Like shoulder chops at retail, neither a USDA-AMS process verified Never-Ever 3

claim nor natural label claim were worth a premium for lamb loin chops at U.S. retail markets (P

> 0.05). Lamb loins were of the greatest value at retail originating from the U.S., sold at specialty stores, source branded, and merchandised through a full-service retail counter.

Lamb Loin Hedonic Pricing Model

The evaluation of lamb loin chops and coefficients for hedonic modeling of price per kg are reported in Table 4.6. The price range of loin chops in this study was from \$15.19/kg to \$52.92/kg (mean = \$31.71/kg) at retail. The magnitude of coefficients allowed interpretation of attributes that represent either larger or smaller marginal effects of specific attributes on retail lamb value.

Country of Origin

Lamb of Australian origin was used as the base comparison because it had the lowest price. New Zealand lamb was numerically worth \$1.12/kg premium but was not statistically different ($P > 0.05$). American lamb was worth a premium of \$8.51/kg compared to Australian lamb ($P < 0.05$). Similar to the shoulder hedonic model, the OLS regression identified that when store demographics, packaging, and label claims are accounted for American lamb was worth more than Australian product.

Store Location and Type

Store location and region of the country for lamb loin chops was not different ($P > 0.05$). This mirrored results of shoulder chops and potentially location could be taken out of the hedonic model for further analysis. Specialty stores contributed to a greater percent of lamb loin chops (24%) than for shoulder chops available at retail. This result followed an intuitive expectation that higher value cuts were more common at specialty stores. Hedonic analysis for store type showed the greatest magnitude of coefficient for the comparison of specialty stores and national chain stores. This implied that loin chops merchandised at specialty stores garnered

$11.75/kg advantage over national stores ($P < 0.05$) when accounting for all other attributes. This result indicated that store type trumped the label classification differences of products. Locally owned grocers had an advantage for shoulder chop price, but the numerical $2.56/kg difference for loin chops over national stores was not significant ($P > 0.05$). Further information regarding the demographic of the consumer, purchasing decisions, and tendency to purchase lamb would be important to fully characterize the value of store type and location to the lamb industry.

Packaging Type

Overwrap was the most common (44%) packaging type for lamb loin chops, full-service retail was second in prevalence and increased from 14% to 24% for shoulder and loin chops, respectively. In the hedonic analysis, MAP ($4.56/kg) and full-service ($3.95/kg) had the highest numerical coefficient, yet there was no statistical difference compared to overwrap packaging ($P > 0.05$). Additionally, vacuum packaged loins tended to have a decreased (-$6.15/kg) value in the retail case ($P = 0.09$). Overall, packaging of loin chops was not an important factor in the regression analysis of pricing at U.S. retail markets.

Product Label Claims: Branded Product

Source branded product was worth a premium for both shoulder and loin chops. The proportion of source branded product increased from 27% of shoulder chops to 37% of loin chops at retail. Source branded product was worth an additional $9.19/kg ($P < 0.05$) when least squares means were compared to having no brand label. However, lamb loin chops with source designation were merchandised with a $7.21/kg value increase over non-branded lamb loin chops when analyzed with the OLS regression analysis that accounted for all other variables.

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Also, an evaluation between store branded and non-branded lamb was not different with the hedonic modeling analysis ($P > 0.05$).

Product Label Claims: Grass-Fed, Natural, No Hormone/No Antibiotic, Local

Prevalence of production management label claims were slightly greater for local (12.9% vs. 10.8%) and grass-fed (21.0% vs. 16.2%) loin chops and slightly lesser for no hormone/no antibiotic (24.2% vs. 30.4%) and natural claims (29.0% vs 37.8%) compared to shoulders purchased at similar locations. A statistical analysis and evaluation of least squares means comparisons of product label claims indicated that there were no differences of loin chops for either, local designation, grass-fed, USDA-AMS process verified Never-Ever 3, or natural label claims at U.S. retail markets ($P > 0.05$). No value difference of loin chops were additionally found via hedonic modeling. Intriguingly, when all other variables are accounted for in the regression the grass-fed (-\$4.04/kg), Never-Ever 3 (-\$1.30/kg), local (-\$0.93/kg), and natural (-\$0.44/kg) label designations all had a negative coefficients and association with retail price. Despite this, all of the aforementioned label claims were not important in the regression model ($P > 0.05$).

Lamb Loin/Rib Physical and Tenderness Attributes

Analysis of visual physical attributes were compared for loin chops purchased at retail from origins of U.S. (n = 383), Australia (n = 67), and New Zealand (n = 115; Table 4.7). American lamb loin chops had a greater loin eye area (19.55 cm^2) than chops from either Australia or New Zealand, and loin eye area of Australian chops (16.77 cm^2) was greater ($P < 0.05$) than the loin eye area of loin chops from New Zealand (14.52 cm^2). While the mean area of the tenderloin (*Psoas major*) did not differ by country ($P > 0.05$), the mean *Longissimus dorsi* length was different for all countries ($P < 0.05$). The full length, full width, and total area of loin

chop were different for American compared to Australian, and New Zealand ($P < 0.05$). Chops of U.S. origin had a greater amount of exposed bone than either chops from Australia or New Zealand ($P < 0.05$).

Lamb loin chops of New Zealand origin had the greatest amount of fat nearest the lumbar vertebra compared to U.S. and Australia ($P < 0.05$), and chops from New Zealand and the U.S. had greater amount of external measurable fat at the 50% location and the distal portion (or closest to the tail of a lamb loin chop) compared to trimmer Australian lamb loin chops ($P < 0.05$). Also, U.S loin chops were merchandised with the most tail length (0.91 cm), and Australian loins (0.74 cm) had greater ($P < 0.05$) tail length than New Zealand lamb loins (0.46 cm). Overall, U.S. lamb loin chops had the most muscle and red meat, and Australian loin chops were the trimmest products available at the U.S. retail meat case.

An evaluation of rib chops purchased at U.S. retail markets is shown in Table 4.8. Results indicated that chops from U.S. origin had the greatest *Longissimus dorsi* area (15.29 cm^2) compared to chops of New Zealand origin (13.35 cm^2; $P < 0.05$), and American rib chops had the greatest surface area ($P < 0.05$). No difference was found for fat at the 0% or 50% location ($P > 0.05$), but Australian product (0.30 cm) had the least fat ($P < 0.05$) at the most distal location of the rib chop compared to chops from New Zealand (0.81 cm) and the U.S. (0.97 cm). Rib chops of U.S. origin had increased full width ($P < 0.05$) and tail length ($P < 0.05$) measurements than either Australian or New Zealand chops. The tail length of the U.S. chop would contribute to greater plate waste from purchased rib chops. Overall, U.S. lamb rib chops had the greatest surface area of product; however, this was partially due to increased ribeye area as well as increased tail length. Australian rib chops were the trimmest chops available in the U.S. retail case.

Loin chops available for purchase at retail may be designated by production management and finishing protocol (i.e., grass-fed and grain-fed lamb). A comparison of visual physical attributes for loin chops that originating from lamb that were either grass-fed or grain-fed are reported in Table 4.9. Overall, loin chops originating from grain finished lambs were more muscular and had greater *Longissimus dorsi* length, width, and total area measurements ($P < 0.05$). Results indicated that loin chops did not differ ($P > 0.05$) at either 0% (closest to vertebra) or 100% (closest to loin tail) locations, but loin chops from grass-fed animals showed less fat over the middle of the loin chop ($P < 0.05$). While loins from grain-fed lambs had a greater overall length and width ($P < 0.05$), loins from grass-fed origin were merchandised with a greater tail length, or accessory muscles and fat at the end of a loin chop ($P < 0.05$).

Tenderness of lamb chops purchased from U.S. retail markets were compared using Warner-Bratzler Shear Force (WBSF) for each origin (U.S., Australia, and New Zealand) for loin and rib chops and by finishing diet for products of U.S. origin (Table 4.10). Lamb chop *Longissimus* WBSF values were lower (more tender) for product of Australia and New Zealand origin than product from the U.S. for rib ($P < 0.05$) and loin ($P < 0.05$) chops. In perspective, the tenderness values obtained in this research generally all low, albeit differing, indicating that lamb available for purchase at retail is extremely tender. Furthermore the muscle tenderness difference found, while significant, would likely not be distinguishable by consumers. As result of visual and tenderness evaluation of lamb loin and rib chops in this study, American lamb was more muscular than Australian, and New Zealand was the least muscular. Furthermore, lamb originating from Australia was the leanest lamb option available to U.S. consumers. Also, the mean scores for tenderness evaluation reconfirmed that product tenderness (loin and rib chops) was a strength for all lamb albeit less so in American lamb.

Lamb Pricing

Product quality attributes were considered important to retail, foodservice, and purveyor sectors of American Lamb; still U.S. lamb must be careful to not price itself out of a consumer's shopping cart or menu choice. Researchers in this study asked interview respondents (N = 120) "At what price would you decrease or eliminate your lamb purchase?" for rack, loin chop, leg, and ground lamb (Table 4.11). Lamb price was often mentioned as a weakness or threat to the U.S. lamb industry, and the feeder and fed lamb price spikes of 2011 and 2012 were not advantageous to lamb volume, consumer acceptability, and marketability for many respondents at retail and foodservice. Sixteen of sixty retail and foodservice interview respondents stated that there was no price limit for rack price as they required rack in their store and on their menu, while another sixteen companies confirmed that we are already past the preferred price limit. Respondents stated they would decrease or eliminate rack from their sales at an average price of $39.69/kg for retail and $40.86/kg for foodservice sectors.

Loin chops were the only cut of the four evaluated that resulted in more people saying that the price was too high (n = 8), than there was no price limit (n = 6). Interview respondents showed a greater price limit at retail ($34.60/kg) compared to foodservice and purveyor ($28.25/kg) sectors. Lamb leg purchases were considered to have an upward price limit of $19.89/kg for retail and $18.57/kg for foodservice and purveyor entities. The price limit threshold for ground lamb was determined at $16.93/kg for retail and $17.46/kg for foodservice and purveyor companies. As an American Lamb industry, price point can and will be a challenge to keep lamb at the center of the plate both at home and on restaurant menus. Currently, increases in competitive protein prices may soften the comparison of lamb only being considered an exclusive protein for high end occasions. A segment of American lamb

consumers will purchase lamb regardless of cost, while another segment of the population already believes that American lamb is too expensive at the current prices.

CONCLUSIONS

Price comparisons and the associated or implicit value of store demographics, packaging, and product labeling claims can provide insight into consumer preferences of lamb. Lamb merchandised at retail were multi-attribute goods, and further understanding of the true market value of specified product traits and labeling claims can be used within the sheep and lamb industry and assist to identify future marketing opportunities for lamb.

Lamb loin and rib chops purchased at U.S. retail markets indicated that U.S. lamb is larger, and more muscular with *Longissimus dorsi* area of loin chops from U.S. origin (19.55 cm^2) greater than chops from Australia (16.77 cm^2), and which were greater than chops from New Zealand (14.52 cm^2; $P < 0.05$). Rib chops had the greatest area of U.S. loin chops, partially due to increased tail length ($P < 0.05$). Australian loin chops were the trimmest in external fat at the middle (50% location) and closest to the loin tail (100% location), and rib chops were trimmest over the lower rib (100% location; $P < 0.05$). Australian and New Zealand loin and rib chops were more tender than loin and rib chops originating from the U.S. ($P < 0.05$), yet the mean for all chops was well below a threshold considered to be "very tender." The visual appearance and tenderness characteristics of lamb summarized the current product attributes at retail. However, the implicit value advantage of American lamb for both shoulder and loin chops can additionally be explained with the value of branding and product classifications.

Factors influencing lamb shoulder price included country of origin, store type/location, packaging type, and product labeling claims. In general, lamb of U.S. origin received a price

incentive over New Zealand, and Australian lamb can be considered the most economical lamb choice in the retail case. Importantly, the evaluation of label claims of lamb shoulder chops (N = 148) collected at retail markets from 46 stores in 10 states reinforced through hedonic modeling that locally raised designation (+ \$5.42/kg), and natural labeled lamb (+ \$5.42/kg) were merchandised at a premium to American consumers ($P < 0.05$).

The pricing of lamb loin chops available at U.S. retail markets reinforced that American lamb was merchandised at a higher price than Australian or New Zealand lamb. Furthermore, specialty type stores merchandised lamb shoulder (+ \$10.67/kg) and loin (+ \$11.75/kg) chops at an increased price per kg than locally owned or national grocery chains. Source branded lamb resulted in retail price premiums (+ \$7.21/kg) despite neither local, grass-fed, USDA-AMS process verified Never-Ever 3, nor natural label claims resulted in loin chop premiums when merchandised to American consumers.

In this research, linear hedonic modeling was utilized to determine incentives for product attributes that consumers consider important for retail purchasing decisions for lamb shoulder and loin chops offered for sale in U.S. retail markets. Notable conclusions were that modified atmosphere packaging resulted in price incentives for shoulder chops and higher price loin chops were merchandised through the full-service counter while lamb packaged with overwrap was sold at a discount. Hedonic price modeling determined a consistent positive association for specialty stores over national chains, and premiums for American lamb compared to Australian lamb for shoulder and loin chops. Source branded labeling was important to loin chop value, and packaging type, and local label designation improved the implicit value of lamb shoulder chops. This research can provide insight to the lamb supply chain on product attributes of lamb and assist with future marketing strategies at retail for U.S. consumers.

Table 4.1. A price comparison of lamb shoulder chops purchased at U.S. retail markets based on cut type, country of origin, store location, store type, and packaging type.

Attribute	Classification	N = 148	Price per kg	Standard Error	P - Value
Shoulder Chop	Arm Chop	n = 51	$17.04	0.53	P = 0.84
	Blade Chop	n = 97	$16.87	0.73	
Country of Origin	U.S.	n = 95	$18.54[a]	0.49	P < 0.0001
	New Zealand	n = 34	$16.98[b]	1.06	
	Australia	n = 19	$12.66[c]	0.79	
Store Location	East	n = 46	$17.64[a]	0.75	P = 0.01
	Central	n = 58	$18.04[a]	0.66	
	West	n = 44	$15.02[b]	0.77	
Store Type	National	n = 63	$16.80[b]	0.62	P < 0.0001
	Local	n = 64	$15.77[b]	0.62	
	Specialty	n = 21	$21.23[a]	1.06	
Packaging Type	Overwrap	n = 78	$14.24[c]	0.49	P < 0.0001
	Modified Atmosphere Packaging	n = 19	$22.14[a]	0.99	
	Vacuum Packaging	n = 16	$19.49[ab]	1.06	
	Rollstock	n = 15	$18.94[b]	1.10	
	Full-Service Counter	n = 20	$19.34[b]	0.97	

[a,b,c] Least squares means in the same column lacking a common superscript differ (P < 0.05).

Table 4.2. A price comparison of lamb shoulder chops purchased at U.S. retail markets based on branded program, origin, production type, and management and natural claims.

Attribute	Classification	N = 148	Price per kg	Standard Error	*P* - Value
Branded Program	Source Branded	n = 40	$20.02[a]	0.77	*P* < 0.0001
	Store Branded	n = 58	$15.96[b]	0.64	
	No Brand	n = 50	$15.74[b]	0.68	
Origin Description	Local Designation	n = 16	$20.31[a]	0.44	*P* < 0.0001
	No Designation	n = 132	$16.58[b]	1.83	
Production Type	Grass-Fed	n = 24	$19.05[a]	1.06	*P* < 0.0001
	Grain-Fed	n = 124	$16.58[b]	0.46	
Management Claim	No Antibiotics/No Hormones/No Animal By-Products	n = 45	$17.71	0.77	*P* = 0.26
	No Designation	n = 103	$16.67	0.51	
Natural Claim	Minimally Processed, No Artificial Ingredients	n = 56	$17.20	0.71	*P* = 0.69
	No Designation	n = 92	$16.85	0.55	

[a,b] Least squares means in the same column lacking a common superscript differ (*P* < 0.05).

Table 4.3. Hedonic model estimation results of price per kg comparison for lamb shoulder chops (N = 148) collected at U.S. retail markets.

	Lamb Shoulder Chops			
Independent Variable	Percent of Total	Linear Parameter Estimate	Standard Error	*P* - Value
Intercept		6.92		
Chop				
Arm	34.5	Base		0.38
Blade	65.5	0.53	0.57	
Country of Origin				
U.S.	64.2	6.00	0.97	< 0.0001
Australia	23.0	Base		
New Zealand	12.8	4.10	1.21	0.001
Store Location				
West	29.7	Base		
Central	39.2	-0.29	0.88	0.75
East	31.1	-0.18	0.88	0.84
Store Type				
National	42.6	Base		
Local	43.2	3.70	0.82	< 0.0001
Specialty	14.2	10.67	1.59	< 0.0001
Packaging Type				
Overwrap	52.7	Base		
Full-Service	13.5	0.44	1.30	0.74
Modified Atmosphere Packaging	12.8	12.28	1.54	< 0.0001
Rollstock	10.1	7.23	1.26	< 0.0001
Vacuum Package	10.8	6.90	1.46	< 0.0001
Branded Type				
Source Brand	27.0	-8.62	1.72	< 0.0001
Store Brand	39.2	-1.15	0.88	0.20
No Brand	33.8	Base		
Grass-fed Label				
Grass-fed (Yes)	16.2	-3.37	1.35	0.01
Grass-fed (No)	83.8	Base		
Natural Label				
Natural (Yes)	37.8	5.40	0.99	< 0.0001
Natural (No)	62.2	Base		
Hormone/Antibiotic Label				
No added Hormones/ No Antibiotics(Yes)	30.4	-0.09	0.75	0.91
No added Hormones/ No Antibiotics (No)	69.6	Base		
Local Label				
Local (Yes)	10.8	5.42	1.30	< 0.0001
Local (No)	89.2	Base		

Table 4.4. A price comparison of lamb loin chops purchased at U.S. retail markets based on country of origin, store location, store type, and packaging type.

Attribute	Classification	N = 62	Price per kg	Standard Error	P - Value
Country of Origin	U.S.	n = 41	$34.35^a	1.30	$P = 0.0015$
	New Zealand	n = 7	$28.47^b	2.23	
	Australia	n = 14	$22.67^b	3.15	
Store Location	East	n = 17	$29.90	2.23	$P = 0.38$
	Central	n = 16	$30.50	2.27	
	West	n = 29	$33.43	1.70	
Store Type	National	n = 20	$26.39^c	1.83	$P = 0.0007$
	Local	n = 27	$32.26^b	1.59	
	Specialty	n = 15	$37.75^a	2.12	
Packaging Type	Overwrap	n = 27	$27.56^b	1.63	$P = 0.013$
	Modified Atmosphere Packaging	n = 5	$35.26^{ab}	3.79	
	Vacuum Packaging	n = 7	$32.06^{ab}	3.20	
	Rollstock	n = 8	$32.79^{ab}	3.00	
	Full-Service Counter	n = 15	$37.22^a	2.18	

[a,b] Least squares means in the same column lacking a common superscript differ ($P < 0.05$).

Table 4.5. A price comparison of lamb loin chop purchased at U.S. retail markets (N = 62) based on branded program, origin, production type, and management and natural claims.

Attribute	Classification	N = 62	Price per kg	Standard Error	P - Value
Branded Program	Source Branded	n = 23	$36.40[a]	1.74	P = 0.0026
	Store Branded	n = 19	$30.74[b]	1.92	
	No Brand	n = 20	$27.21[b]	1.87	
Origin Description	Local Designation	n = 8	$34.91	3.22	P = 0.29
	No Designation	n = 54	$31.22	1.23	
Production Type	Grass-Fed	n = 13	$31.24	1.32	P = 0.84
	Grain-Fed	n = 49	$31.82	2.56	
Management Claim	No Antibiotics/ No Hormones/ No Animal By-Products	n = 15	$30.54	2.36	P = 0.58
	No Designation	n = 47	$32.06	1.35	
Natural Claim	Minimally Processed, No Artificial Ingredients	n = 18	$29.72	2.16	P = 0.28
	No Designation	n = 44	$32.50	1.37	

[a,b] Least squares means in the same column lacking a common superscript differ ($P < 0.05$).

Table 4.6. Hedonic model estimation results of price per kg comparison of U.S. retail market store demographic and product label claims (N = 62) of lamb loin chops.

Independent Variable	Percent of Total	Linear Parameter Estimate	Standard Error	*P* - Value
Intercept		18.68		
Country of Origin				
U.S.	66.1%	8.51	2.98	0.01
Australia	11.3%	Base		
New Zealand	22.6%	1.12	3.81	0.77
Store Location				
West	46.8%	Base		
Central	25.8%	-0.68	2.45	0.78
East	27.4%	0.77	2.51	0.76
Store Type				
National	32.3%	Base		
Local	43.5%	2.56	2.73	0.35
Specialty	24.2%	11.75	3.57	0.002
Packaging Type				
Overwrap	43.5%	Base		
Rollstock	12.9%	2.05	3.31	0.54
Vacuum Packaging	11.3%	-6.15	3.57	0.09
Modified Atmosphere Packaging	8.1%	4.56	3.81	0.24
Full Service	24.2%	3.95	2.62	0.14
Branded Type				
Source Brand	37.1%	7.21	2.93	0.02
Store Brand	30.6%	3.15	3.22	0.33
No Brand	32.3%	Base		
Grass-fed Label				
Grass-fed (Yes)	21.0%	-4.04	2.67	0.14
Grass-fed (No)	79.0%	Base		
Natural Label				
Natural (Yes)	29.0%	-0.44	2.47	0.86
Natural (No)	71.0%	Base		
Hormone/Antibiotic Label				
No added Hormones/ No Antibiotics (Yes)	24.2%	-1.30	2.12	0.54
No added Hormones/ No Antibiotics (No)	75.8%	Base		
Local Label				
Local (Yes)	12.9%	-0.93	2.67	0.14
Local (No)	87.1%	Base		

Table 4.7. Product dimensions for area [cm^2] and linear measurements [cm] of loin chops (SE) purchased at U.S. retail markets from origins of U.S., Australia, and New Zealand.

Measurement	U.S. n = 383	Australia n = 67	New Zealand n = 115	P - Value
Longissimus dorsi Area	19.55[a]	16.77[b]	14.52[c]	P < 0.0001
	(0.26)	(0.58)	(0.45)	
Psoas major Area	7.16	5.87	6.19	P = 0.18
	(0.32)	(0.84)	(0.65)	
Total Area	50.84[a]	41.35[b]	39.68[b]	P < 0.0001
	(1.23)	(2.84)	(2.19)	
Kidney Pelvic Area	1.94[a]	1.61[ab]	1.29[b]	P = 0.0008
	(0.06)	(0.19)	(0.19)	
Bone Area	6.06[a]	5.16[b]	5.35[b]	P = 0.003
	(0.13)	(0.32)	(0.10)	
Longissimus dorsi Width	3.28	2.97	3.00	P < 0.0001
	(0.03)	(0.08)	(0.05)	
Longissimus dorsi Length	6.53[a]	6.17[b]	5.54[c]	P < 0.0001
	(0.05)	(0.15)	(0.10)	
Psoas major Length	3.05	3.02	3.00	P = 0.92
	(0.05)	(0.15)	(0.010)	
Psoas major Width	3.07[a]	2.95[ab]	2.79[b]	P = 0.04
	(0.05)	(0.13)	(0.10)	
Fat – 0% Location	0.66[b]	0.64[b]	0.79[a]	P = 0.01
	(0.03)	(0.05)	(0.05)	
Fat – 50% Location	0.84[a]	0.64[b]	0.86[a]	P = 0.003
	(0.03)	(0.05)	(0.05)	
Fat – 100% Location	0.76[a]	0.58[b]	0.86[a]	P = 0.01
	(0.03)	(0.08)	(0.05)	
Tail Length	0.91[a]	0.46[c]	0.74[b]	P < 0.0001
	(0.05)	(0.10)	(0.08)	
Full Length	8.76[a]	7.95[b]	7.72[b]	P < 0.0001
	(0.05)	(0.13)	(0.10)	
Full Width	6.58[a]	5.89[b]	6.12[b]	P < 0.0001
	(0.05)	(0.13)	(0.10)	

[a,b,c] Least squares means in the same column lacking a common superscript differ (P < 0.05).

Table 4.8. Product dimensions for area [cm^2] and linear measurements [cm] of rib chops (SE) purchased at U.S. retail markets from origins of U.S., Australia, and New Zealand.

Measurement	U.S. n = 71	Australia n = 16	New Zealand n = 25	P - Value
Longissimus dorsi Area	15.29[a]	13.35[ab]	12.58[b]	P = 0.003
	(0.52)	(1.10)	(0.90)	
Total Area	52.71[a]	40.90[b]	38.71[b]	P < 0.0001
	(1.74)	(3.68)	(2.90)	
Longissimus dorsi Width	3.68[a]	2.90[b]	3.18[b]	P = 0.002
	(0.10)	(0.23)	(0.18)	
Longissimus dorsi Length	5.28	5.61	4.90	P = 0.16
	(0.15)	(0.30)	(0.23)	
Fat – 0% Location	1.17	0.74	1.22	P = 0.19
	(0.10)	(0.23)	(0.18)	
Fat – 50% Location	0.99	0.56	0.91	P = 0.06
	(0.08)	(0.18)	(0.13)	
Fat – 100% Location	0.97[a]	0.30[b]	0.81[a]	P = 0.003
	(0.08)	(0.15)	(0.13)	
Tail Length	2.74[a]	0.71[b]	1.40[b]	P = 0.005
	(0.33)	(0.56)	(0.69)	
Full Length	13.64	12.70	12.95	P = 0.32
	(0.33)	(0.66)	(0.53)	
Full Width	6.10[a]	5.13[b]	5.26[b]	P = 0.0005
	(0.13)	(0.28)	(0.23)	

[a,b] Least squares means in the same column lacking a common superscript differ (P < 0.05).

Table 4.9. Product dimensions for area [cm^2] and linear measurements [cm] of loin chops (SE) purchased at U.S. retail markets from lambs that were finished on grain or from U.S., Australia, and New Zealand and marketed as finished on grass-based diets.

Measurement	Grain n = 297	Grass n = 73	P - Value
Longissimus dorsi Area	20.45[a]	16.45[b]	P < 0.0001
	(0.26)	(0.58)	
Psoas major Area	7.42	6.26	P = 0.19
	(0.39)	(0.77)	
Total Area	53.16[a]	43.23[b]	P = 0.008
	(1.61)	(3.29)	
Kidney Pelvic Area	1.94	2.19	P = 0.35
	(0.13)	(0.26)	
Bone Area	6.13[a]	5.16[b]	P = 0.004
	(0.13)	(0.32)	
Longissimus dorsi Width	3.33[a]	3.00[b]	P < 0.0001
	(0.03)	(0.08)	
Longissimus dorsi Length	6.73[a]	5.82[b]	P < 0.0001
	(0.08)	(0.13)	
Psoas major Length	3.07	3.00	P = 0.58
	(0.08)	(0.13)	
Psoas major Width	3.10	3.10	P = 0.90
	(0.08)	(0.13)	
Fat – 0% Location	0.66	0.64	P = 0.53
	(0.03)	(0.05)	
Fat – 50% Location	0.84[a]	0.74[b]	P = 0.04
	(0.03)	(0.05)	
Fat – 100% Location	0.76	0.79	P = 0.79
	(0.05)	(0.08)	
Tail Length	0.89[b]	1.17[a]	P = 0.02
	(0.05)	(0.10)	
Full Length	8.94[a]	8.28[b]	P < 0.0001
	(0.08)	(0.13)	
Full Width	6.68[a]	6.05[b]	P < 0.0001
	(0.05)	(0.13)	

[a,b] Least squares means in the same column lacking a common superscript differ (P < 0.05).

Table 4.10. Comparison of Warner-Bratzler Shear Force of loin and rib chops (SE) purchased at retail from U.S., Australia, and New Zealand and Warner-Bratzler Shear Force from loin chops that from labeled as grass-fed and USA grain fed chops.

Tenderness	U.S. n = 71	Australia n = 13	New Zealand n = 22	P - Value
Warner Bratzler Shear Force (Rib Chop)	1.90[a]	1.52[b]	1.57[b]	P = 0.009
	(0.06)	(0.015)	(0.12)	
	U.S. n = 191	Australia n = 34	New Zealand n = 56	
Warner Bratzler Shear Force (Loin Chop)	1.78[a]	1.51[b]	1.56[b]	P = 0.0003
	(0.03)	(0.08)	(0.06)	
	Grass-Fed n = 125	Grain-Fed n = 294		
Warner Bratzler Shear Force (Loin Chop)	1.80	1.74		P = 0.21
	(0.04)	(0.03)		

[a,b] Least squares means in the same column lacking a common superscript differ ($P < 0.05$).

Table 4.11. Responses from interviewees for "At what price would you (and your customers) decrease or eliminate your lamb purchase?" for rack, loin chop, leg, and ground lamb.

Lamb Cut / Location	Total Responses	No Price Limit	Adjust Accordingly	Price Responses	Price Value	Already Past the Price Limit
Rack						
Retail	N = 42	n = 8	n = 3	n = 23	$39.69/kg	n = 8
Foodservice/ Purveyor	N = 38	n = 8	n = 4	n = 18	$40.86/kg	n = 8
Loin Chops						
Retail	N = 29	n = 3	n = 0	n = 23	$34.60/kg	n = 3
Foodservice/ Purveyor	N = 20	n = 3	n = 1	n = 11	$28.25/kg	n = 5
Leg						
Retail	N = 26	n = 2	n = 3	n = 20	$19.89/kg	n = 1
Foodservice/ Purveyor	N = 16	n = 4	n = 2	n = 9	$18.57/kg	n = 1
Ground Lamb						
Retail	N = 23	n = 2	n = 0	n = 21	$16.93/kg	n = 0
Foodservice/ Purveyor	N = 25	n = 4	n = 2	n = 17	$17.46/kg	n = 2

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APPENDICES

APPENDIX A.1. Define Lamb for U.S. Retailers

Interview responses categorized by central themes when asked to "Define Lamb." Retailers (n=60) include supermarket, butcher, and direct/farmer's market sectors.

Young Sheep	[1]Small sheep
	[1]A young sheep. Meat with flavor. I love lamb and it is a great eating experience. Richness. It is what you want from a restaurant type eating experience you can have two or three chops and great experience without eating a whole beef steak.
	[1]Baby sheep. Rib and Loin chop.
	[1]Just a little baby sheep. A specialty meat.
	[1]An animal. Mammal. Livestock. Europeans like to eat.
	[2]Sheep under 12 months.
	[2]Meat from young sheep.
	[3]Meat from a sheep under 12 months of age.
	[3]Eight months or younger.
	[3]Where the break joint breaks.
	[3]Lamb is under 12 months of age, a USDA yield grade of 3 or less. A carcass less than 85 lbs. Emphasis on 12 months of age. Leanness and tenderness.
	[3]Lamb is under a year old. It is considered an animal and it is lamb meat that we are selling. I am worried about the connection of the animal to the protein. Lamb means sheep meat, and war people ate mutton. Can't name it mutton. Other side is tough to sell lamb as they think of baby lambs with flowers around their neck in grassy pastures.
	[3]Young sheep with a break joint.
	[3]Meat from lamb.
	[3]Lamb is a sheep that is less than 18 months old and weighs less than 140 pounds.
	[3]Lamb is a young sheep that has been domesticated and is harvested for meat. Lamb is flavorful and provides a good eating experience for customers.
	[3]Lamb is a sheep product less than a year old.
	[3]It has to be young. Unique eating experience. Different. I have people that love lamb, because it is tender and you can cut it with a fork.
Healthy	[1]A protein.
	[1]A source of protein.
	[1]It is a good tasting meat full of omega 3 fatty acids. Reasonably priced.
	[3]Lamb to my customers is a wholesome, nutritious meal. Ethnics like taste or flavor that is desirable for them.
Red Meat Alternative	[1]Comparable to beef, but with more gaminess flavor. Product not for everybody. For me, high end yuppie meat. Most people haven't tried lamb in their life
	[1]Best of the rest. What's left after beef pork and chicken. Niche.
	[1]Really like lamb. Another protein that taste good not for everyone.

APPENDIX A.1 (cont.) Define Lamb for U.S. Retailers.	
Red Meat Alternative (cont.)	[1]The other meat. It is actually has a captured audience and has the capability to be promoted and gaining customer support if priced properly. You can capture other customers if priced right and increases to other customers that would not otherwise purchase it. People have slightly shifted to fish in comparison to the whole increase in red meat as of late.
	[1]The other meat. It is actually has a captured audience and has the capability to be promoted and gaining customer support if priced properly. You can capture other customers if priced right and increases to other customers that would not otherwise purchase it. People have slightly shifted to fish in comparison to the whole increase in red meat as of late.
	[1]A great product that if we don't as an industry take it to the next level with education, product awareness, and ease of preparing and cooking, it is going to be a category that will phase out and be smaller and smaller. It has the potential of growing in the retail sector.
	[1]Food that was more common decades ago, before then it was mutton and it was bad. Lamb dwindled over time but resurged with foodies.
	[1]The other, other red meat. 1% of overall beef sales. Different eating experience. Don't eat it every day. Alternative dish. Lamb is for special occasions.
	[1]Lamb is the largest consumed meat animal in the world. It is vastly underrated in the United States. It has a tremendous potential in the US.
	[1]Gamier than beef. Beautiful nice tender piece of meat with slight gaminess to it.
	[1]Other red meat. Personally like it, but you either love it or you don't.
	[1]A variety in the meat case.
	[1]Lamb is a great red meat alternative to beef. Second only to beef in flavor. And it offers from a catering standpoint a lot of latitude and options when discussing menus. From a cost standpoint, there are certain cuts that retailers can make friends with their customers. The richness of lamb shanks as an alternative to veal for osso bucco. I prefer pork, then lamb, then veal for osso bucco.
	[1]Lamb appeals to older customers. Younger customers do not eat it, understand how to cook it or wish to eat it. It doesn't appeal to the masses, but those that do like it spend a lot in our store.
	[1]Lamb to me is 5% of my business. I like to make it a little more relevant. It is what it means to me business. I am a lamb lover and have struck a chord with my consumers by providing domestic and not switching over to imported.
	[1]Protein offering that makes up small percentage four percent of our overall meat department.
	[2]Lamb is more complex and leaner than beef. Nothing like a roasted leg of lamb.
	[2]Lamb is an extremely viable protein because of the way it interacts with the land. It is very responsible because the practices are typically very good ones. Versatile protein and with a little guidance most people can cook lamb. Very marketable. Works in Texas.
	[2]Red meat. Local, native to Colorado.
	[2]It is a complement to our whole animal protein line up which is very valuable to have available year round of consistent quality.

APPENDIX A.1 (cont.) Define Lamb for U.S. Retailers.	
Delicious and Flavorful	[1]Good, chops, Juicy and tender. [1]U.S. raised, fascinating delicious and nutritious animal that I enjoy cutting a lot. Cook like beef, but tastes like lamb. [1]I love lamb. Not everybody loves lamb, not everybody eats lamb. We know that lamb consumers have a bigger basket share than other protein consumers. Is it because they are more affluent or more foodie? It is important to have lamb in the store so consumers can go to stores and get it? Any store can sell lamb if they work at it. [2]Rack of lamb. [2]USDA choice, Colorado product. [2]If raised right and shorn, looks good. Have nice carcass. Can tell if worth eating. [2]American product, American lamb, good flavor for dinner. [3]The very best meat product that we can eat and there is no reason not to grow a whole bunch more good sheep. We are going into the area where people are respective of the quality of lamb. As producers we are given the responsibility to raise the very best products. The real future is in high quality lamb, and nobody wants to eat extra lamb fat." [3]A unique eating opportunity. Stand-alone flavor. [3]Lamb is delicious! In one word, delicious. Exotic and flavorful. Lamb is like taking a vacation, it is out of the norm and really wonderful all at the same time. Lamb has a cute connotation. Mutton has a strongly negative connotation. Beauty of lamb is that it is as close to the Earth as possible. If you choose to do the right things the right way you can't get less expensive in production than lamb on grass and great for the environment. [3]Delicious. Locally grown. Good for you. Good protein for high protein, and alternative red meat.
Delicacy and High End	[1]A gourmet meal that is real high quality, good tasting protein. Not an every day experience and something that is special occasion. [2]Tender, juicy, tasty. Quality [3]Very flavorful product that although does require additional prep is well worth the time for the flavor.
Other	[1]Greasy and doesn't taste good. [2]They stink. [3]My whole life. [3]The responsibility is for purebred producers to grow really good sheep and we need quality in order to compete in the global market.

[1] Interview responses for define lamb for supermarket sector; [2] Interview responses for define lamb for butcher sector; [3] Interview responses for define lamb for direct/farmer's market sector

APPENDIX A.2. Define Lamb for U.S. Foodservice/Purveyors.

Interview responses categorized by central themes when asked to "Define Lamb." Foodservice and Purveyors (n=60) include fine dining, casual dining, and purveyor market sectors.

Young Sheep	[4]Baby sheep.
	[4]Tasty Baby sheep.
	[4]A young sheep.
	[4]Lamb is a farm animal that can be used for meat and milk.
	[4]A sheep under one year of age. A red meat protein with gamey flavor.
	[4]Sheep under a year old. It is a bolder, and more adventurous meat. It is not super gamey, but actually has more flavor. It has terrior, or means that it's taste like where it came from and how it is raised.
	[4]A young sheep. A unique protein, a lot of people don't carry it. Unique product we can offer to people at a competitive price where people can something different. Serve lamb at affordable product for people to enjoy. Different texture and flavor.
	[5]A young sheep.
	[5]Young sheep.
	[5]Baby sheep. Gamey red meat.
	[5]A little animal. Think of a shepherd.
	[5]A four legged animal that goes baa.
	[5]Any sheep up to a year and a half of age. A yearling is still tender. Delicious.
	[5]It is a sheep less than nine months of age without a second set of teeth in. Real delicious, and faintly gamey. Denser red meat and lower fat content than beef. A good alternative for beef on the menu. Extremely versatile for the whole animal.
	[6]Young sheep.
	[6]A baby sheep.
	[6]Young sheep.
	[6]A sheep under a year old. Tasty.
	[6]12 months of age or less.
	[6]Ovine, a livestock that produces many products including wool, hides and edible product .
Healthy	[4]Protein
	[4]A good alternative red meat that has good nutritional value, it is versatile, can be very sustainable, harvested at young age and requires less feed.
	[5]Lean meat. Healthy meat. Delicious!
	[5]Four legged wooly animal. Somewhat loud. Appeals to older generation.
Red Meat Alternative	[4]A tasty flavorful meat that is the perfect option between venison and beef. It is a meat that really brings out the flavor of its origin. You have an idea of the flavor based on what the animal ate. It has a very distinctive flavor.
	[4]Lamb has the highest level of integrity than any other protein.

APPENDIX A.2. (cont.) Define Lamb for U.S. Foodservice/Purveyors.	
Red Meat Alternative (cont.)	[4]Premium product. Great nutritional source. Has a lot of diversity of cuts and utilization.
	[4]A meat, a challenging protein that offers a lot of opportunities for new and creative items, a lot of uses for cooking opportunities.
	[4]Meat!
	[4]An exceptional ingredient that enables limitless creativity and truly defines the enjoyment of being a chef. Lamb and bison are my favorite proteins. Lamb is riding this great place of being wild game and an easily accessible main line protein. You can be high end and special, and others can know lamb is lamb. Lamb can special occasion, but it is also on the menu every day. It has universal appeal. With global culinary immersion from Morocco and Colorado lamb is the most enjoyable protein. So much easier to find lamb that is raised properly than any other protein. Where do you get that ratio with farms doing it correctly? Every farm or ranch is doing it right with pasture grazing and open space.
	[4]Flavor. Diversity and creating different dining experience for guests. Makes it special for people.
	[5]Lamb is something I grew up on my life eating. It used to be considered wild game, now it is very commonplace. It is a misunderstood protein. Consumers say, my grandma made it and it was terrible. It goes from I had a bad lamb experience to holy crap it is expensive and I don't eat it a lot.
	[5]Being a middle eastern restaurant it is very, very central to our cuisine, and it is the most important protein that we serve.
	[5]The other red meat, unique flavor.
	[6]Just a species we handle.
	[6]Underrated protein that needs bigger presence in the U.S.
	[6]Retail opportunity and an unmet need.
	[6]Meat. Regionally raised alternative.
Delicious and Flavorful	[4]Delicious, sweet red meat. Mild in flavor. Succulent. A hint of gaminess.
	[4]Good tasting.
	[4]Flavorful meat. Great alternative to beef. It goes back to family. Every other Sunday we had a lamb roast and reminded me of my childhood.
	[4]Delicious.
	[4]Delicious. Versatile. Flavor.
	[4]Flavor!
	[5]Lamb chops. Whole roasted. Yummy.
	[5]The best ever tasting protein in the Whole World! I don't need beef, pork, poultry, I would be happy with just lamb.
	[5]With lamb, the people that like lamb love lamb. In fact, people will come to our restaurant, Fogo de Chao just to eat our lamb.
	[5]Lamb chops! Cut that most Americans have not tried or had a bad experience. Don't know how good it can be if done correctly.

APPENDIX A.2. (cont.) Define Lamb for U.S. Foodservice/Purveyors.	
Delicious and Flavorful (cont.)	[6]Flavorful, versatile and lean protein. [6]A flavorful, versatile meat that can be used in most applications and specifically quality is determined by origin.
Delicacy and High End	[4]Customer gets 100% satisfaction at eating/dining experience. [5]Yummy. It is like a filet mignon; high end food. It is like cashmere fiber. [5]Terriorre. [5]Food that is high end meat product. Flavor might take getting used to. [5]The closest thing still to real meat. Generally, it still tastes like meat. It feels like the least furthest down the slope. Chicken, beef, pork, and turkey are a long way into industrial farming. Mass produced meat have like zero flavor left. Flavor of lamb has a flavor that connects you with farming. The smell/aroma takes you there. An earthy flavor. [6]Delicacy. [6]It is an ovine species. Luxury meat and a delicacy. It is specialized and delicious. [6]It is a higher end protein. Ranks above beef. Lamb is an acquired taste. [6]A high end niche market that represents twenty percent of the population with consumers. Only twenty percent even eat lamb. Restaurant driven protein. Most people eat lamb at restaurant and or mom buys lamb for Christmas or holiday experience.
Other	[4]A hanging carcass of sheep. [5]My favorite lamb. [6]Very small markets. [6]Biblical food.

[4] Interview responses for define lamb for fine dining sector; [5] Interview responses for define lamb for casual dining sector; [6] Interview responses for define lamb for purveyor market sector

APPENDIX B.1. Define Quality for U.S. Retail Supermarkets.

Interview responses from supermarket representatives (n = 31) when asked to "Define Quality."

Consistent.

Consistency. Good taste. Free of hormones and antibiotics. Getting it right the first time every time.

Eat ability. Good eating experience.

Consistently palatable.

Eating experience is the end game. It has to taste good. The ultimate. Why do people eat lamb?:sustainable story, nutrition, or eating experience? Generally it is the eating experience.

Quality is a combination of grade appearance and consistent sizing.

Wholesome, good eating experience. Tender. Flavorful.

Wholesome.

Quality is the freshness, meet specification. Some intramuscular marbling without too much external fat.

Nice lamb flavor without being too overpowering and tenderness.

Should be expected. What you expect. 100% best.

Quality is the aesthetic look, and the eating experience.

Product has correct marbling and nice presentation for purchase.

Color and size.

Fresh, proper size, not frozen.

Brightness of color. Being the best. Eye appearance.

Product freshness, packaging, brand recognition.

Fresh, wholesome flavor.

Fresh, tenderness, flavor.

Color and freshness.

Initial appearance. Color. Appearance of yield. Shelf life. Eating experience.

Richness of flavor and tenderness.

Tenderness, flavor. Intermuscular fat. Trim specifications.

Quality deals with specifications of product. USDA Choice. Product should come in less than 39F and have good shelf life.

Customer are looking for a smaller portion that is of good quality and gives a memorable meal for the price they are going to pay. A nice appearance, good yield and good conformation.

What you are getting for your money. We try to have higher quality so that we can try to charge a little bit more money.

Meat that eats well. Workmanship is there color is good so animal healthy.

A consumer will believe and trust the commentary for the rancher and farmer than the retailer putting the label on it. They believe more in the person that raised it than the person trying to sell it. Quality is the level of value that you get for the product for the amount that you spend on it.

In regards to lamb, quality is a word we use to describe the effort of individuals for a product to be marketed.

Being held to a higher standard than other commodities and accountability.

APPENDIX B.2. Define Quality for U.S. Retail Butcher's Markets.

Interview responses from butcher's markets representatives (n = 11) when asked to "Define Quality."

The grade of lamb.

Healthy looking animal with some fat. When you look at it you want to eat it raw.

Composition, size, and we look for workmanship and freshness.

Consistent appearance and flavor.

Appearance and flavor. Bright red color. Not dry, still moist. Marbling.

Fat is quality. Aged.

Fresh, delicious and healthy.

Pasture raised and slaughtered under low stress conditions. Aged for proper amount of time.

Eating performance, flavor and tenderness are the bottom line.

Product that is treated with a higher standard.

Halal. The holy book Koran. When you slaughter an animal it has to be blessed. God is Great, we appreciate the food that you have gave us. Blood is forbidden in Muslim. Blood creates disease. No Muslim is allowed to eat blood. Take the blood out. Tenderness and juiciness. Look and appearance. Aroma and Flavor. Not too much lean, not too much fat.

APPENDIX B.3. Define Quality for U.S. Direct/Farmer's Markets

Interview responses from direct/farmer's market representatives (n = 18) when asked to "Define Quality."

Flavorful, wholesome.

Quality is tenderness, flavor, size, freshness.

Quality is a good eating experience.

Texture, taste, and flavor.

Flavor.

The richness of the flavor of the meat. A certain taste. The goodness of it.

Primarily quality is the eating experience of lamb.

It has to taste good. Customers have to be happy. We raise our lambs on our production system. I can taste the difference in grass fed and older lambs. We don't want lambs too fat.

A combination of rich flavor, tenderness and juiciness for customer satisfaction. Sustainable raised.

Quality is a product that is young lean, tender, mild flavor, consistent size, palatable, consistent taste.

Dorper! Tenderness.

Eating experience. Has to look good, but you can take anything and make it look good. Taste and flavor is what it is all about. We sell 5400 dozens of mutton chislic in four evenings at the local county fair. 150 - 200 ewes and mutton. $10/dozen; 12 sticks with 4 cubes. One dozen sticks weigh 0.65 lb.

Consistent high end reliable sourced product.

Quality is appearance and composition, nutritious and eating satisfaction because they will order it once and want to come back and eat it again as a repeat experience.

The right amount of fat covering and the percentage of meat in the product.

Quality is a good looking package and product that can provide a rich flavor and good experience.

The local thing and the Farmers Market in Massachusetts is a big deal. Everybody thinks because it is close it is better. The butcher does a good job. Important to find USDA plant that will work to meet specifications.

Quality is a product of lamb that you would be proud to serve at you own table.

APPENDIX B.4. Define Quality for U.S. Fine Dining Restaurants.

Interview responses from fine dining representatives (n = 23) when asked to "Define Quality."
Freshness and yield.
Flavor, consistent size.
Ribeye size.
Fresh, tender. Good flavor profile. Consistent size.
Flavor! Tenderness. Price.
Wholesome product. Perception of value. Good flavor, good texture.
Texture of lamb. I don't like flabby lamb. Meat color. It should be firm and red.
Quality lamb is delicious. Fresh, tender.
Fat content, appearance, density of meat tissue, fresh color.
Origin and health of animals. Flavor and nutrition for customer.
The level it is enjoyed. Good, wholesome, and safe.
Relentlessly making the best decisions regardless of cost.
Humanely raised. Hormone free. Free range. Natural.
It is consistently clean, and consistent product.
Tenderness, balanced fattiness. Medium lamb flavor.
From the package of lamb to how it tastes on the plate.
We have to know its origin, rancher raising practices. Eat ability. How does it eat, what does it taste like?
It has to have marbling, right amount of fat, good mouth feel, the right size, raised well.
Customer satisfaction.
What keeps the customer returning to our restaurant?
Customer satisfaction.
The quality of life a sheep has. I am a believer that all of that results in the end product.
Quality is in my opinion is something that will always satisfy you. Quality is something that needs to be pricier. Satisfaction is just not enough. Lots of products are satisfying or correct, quality is something that is impressive. If you have first bite of rack of lamb you say oh my god that is delicious.

APPENDIX B.5. Define Quality for U.S. Casual Dining Restaurants.

Interview responses from casual dining representatives (n = 22) when asked to "Define Quality."

TASTY, one word.

Flavor/taste. Conscience of consumer. In the meat world, it is flavor.

I believe it is in the final tasting.

Proper marbling. Good meat color. Proper packing and storage. Good butchery.

Smell, taste, and mouthfeel.

Taste! It goes back to appearance and how cuts are fabricated. Production and what happens in the kitchen.

Firmness, color, texture, aroma.

Quality is fresh, no excess blood, no off-putting aromas.

Lamb that we get is the best. Fresh. Grass fed. Local.

Quality is that it has to be fresh, it has to fat free, it has to be tender, and it has to flavorful.

Everything from fat content and freshness, color, aroma.

Quality starts with the care and raising of the animal.

Local and grass fed.

Quality is the impression. Flavor and tenderness is very huge. Has to be consistent with flavor and tenderness. Consistency.

The people that grow lamb and that they know about lamb. There is a connection with growing lamb.

Our company mantra is quality, consistency, and price. People know what to expect and that is the best meat quality, flavor, and consistency.

Defined by each person for satisfaction.

Something that the customer will want to come back and tell friends about. Not forgettable.

Provide an optimal eating experience. Flavorful, tenderness, and juicy. With burgers, some places have pre-pattied frozen burger. We have fresh and pattied burger that improves tenderness and texture.

I sell Australian lamb because if you go into people that eat lamb, some will say Colorado, Australian, or New Zealand. Australian fresh lamb. Satisfaction. Flavor. All about flavor!!!

It is not about an umbrella on the plate, I am not about that shit.

APPENDIX B.6. Define Quality for U.S. Purveyors.

Interview responses from purveyor representatives (n = 15) when asked to "Define Quality."
Consistent eating experience.
Consistent flavor appropriate finish. Juice and tender.
Met or exceed expectations.
Quality is eating experience. Tender. Buttery.
Flavorful and tender. Consistent.
Consistency, size, fat to lean ratio, graded.
Consistent in size, fat amount and marbling.
Consistency across the board. Sizing and availability.
Product handled flawlessly. Trimmed and cut to spec w/o flaw. Originated and raised in good environment.
Looks wholesome and is. Tastes good. Right color and conformation.
Marbling choice or better, white fat, close trimmed.
The product should have moderate intramuscular fat, mild flavor, expected tenderness, appropriate external and seam fat.
Everyone has their own idea. Nice appearance, fresh. Reputation of supplier, packer, and rancher.
Raising practices and slaughter.
The intrinsic value of the item at hand. In lamb, it is highest attributes to raw material and the animal.
Conformation, young, tender, flavorful. Size of animal, what is fed.

APPENDIX C. Interview Questionnaire.

Interview questionnaire provided for lamb/protein purchaser representatives of retail (n = 60), foodservice (n = 45), and purveyor (n = 15) marketing sectors

Hello, my name is Travis Hoffman and I am a researcher from Colorado State University in the Animal Sciences department. We are conducting a research study on Lamb Quality Perceptions of American Lamb funded by the American Lamb Board. The title of our project is "Preferences and Complaints associated with American Lamb Quality in Retail & Foodservice Markets."

We would like you to take an anonymous survey on questions pertaining to your entity's purchases of lamb, and the relative importance of quality attributes in the decision making process of purchasing lamb and lamb products. Please provide truthful interpretation of questions as you are the lamb purchasing entity of your restaurant, and this research will be used to learn about lamb quality in the retail and foodservice sectors. Participation will take approximately 40 minutes. Your participation in this research is voluntary. If you decide to participate in the study, you may withdraw your consent and stop participation at any time.

Would you like to participate?
If yes: Proceed.
If no: Thank you for your time.

We will not collect your name or personal identifiers. When we report and share the data with others, we will combine the data from all participants. There are no known risks or direct benefits to you, but we hope to gain more knowledge on American Lamb Quality.

Characterize the organization or company being interviewed.

- ☐ Retail - Supermarket
- ☐ Retail - Butcher
- ☐ Retail - Direct / Farmer's Market
- ☐ Foodservice - Fine Dining
- ☐ Foodservice - Casual Dining
- ☐ Food Service - Mid-Scale Dining
- ☐ Food Service - Quick Service
- ☐ Non-Commercial Foodservice _____
- ☐ Government/Trade/Industry _____
- ☐ Other _____

Please describe the scope (and location) of your company.

- ☐ National _____
- ☐ Regional _____
- ☐ Local _____
- ☐ Other _____

Which of the following does your company purchase / merchandise as fresh product?

☐ Whole Lamb Carcass ☐ Preparation / Restaurant-Retail Ready Cuts

☐ Lamb Primals; shoulder, rack, loin, and leg ☐ Lamb Variety Meats

☐ Lamb Steaks / Chops ☐ Live Lambs

☐ Lamb Roasts ☐ Other [____]

☐ Lamb Trimmings / Stew Meat ☐ Other [____]

☐ Ground Lamb ☐ None

Which of the following does your company purchase / merchandise as frozen product?

☐ Whole Lamb Carcass ☐ Ground Lamb

☐ Lamb Primals; shoulder, rack, loin, and leg ☐ Preparation / Restaurant-Retail Ready Cuts

☐ Lamb Steaks / Chops ☐ Lamb Variety Meats

☐ Lamb Roasts ☐ Other [____]

☐ Lamb Trimmings / Stew Meat ☐ None

How many different lamb products do you purchase for your company?

[____]

How many pounds of lamb does your company purchase weekly?

[____]

Is your company currently purchasing imported lamb? If so, where from?

○ Yes [____]

○ No

What percent of lamb purchased is from the following countries?

[0]
United States

[0]
Australia

[0]
New Zealand

[0]
Other [____]

[0]
Other [____]

Does the amount of imported lamb that you purchase shift quarterly/seasonally throughout the year?

○ Yes [   ]

○ No [   ]

During what season do you sell the most and the least amount of lamb?

	Spring	Summer	Fall	Winter	No Difference
Most Lamb Sold	○ Most Lamb Sold	○ Least Lamb Sold	○	○	○
Least Lamb Sold	○ Most Lamb Sold	○ Least Lamb Sold	○	○	○

The next question is about economic conditions that must be satisfied, as required by corporate policy, before your company will purchase sheep or lamb. This question is solely about economic conditions and not about the live sheep or lamb products themselves. Please list the economic conditions that determine whether or not your company will purchase sheep or lamb products.

☐ Access to Credit   ☐ Environmental Regulations   ☐ Inventory Availability

☐ Access to Labor   ☐ Lamb Selling Price   ☐ Lamb Purchase Price

☐ Animal Well-Being Regulation   ☐ Food Safety Regulation   ☐ Seasonality

☐ Bonding   ☐ Government Regulation   ☐ Other [   ]

☐ Cost of Labor   ☐ Industry Consolidation   ☐ Other [   ]

Now, let's discuss lamb quality. Please remember that you are to answer these questions as they relate to your company and be truthful about the importance and value of each attribute of lamb to your company's purchasing decisions.

Are there specific characteristics or attributes of lamb products that are ABSOLUTELY MUST HAVES that your company requires in order to purchase this product?

☐ Origin _____

☐ Sheep Raising Practices _____

☐ Eating Satisfaction _____

☐ Weight / Size _____

☐ Product Appearance / Composition _____

☐ Product Convenience / Form _____

☐ Nutrition / Wholesomeness _____

YES: In your response, you stated ORIGIN must be assured in order for your company to purchase lamb. If this could not be assured, would your company purchase lamb at a discounted price?

OR

NO: If ORIGIN could be assured for lamb products, would your company be willing to pay a premium? And if so, at what percent increase would your company be willing to pay?

○ Yes

○ No

If Origin could NOT be assured, would your company purchase lamb at a discounted price?

Origin

	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	
%Discount																_____

If Origin could be assured for lamb products, what percent premium increase, if any, would your company be willing to pay?

Origin

	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	

%Premium [ ]

THIS FORMAT 7 TIMES; ONE FOR EACH ATTRIBUTE

The next set of questions asks for you to define what specific attributes mean to your company. Please remember that you are to answer these questions as they relate to your company and be truthful about what each attribute means to your company's lamb purchasing decisions.
What is important about Origin when you purchase lamb for your company?

☐ American   ☐ Imported   ☐ Locally Raised

☐ State   ☐ Australian   ☐ Other [ ]

☐ Colorado   ☐ New Zealand   ☐ Other [ ]

☐ Age / Source Verified   ☐ Traceable product   ☐ Other [ ]

What is important about Sheep Raising Practices when you purchase lamb for your company?

☐ Breed - Specific   ☐ No Added Hormones   ☐ Animal Well-Being [ ]

☐ Grass - Fed [ ]   ☐ Antibiotic - Free   ☐ Animal Health & Records [ ]

☐ Grain - Fed [ ]   ☐ Naturally Raised   ☐ Other [ ]

☐ Animal Age   ☐ Sustainably Raised   ☐ Other [ ]

What is important about Eating Satisfaction when you purchase lamb for your company?

☐ Tenderness   ☐ Customer Satisfaction   ☐ Correct Portion Size

☐ Juiciness   ☐ Mutton Flavor   ☐ Other [ ]

☐ Lamb Flavor   ☐ Lean Meat   ☐ Other [ ]

☐ Marbling   ☐ Consistency   ☐ Other [ ]

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What is important about Weight / Size when you purchase lamb for your company?

☐ Consistent Cut Size ☐ Carcass Weight [____] ☐ Cut Specifications

☐ Consistent Cut Weight ☐ Primal Weight [____] ☐ Other [____]

☐ Large Cut Size ☐ Uniformity ☐ Other [____]

☐ Small Cut Size ☐ USDA Yield Grade ☐ Other [____]

What is important about Product Appearance / Composition when you purchase lamb for your company?

☐ Appropriate Product Color ☐ Lean Meat ☐ Seam Fat Amount

☐ Fresh Lamb Color ☐ Fat Trim Level [____] ☐ Other [____]

☐ Marbling ☐ Appropriate Muscle Size ☐ Other [____]

☐ Freshness ☐ Lean to Fat Ratio ☐ Other [____]

What is important about Product Convenience / Form when you purchase lamb for your company?

☐ Packaging [____] ☐ Cut Specifications ☐ Pre - Packaged Cuts

☐ Vacuum Packaged ☐ Frenched Product ☐ Other [____]

☐ Product Size ☐ Block - Ready Cuts ☐ Other [____]

☐ Freshness ☐ Boneless Cuts ☐ Other [____]

What is important about Nutrition / Wholesomeness when you purchase lamb for your company?

☐ Safe ☐ Omega - 3 Fatty Acids ☐ Grain - Fed

☐ Pathogen - Free ☐ Protein ☐ Other [____]

☐ USDA Inspected ☐ Nutritious ☐ Other [____]

☐ Lean ☐ Grass - Fed ☐ Other [____]

Which of the following attributes is most important and which attribute is least important to your company?

	Eating Satisfaction	Product Appearance / Composition	Product Convenience / Form
Most Important	○ Most Important	○ Least Important	○
Least Important	○ Most Important	○ Least Important	○

Which of the following attributes is most important and which attribute is least important to your company?

	Eating Satisfaction	Weight / Size	Nutrition / Wholesomeness
Most Important	○ Most Important	○ Least Important	○
Least Important	○ Most Important	○ Least Important	○

Which of the following attributes is most important and which attribute is least important to your company?

	Sheep Raising Practices	Product Appearance / Composition	Nutrition / Wholesomeness
Most Important	○ Most Important	○ Least Important	○
Least Important	○ Most Important	○ Least Important	○

Which of the following attributes is most important and which attribute is least important to your company?

	Sheep Raising Practices	Weight / Size	Product Convenience / Form
Most Important	○ Most Important	○ Least Important	○
Least Important	○ Most Important	○ Least Important	○

Which of the following attributes is most important and which attribute is least important to your company?

	Origin	Product Convenience / Form	Nutrition / Wholesomeness
Most Important	○ Most Important	○ Least Important	○
Least Important	○ Most Important	○ Least Important	○

Which of the following attributes is most important and which attribute is least important to your company?

	Origin	Weight / Size	Product Appearance / Composition
Most Important	○ Most Important	○ Least Important	○
Least Important	○ Most Important	○ Least Important	○

Which of the following attributes is most important and which attribute is least important to your company?

	Origin	Sheep Raising Practices	Eating Satisfaction
Most Important	○ Most Important	○ Least Important	○
Least Important	○ Most Important	○ Least Important	○

Which of the following attributes is most important and which attribute is least important to your company?

Origin	Sheep Raising Practices	Eating Satisfaction	Weight / Size	Product Appearance / Composition	Product Convenience / Form	Nutrition / Wholesomeness
○ Most Important	○ Least Important	○	○	○	○	○
○ Most Important	○ Least Important	○	○	○	○	○

Define Lamb.

Does the name "lamb" have a positive or negative influence?

Is there another term other than "lamb" that could be used to market meat originating from sheep meat?

- ○ Yes [   ]
- ○ No
- ○ Not Sure

How important is it that lamb is consistently in the retail case / on the menu?

Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important
○	○	○	○	○

Does your company sell branded lamb products?

- ○ Yes [   ]
- ○ No

What are the carcass specifications / requirements of those branded lamb programs?

- ☐ Breed Type
- ☐ Origin - Domestic
- ☐ Origin - Imported
- ☐ Carcass Weight

- ☐ Natural
- ☐ Antibiotic - Free
- ☐ Organic
- ☐ USDA Yield Grade

- ☐ USDA Quality Grade
- ☐ Cut Weight / Size
- ☐ Other [   ]
- ☐ Other [   ]

What attributes and/or specifications do you feel important for a branded lamb program?

- ○ Breed Type
- ○ Origin - Domestic
- ○ Origin - Imported
- ○ Carcass Weight

- ○ Natural
- ○ Antibiotic - Free
- ○ Organic
- ○ USDA Yield Grade

- ○ USDA Quality Grade
- ○ Cut Weight / Size
- ○ Other [   ]
- ○ Other [   ]

Open Ended Questions:

Define Quality.

How would your company describe the image of American Lamb?

How would your company describe the image of Imported Lamb?

The next four questions are part of a SWOT analysis. What are the strengths of the American Lamb industry?

What are the weaknesses of the American Lamb industry?

What are the potential opportunities for the American Lamb industry?

What are the potential threats for the American Lamb industry?

Define Animal Well-Being.

Define Sustainability.

Does your company put emphasis on breed, genetics, and/or type of sheep for your company's lamb purchasing decisions? If so, describe what breed/genetic/type is preferred?

Does your company make purchasing decisions based on any sheep / lamb age and maturity descriptions?

Does your company utilize USDA Yield Grade in lamb purchasing decisions? If so, to what extent?

Does your company utilize USDA Quality Grade in lamb purchasing decisions? If so, to what extent?

How does your company market lamb for ethnic customers?

At what price for the following cuts would you decrease or eliminate your orders for the
following cuts?

- [ ] Rib Chop [_____]
- [ ] Loin Chop [_____]
- [ ] Leg Roast [_____]
- [ ] Ground Lamb [_____]

Since 2011 and increased lamb wholesale and retail prices, what changes or modifications (If
any) has impacted your company purchasing decisions?

Has Country of Origin Labeling, implemented in 2009, affected your purchases or sales of
domestic lamb?

If you could assure attributes for an American Certified Lamb, what attributes would you be
willing to pay for?

- [ ] Grass-Fed
- [ ] Grain-Fed
- [ ] Naturally Raised
- [ ] No Added Hormones
- [ ] No Antibiotics

- [ ] Sustainable
- [ ] Humanely Raised
- [ ] Consistent Cut Size
- [ ] Freshness
- [ ] Tenderness

- [ ] Flavor
- [ ] Other [_____]
- [ ] Other [_____]
- [ ] Other [_____]
- [ ] Other [_____]