Determining Consumer Perceptions of and Willingness to Pay for Appalachian Grass-fed Beef: An Experimental Economics Approach

Jason R. Evans*, Ph.D.
Cheryl Brown*, Ph.D.
Alan R. Collins*, Ph.D.
Gerard E. D'Souza*, Ph.D.
Edward B. Rayburn**, Ph.D.
Mark Sperow*, Ph.D.

***Faculty, Division of Resource Management, Davis College of Agriculture, Forestry and Consumer Sciences, West Virginia University
**Extension Forage Specialist, Davis College of Agriculture, Forestry and Consumer Sciences, West Virginia University

P.O. Box 6108
2030 Agricultural Sciences Building
Morgantown, WV 26505
304-293-4832

Selected Paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Orlando, FL, July 27-29, 2008.

Determining Consumer Perceptions of and Willingness to Pay for Appalachian Grass-fed Beef: An Experimental Economics Approach

Introduction

Since 1975, per capita beef consumption in the United States has fallen by over 30% while the percentage of total meats consumed as poultry has increased from 18% to over 43% (USDA/ERS, 2007). A considerable amount of market research over the past 20 years has been devoted to understanding the causes of this marked change in consumption patterns. Although conclusions have been mixed, many authors have attributed the shift in beef demand to increasing health consciousness and the prevalence of health information linking consumption of fatty foods to the proliferation of chronic degenerative conditions (Horrigan, Lawrence and Walker, 2002; Scollan et al., 2006; Moon and Ward, 1999; Kinnucan et al., 1997). Still others (Schroeter and Foster, 2004; Eales and Unnevehr, 1988) claim that increased demand for convenient, ready-to-eat products brought about by substantial increases in female workforce participation in the 1970s caused the structural change in demand for beef and turned favor toward processed poultry products.

Whether driven by health concerns, demand for convenience, or other factors, consumer behavior suggests that the beef products available at retail have not changed appreciably to accommodate changes in preferences. Thus, from the beef industry's perspective, it is critical that consumer perceptions of commodity beef products be understood relative to novel specialty products that address demand for observed, experience, nutritional and process attributes (Noelke and Caswell, 2000). Observed attributes include readily visible characteristics such as appearance, color, size and freshness. Experience attributes are those that are evident only after purchase and consumption, including flavor and tenderness. Nutritional attributes include mineral, vitamin, fat and caloric content and finally, process attributes, such as environmentally conscious/animal friendly production practices, are not directly observed by the consumer and are created and modified at the farm level.

The importance of process attributes is increasingly being recognized by individuals in the food industry, who, supported by the research community, are offering an ever-widening array of products that appeal to consumers' demands for non-commoditized, specialty foods. Changes in production attributes can fundamentally impact all other attribute types, given that appearance, taste, and nutritional content are all inexorably linked to growing and finishing protocol. The surging demand for process attributes over the last 20 years has led to the success of such innovative retailers as Whole Foods (Codron et al., 2004) and is the driving force behind the differentiation and segmentation of supermarket products.

Federally imposed marketing standards and labeling for specialty products that entail value-added production techniques serve to transform process attributes into observed attributes and facilitate the market by condensing a great deal of information about a product into a single and universally accepted convention. In the U.S. beef sector, several value creation strategy options exist for producers since beef products can be differentiated in terms of production practices involved, animal genetics, meat characteristics (e.g., leanness), and geographic area of origin. The potential economic merit of differentiating products according to these parameters is perhaps best exemplified by the current market for organic products in the U.S. and the emergent prevalence of these items on supermarket shelves (Oberholtzer, Dimitri, and Greene, 2005). In addition to the organic market, research into the process attributes associated with beef products has also focused on consumer acceptance of production labels that identify beef as hormone/antibiotic-free, non-GM corn-fed, natural, locally produced, and grass-fed. In general, these studies have shown considerable consumer interest in and willingness to pay for these process attributes (Lusk and Fox, 2000; Grannis, Thilmany, and Sparling, 2001; Goss, Holcomb, and Ward, 2002; Maynard, Burdine, and Meyer, 2003; Patterson et al., 1999). Bjerklie (2006) estimated that all of these so-called alternative beef niches comprise about $1 billion of the total $40 billion annual beef market, and significant growth seems likely.

Each of the value creation opportunities for beef producers discussed above implies a change in at least one convention associated with commodity beef production. In particular, grass-fed beef production entails a shift in focus from efficiency-focused, accelerated cattle finishing toward "back to the land" principles of intensive pasture resource management and an abridged marketing process that negates the role of the feedlot system. The recently amended Agricultural Marketing Service's marketing claim standard for products labeled as "grass-fed" states that "grass and/or forage shall be the feed source consumed for the lifetime of the ruminant animal, with the exception of milk consumed prior to weaning" (The Federal Register, 2007). Grass-fed beef embodies observed, experience, nutritional, and process attributes that may appeal to consumers searching out alternatives to commodity beef, and evidence suggests that consumers are indeed responding to the availability of these specialty products. Retail sales of grass-fed beef products totaled over $120 million in 2005 and more than 1200 producers across the U.S. have begun grass-finishing at least some of their beef (Spiselman, 2006). Tallgrass Beef Company Chief Operating Officer Allen Williams projected in 2005 that the grass-fed market could grow by 30% or more annually over the next 5 to 10 years (Spiselman, 2006).

In terms of the nutritional attributes offered by grass-fed beef products, research over the past 30 years has consistently shown that increasing the proportion of forage in cattle diets, relative to grain-based products, significantly improves the fatty acid profiles of beef, and in particular lowers the percentage of total fatty acids as SFAs, improves the Polyunsaturated:Saturated fatty acid ratio, decreases the ratio of n-6 to beneficial n-3 fatty acids, and increases the levels of Conjugated Linoleic Acid (CLA), which have been shown to be anticarcinogenic and antiatherogenic (e.g., Realini et al., 2004; French et al., 2000a; French et al., 2000b; Noci et al, 2005; Purchas, Knight, and Busboom, 2005; Rule et al., 2002; Dhiman et al., 1999). In addition to superior fatty acid profiles, grass-fed beef has also been shown to have higher contents of Vitamin E and Beta-carotene than grain-fed products due to fundamental differences in feed sources (Scollan et al., 2006; Simmone et al., 1995).

It is reasonable to assume that the benefits offered by process and nutritional attributes may be perceived as inconsequential if the core observed and experience attributes of palatability and appearance are not acceptable, and successful marketing of novel specialty products requires that these characteristics be well understood. Though the literature on palatability and carcass characteristics of grass-fed and grain-fed beef is profuse, studies differ appreciably in the methods employed, making it difficult to draw unambiguous conclusions. Cross and Dinius (1978) and Schaake et al. (1993) suggest that considerable variability *within* grass-fed samples may come from the particular type of forage fed. For example, alfalfa or ryegrass-based diets have been shown to produce meat quality superior to that from cattle fed harvested cool season grasses (Simmone et al., 1995; Schroeder et al., 1980; Schaake et al., 1993; Cross and Dinius, 1978).

Evidence suggests that most differences in meat and carcass quality *between* grass-fed and grain-fed beef products disappear when animals are finished to common endpoints (i.e., to similar slaughter weights or degree of marbling) (Mandell et al., 1998; Bidner et al., 1981; Simmone, Green, and Bransby, 1996; Schupp, Binder, and Clark, 1980; French et al., 2000b). In studies in which endpoints are not homogenized, grass-fed animals are typically slaughtered at lower weights than their grain-fed counterparts due to slower growth rates and consequently yield carcasses that are inferior in terms of marbling and tenderness and taste panel palatability ratings (Bowling et al., 1978, May et al., 1992; Schaake et al., 1993; Schroeder et al., 1980).

In terms of product appearance, several studies (Bowling et al., 1977; Schroeder et al., 1980; Realini et al., 2004) have shown muscle tissue from grass-fed animals to be darker than that from grain-fed. However, in each of these studies, grass-fed cattle were older than their grain-fed counterparts at slaughter and Lanari et al. (2002) suggest that the reported effect of finishing system on meat color may have been confounded with that of animal age. In contrast, Bowling et al. (1977) and Schroeder et al. (1980) claim that grass-fed cattle may be more susceptible to pre-slaughter stress and hence to the "dark cutting beef syndrome" than feedlot-finished animals because they are less accustomed to people, pens, and general pressure. Bidner et al. (1981), Simmone et al. (1996), and Lanari et al. (2002) found no significant difference in objective color scores between grass-fed and grain-fed products. As an additional benefit of grass-finishing, several authors (Lanari et al., 2002; O'Sullivan et al., 2003; Mercier et al., 2004) have noted that color shelf life of grass-fed beef is superior to that of grain-fed beef in that redness levels remain stable longer and there is less lipid oxidation, likely due to the enhanced Vitamin E content of grass-fed samples.

Given potential consumer demand for the attributes offered by grass-fed beef products, grass-finishing as a value-added production system seems a desirable alternative for cow-calf producers wishing to increase enterprise profitability in a time of rising and volatile input prices and for consumers dissatisfied with commoditized beef products currently available in retail markets. Such systems may be particularly appealing for producers in the Appalachian region of the U.S., where a comparative advantage exists for pasture production and corn deficiencies translate into high grain prices relative to those in the major cattle feeding regions of the country.

Although there is evidence to suggest that the market for grass-fed beef is substantial and expanding (Spiselman, 2006), thorough assessment of consumer attitudes toward and willingness to pay for these products needs to be made in order to more fully understand market potential and to subsequently mitigate the market risk faced by potential producers. Though domestic grass-fed products have many times been evaluated by trained taste panels without elicitation of willingness to pay values, and *imported* grass-fed beef has been appraised by consumer panels in laboratory settings, no such assessments for domestic, region-of-origin labeled grass-fed beef have been made in active market environments (supermarkets) by beef consumers.

In order to determine consumer perceptions of and willingness to pay for Appalachian grass-fed beef, a variant of the Becker-DeGroot-Marschak experimental auction mechanism that facilitates direct sensory evaluations and revelation of true valuations was employed in grocery stores in an urban area (Pittsburgh, PA) and an urbanizing area (Morgantown, WV) of the Appalachian region with the primary objective of determining overall market potential for these specialty products in the retail sector. Experimental treatments were designed to allow determination of the demographic and behavioral characteristics that affect relative preferences and willingness to pay for Appalachian grass-fed beef and the marginal influences of various grass-fed beef attributes on consumer choice.

Review of Literature

In economic research, it is difficult to evaluate complex market phenomena using data from natural markets, where effects of interrelated variables or confounding historical contexts may go unaccounted. In the "field", relatively few aspects of the environment can be controlled, and researchers may have limited access to the economic agents of interest (Davis and Holt, 1993). Other observational sciences have overcome the obstacles inherent in the use of naturally occurring data by systematically collecting information in controlled laboratory conditions. Because controlled experimentation facilitates ceteris-paribus analyses in which the effects of variables of interest can be measured while stringently controlling for others, economists too have been implementing and perfecting the practice of gathering economic data in laboratory environments over the past few decades (Davis and Holt, 1993). The primary advantages of such methods, replicability and control, have encouraged application of experimentation to an increasingly broad range of economic research.

Historically, experimental methods in economics have been applied to issues such as the free rider problem, game theory dynamics, individual choice and expected utility over lotteries and certain outcomes, and documentation of regularities in relationships among observed economic variables (Davis and Holt, 1993). Experimental auctions, which are broadly defined as noncooperative games among bidders behaving competitively, account for a large proportion of all the work done in the experimental economics arena and are used to assess consumers' willingness to pay for novel private market goods or non-market public goods, or to otherwise induce elicitation of true, privately held values that cannot be validly obtained via *hypothetical* research instruments (Balistreri et al., 2001). Optimal auctions in the experimental context embody the essential constituents of procedural regularity, motivation, unbiasedness, and design parallelism critical for replicability and valid interpretation of findings (Davis and Holt, 1993).

In the laboratory, auction mechanisms such as the Vickrey 2nd price auction, the first-price sealed bid auction, or the English auction are typically administered. These are *competitive* auctions, in that "winning" the item or items for sale requires out-bidding fellow participants. In practice, English auctions are the most common and well-known and entail sequential bids being offered (open outcry) in response to an auctioneer progressively raising asking prices. Vickrey (1961) asserted that just as in English auction formats, the dominant strategy in 2nd price mechanisms would be to reveal true willingness to pay, without any consideration of the bidding strategies employed by competitors. The Vickrey auction involves bidders submitting sealed bids, with the person holding the highest valuation "winning" the item for sale but paying a price equal to the second-highest bid. Since final sale price (market price) is divorced from individual bids under such a structure, bidders have no incentive to misrepresent their actual preferences, and thus the Vickrey auction is said to be incentive-compatible, or demand revealing. The Vickrey auction was introduced to address the problem of ascertaining the highest bidder's actual willingness to pay in English auctions, since he or she doesn't bid their true valuation but instead simply bids marginally higher than the person with the second highest bid (Vickrey, 1961). Several authors (Coppinger, Smith and Titus, 1980; List and Shogren, 1999; Shogren et al., 2001; Kagel, Harsted and Levin, 1987) have tested and confirmed the hypothesis that Vickrey 2nd price auction formats are indeed incentive-compatible.

A non-competitive auction structure, namely the Becker-DeGroot-Marschak (BDM) mechanism, is commonly used in experimental setups outside of the laboratory. The BDM is not an auction per se, because subjects do not bid against one another, but instead submit sealed bids to experiment proctors and purchase the good in question if their bid is greater than a price randomly drawn from a distribution that is known to the bidder. In the original BDM application (Becker, Degroot, and Marschak, 1964), focus was on eliciting minimum seller prices, not maximum willingness to pay. Subjects were given tickets constituting the right to play a lottery and receive the resulting monetary payoff, and were then asked to state the smallest price for which he or she would be willing to sell the chance to play the lottery back to the experimental proctor. Buying prices for the lottery were drawn from a distribution known to the participants, and a sale was made if the randomly determined buying price exceeded the sale price offered by the participant. If no sale was made, the subject kept and played the lottery. On the other hand, if a sale *was* made, subjects received cash in an amount equal to the drawn buyer price.

Under the tenets of such a mechanism, Becker, Degroot, and Marschak (1964) suggested that, just as in the Vickrey and English formats, dominant strategy would be to reveal true WTA (or, WTP). Intuitively, a truthful revelation of privately held value is optimal under the BDM mechanism because the price (bid) reported by the seller (bidder) affects only the probability of making the sale (purchase), not the distribution from which bids (selling prices) are drawn. In other words, offered bids or selling prices are divorced from the ultimate market price, just as in Vickrey. Subjects should report a price that maximizes the probability of selling (buying) at a profit. For auctions in which the participant is the buyer, any bid higher than true WTP would increase the probability of purchase, but under unfavorable, or unprofitable, conditions. Likewise, bids lower than actual WTP decrease the probability of making a profitable purchase. As discussed, theory holds that due to similar bidding conditions, the non-competitive BDM mechanism and the isomorphic English and Vickrey auctions should yield similar bidder behavior.

To test this notion, Lusk, Feldkamp, and Schroeder (2004) conducted English, 2nd price, and BDM auctions for generic, guaranteed tender, natural, USDA Choice, and Certified Angus Beef (CAB) steaks in order to test theoretical predictions of bidding behavior and to determine the effects of an initial endowment on bidding behavior. The effect of endowment was considered because it is often the case in experimental auctions (especially BDM) that subjects are endowed with a good and are asked to bid to upgrade to a "higher quality" product. The advantage of endowment is that it isolates the effect of interest, namely, *relative* valuations of standard and quality-differentiated goods. Further, the endowment approach can be helpful in attracting participants in a field setting such as the grocery store. Rather than paying subjects to attend a laboratory setting, subjects can be given a lower quality good for participation and WTP for a higher quality good can be elicited. Despite the advantages of the endowment approach, it may introduce bias in WTP estimates. Tversky and Kahneman (1991) suggest that valuations may be reference dependent, i.e., individuals may place greater value on a good if they possess it than if they do not, an effect that is thought to arise from loss aversion (where losses are valued more highly than gains).

Participants in the Lusk, Feldkamp, and Schroeder (2004) study were either endowed with a generic steak and asked to bid to upgrade to one of the four higher quality products or were not endowed with anything and simply submitted bids under one of the three auction mechanisms. Results in both no endowment and endowment treatments suggested that bids elicited from the 2nd price auction were generally higher than those from other mechanisms, especially in later bidding rounds. Bids were not significantly different across the BDM and English auctions in either endowment treatment (as theory would predict). Further, English and BDM bids were not significantly affected by endowment treatment, but bids in the 2nd price auction were.

Agricultural economists are increasingly relying on controlled experimental auctions in assessing consumer perceptions of novel agricultural products including snack foods with varying levels of safety guarantee (Hayes et al., 1995), insecticide reduction in apples (Roosen et al., 1998), meat products with traceable origin (Dickinson and Bailey, 2002), beef produced with and without growth enhancers (Buhr et al., 1993), international grass-fed beef (Umberger et al., 2002), alternative packaging types for steak (Menkhaus et al., 1992), and non-genetically modified corn chips (Lusk et al., 2002). Auctions are conducted in non-hypothetical contexts that involve real goods and real money, unlike contingent valuation (CV) methods in which respondents are asked to reveal their WTP for goods or services without facing monetary consequences. As intuition would predict, Balistreri et al. (2001), Cummings, Harrison, and Rutstrom (1995), List and Shogren (1998), and other researchers have found WTP values solicited through experimental auction setups to be significantly lower than those obtained through hypothetical open-ended or dichotomous choice contingent valuation surveying.

The capacity of experimental auction procedures to mimic natural market conditions through active market feedback, incentive-compatible design, and imposition of actual monetary consequences for bidding behavior makes them ideal for determining consumer preferences for novel private market goods. Accurate assessment of consumer attitudes and preferences is imperative in an era of increasing product differentiation. Value-added production techniques, especially in the agricultural sector, have fundamentally impacted the variety and quality of products offered to consumers, and experimental economics play an increasingly important role in estimating new product premiums and targeting novel foods to specific consumer segments.

In practice, auctions in the experimental realm are generally sealed-bid in order to facilitate data collection and, in particular, the Vickrey auction and variants thereof and the BDM mechanism have earned favor because of their theoretically incentive-compatible properties. Vickrey procedures are typically carried out in the laboratory, while BDM auctions allow researchers to solicit individual participants in active market settings such as supermarkets. Both procedures have been used in assessment of consumer perceptions of and willingness to pay for alternative and commoditized beef products.

As an illustration of a beef marketing study conducted in an active market environment, Lusk et al. (2001) used a variant of the BDM mechanism to estimate consumer WTP for a higher level of steak tenderness and the influence of economic and demographic factors on WTP values. Data were collected from shoppers (313 in total) at three urban grocery stores, owned by a large regional chain. Shoppers approaching the meat counter were asked to participate in an experiment for which they would receive a free 12 oz. ribeye steak. To begin, those agreeing to participate were asked to fill out a short survey that required disclosure of basic demographic information and preferences for steak doneness and USDA quality grades.

Next, participants sampled two different types of steaks labeled simply as "Red" or "Blue" (where Red was actually "guaranteed tender" and Blue was "probably tough"). (Steaks used in sampling were deemed tender or tough according to an a priori WBSF test.) In treatment 1, consumers were not told that the samples differed in tenderness. Participants then responded to questions about which steak they preferred for the individual attributes of taste, tenderness, texture and juiciness and were given, free of charge, a Blue (probably tough) steak. If they preferred the Blue steak, the experiment ended. If Red was preferred, they were asked to indicate the most they would be willing to pay to exchange their Blue steak for the 12 oz. Red steak. Respondents were told that if their bid exceeded a predetermined price (unknown and exogenous to them), the exchange would be made at that predetermined price. If their bid was less than the predetermined market price to exchange, they kept their Blue steak.

In treatment 2, the demarcations Red and Blue were replaced with the descriptors "Guaranteed Tender" and "Probably Tough". That is, the consumers were provided information about the steaks in addition to their taste sampling. Results indicated that consumers could readily distinguish between tenderness levels via blind tasting and that many, but not all, were willing to pay a premium for the tender product. Specifically, 69% of participants in treatment 1 preferred the “Red” (guaranteed tender) steak, but only 36% of respondents were willing to pay to exchange their “Blue” steak for “Red. When information regarding tenderness was revealed (treatment 2), consumers were significantly more likely to prefer (84%) and express positive WTP (51%) for the tender steak. Average WTP (of those wiling to pay) was $1.23 per pound in Treatment 1 and $1.84 in Treatment 2. Explanatory models revealed that females and younger consumers were willing to pay more for the upgrade to the tender steak, but that income level did not significantly affect the amount respondents were willing to pay. Overall, the most important determinant of willingness to pay was the information treatment, suggesting that information and labeling have important economic impacts for quality-differentiated products.

Methodology

In studying relative consumer perceptions of and willingness to pay for commoditized and quality-differentiated food products, researchers rely on the assumption that consumers derive utility from consumption of distinct product attributes, not from the products themselves. Lancaster (1966) was the first to popularize the notion that a single good possesses more than one characteristic, and that goods are not the direct objects of utility but rather are secondary to the characteristics or attributes they embody in determining consumption behavior. Utility or preference orderings, according to Lancaster (1966), are assumed to rank collections of attributes and only to rank collections of *goods* indirectly through the attributes they possess.

As noted in the introduction, beef products embody four general types of attributes: observed, experience, nutritional, and process. The theory espoused above implies that individual consumer preference orderings for differentiated beef products will be based on rankings of the combinations, or bundles, of these attributes offered by each product. Between-consumer orderings will vary widely due to personally held perceptions of the importance of individual characteristics.

Joint consideration of work done by Bassman (1956), Capps and Schmitz (1991), and Baker and Crosbie (1993) allows construction of attributed-focused utility and demand functions for beef consumers, as follows: Consider a beef product x_1 offered at price p_1 and a vector of n alternative products, $\boldsymbol{x} = (x_2, \ldots, x_N)$, offered at prices corresponding to vector $\boldsymbol{p} = (p_2, \ldots, p_N)$. Product x_1 contains a vector of J quality attributes, $\boldsymbol{a}_1 = (a_{11}, \ldots, a_{1J})$; products $\boldsymbol{x}$ contain a matrix of attributes, $\boldsymbol{a} = \boldsymbol{a}_{ij}$, $i = 2, \ldots, I$, and $j = 1, \ldots, J$. Consumption *services* are provided by product attributes, and services are determined by

$$(1) \qquad s_k = s_k\,(x_1, \boldsymbol{a}_1, \boldsymbol{x}, \boldsymbol{a}), \;\; k = 1, \ldots, K$$

where K represents the full set of services offered by the consumption bundle.

The individual consumer's utility function and budget constraint are represented by

$$(2) \qquad U_i = u_i(s_1, \ldots, s_k; \theta_i\,(r, D)) \;\; \text{s.t.} \;\; p_1 x_1 + \boldsymbol{p'x} \leq m$$

where θ_i is a parameter vector defining the shape of the ordinal utility function. The vector (D) represents socioeconomic and demographic characteristics that have a direct effect on the shape of the utility function, and (r) is a vector of state variables that describe personal knowledge or concerns about product attributes (health concerns and knowledge of nutritional content, for instance). Changes in (r) are hypothesized to lead to changes in the parameters of the utility function, in turn giving rise to changes in s_k. Substituting for services in the utility function (2) yields

$$(3) \qquad U_i = u_i\,(x_1, \boldsymbol{a}_1, \boldsymbol{x}, \boldsymbol{a};\, \theta_i\,(r, D)) \;\text{ s.t. } p_1 x_1 + \boldsymbol{p'x} \leq m$$

Maximization of equation (3) with respect to x_1, given (r) and (D) yields a Marshallian demand function of the form

$$(4) \qquad x_1 = x_1\,(p_1, \boldsymbol{a}_1, \boldsymbol{p}, \boldsymbol{a}, m;\, \theta_i\,(r, D))$$

The resulting demand equation for beef products indicates that consumption depends not only on prices and income but also on embodied attributes and state variables describing personal knowledge and concerns. It is logical then to assume that willingness to pay for *grass-fed* beef products will vary across consumers according to demographics, personally held beliefs, and the amount and type of product attribute information offered. An experimental analysis of demand for grass-fed beef in which varying amounts of product information are offered across multiple treatments and in which demographic information and preferences for beef attributes are surveyed should allow determination of marginal valuation of individual attributes and identification of potential market segments. More specifically, because of the benefits associated with experimental *auction* procedures in eliciting true valuations, such mechanisms may prove valuable in identifying target consumer segments and in determining overall market potential for these specialty products.

Supermarket shoppers in one urban area (Pittsburgh, PA) and one urbanizing area (Morgantown, WV) of the Appalachian region were the focus of an experiment designed to facilitate revelation of relative preferences and willingness to pay for Appalachian grass-fed beef and commoditized grain-fed beef products. Specifically, experiments were conducted across four weeks in October and November, 2006 at two conventional retail grocery stores in

Morgantown (Giant Eagle and Cheat Lake Shop N' Save), a retail grocery store in Pittsburgh (Lawrenceville Shop N' Save), and a large food cooperative in Pittsburgh (East End Food CoOp). Two days were spent at each venue (Thursdays and Saturdays), and sessions were conducted from approximately 9:00 a.m. to 6:00 p.m. each day. Both a weekday and a weekend day were chosen in order to capture a more representative sample of supermarket shoppers.

In line with much of the previous research aimed at assessing consumer perceptions of beef products in general, preference and willingness to pay data were collected in-store for ribeye steaks. Ribeyes are high-value cuts with which most consumers are familiar. Unlike other studies, though, ground beef was also used since many beef consumers who do not typically purchase steaks may frequently purchase ground beef because of its mass availability, ease of preparation, versatility, and relative inexpensiveness (Eales and Unnevehr, 1988). Grain-fed ribeye steaks were fabricated from the right 107 rib primal of 12 Angus/Angus-cross steers that were wintered in Reedsville, WV on harvested forage and then finished on a high energy, 70% corn silage diet. Grass-fed ribeyes were fabricated from the same rib section of 12 Angus/Angus-cross steers that were finished on Alfalfa at the *West Virginia University Demonstration Farm at Willow Bend* in Monroe County, WV. Grain-fed and grass-fed ground beef samples were fabricated from trimmed 114 shoulder clods from the same 24 animals. Rib primals and shoulder clods were wet aged for 14 days at 38^{o}F prior to fabrication at a USDA inspected slaughter facility in Preston County, WV. Ribeyes were cut to one inch thick, trimmed of external fat, vacuum sealed, and flash frozen at 0^{o}F. Similarly, ground beef was flash frozen in one-pound vacuum seal packs. All grain-fed carcasses received USDA quality grades ranging between Choice^{-} and Choice^{+}, while grass-fed carcass grades ranged from Standard^{+} to Select^{+}.

Approximately half of the grain-fed shoulder clods qualified for the “Certified Angus Beef” marketing claim and were labeled as such.

An in-store procedure (as opposed to laboratory experimentation) was chosen for this study primarily because it allows more precise targeting of the population of interest, namely meat buyers. Lusk et al. (2001) note that although sample selection bias may still arise in the grocery store since not every shopper will participate, bias will likely be smaller than in laboratory experiments because participation involves less inconvenience for the subject. Further, grocery store participants complete experiments in natural market settings where market prices are readily observed and where decisions between alternative products are routinely made, while the unfamiliar setting of the laboratory may induce irrational behavior (Lusk et al., 2001). Because participants in the in-store setup are assessed on an individual basis (as opposed to assessment of groups in laboratory settings), a variant of the BDM mechanism was employed.

At each experimental venue, a sign advertising the research project with information about general procedure and participant compensation was placed in front of the setup (two 24”X48” tables in an “L” formation). All shoppers approaching the setup were invited to participate, with a maximum of four persons participating at any given time (due to limited space and manpower). Only one person (the primary shopper) per household unit was allowed to participate. Upon agreeing to participate, subjects were asked to provide information on a survey that, based on a priori trials, was said to take three to four minutes to complete. Survey instruments contained questions regarding meat purchasing behavior, beef consumption patterns, concerns over currently available beef products, the importance of various beef attributes, knowledge of the definition of “grass-fed”, and basic demographic information.

After completing the survey, respondents were randomly assigned to evaluate either steak or ground beef samples (assignment to product and treatment by participant i.d. number was done prior to experimental sessions). Experimental treatments for steak assessment were arranged according to a 3X2 factorial design, and are summarized in Table 1. Most generally, treatments varied according to the amount of product information offered to respondents and the USDA quality grade of the grass-fed test product. All participants in steak treatments were presented with raw grain-fed and grass-fed ribeye samples of similar size and shape in overwrapped Styrofoam trays labeled as "A" and "B" for visual appraisal. It can be said, in general, that treatments 1:1 and 1:2 facilitate revelation of preferences and willingness to pay based on observed and nutritional attributes only. In contrast, responses in treatments 2:1 and 2:2 are based on observed, nutritional, and process attributes, and treatments 3:1 and 3:2 were established to acquire feedback based on all four beef attribute types (observed, nutritional, process, *and* experience).

Table 1. Steak Experimental Treatments (N=203)

Treatment	Evaluation Method	Grass-Fed Steak USDA Grade	Production Info Given?	Nutritional Info Given?
1:1	Visual Appraisal	Standard	No	Yes
1:2	Visual Appraisal	Select	No	Yes
2:1	Visual Appraisal	Standard	Yes	Yes
2:2	Visual Appraisal	Select	Yes	Yes
3:1	Visual Appraisal + Taste	Standard	Yes	Yes
3:2	Visual Appraisal + Taste	Select	Yes	Yes

In treatments 1:1 and 1:2, USDA grades of the steak samples were made known to the participants (Standard grade steaks were labeled as "USDA inspected", as is common practice in retail; all grain-fed samples were labeled as USDA Choice), along with relative nutritional information. Objective nutritional information was derived from the meat science literature and was focused on fatty acid composition (percentage of total fat as saturated fat, percentage of total fat as CLA, and percentage of total fat as Omega-3 fatty acids). Nutritional data reported to participants were the averages of those found in the studies consulted. In order to account for the fact that participants may not be familiar with the various fatty acid types and their implications for human health, brief parenthetical statements about the health effects of each fatty acid, drawn from cited literature, were also presented. USDA Grade and nutritional information were presented on laminated 6"X10" cards that were placed in front of the respective steak samples. The only difference between treatments 1:1 and 1:2 was the USDA grade of the grass-fed steak presented ("USDA inspected" for 1:1 and "USDA Select" for 1:2).

In Treatments 2:1 and 2:2 (differentiated only by grass-fed sample quality grade, as in treatments 1:1 and 1:2), the information discussed above was presented to participants, but, in addition, information cards revealed process attributes for each steak. Specifically, grain-fed steaks were labeled as "Grain-fed" and grass-fed steaks were labeled as "Grass-fed in Appalachia". Finally, in treatments 3:1 and 3:2, participants first tasted grass-fed and grain-fed steak samples and rated them for flavor, tenderness, juiciness, and overall acceptability on an eight-point scale before visually appraising the raw products and receiving the same information presented in 2:1 and 2:2. Again, grass-fed steak quality grades differed between 3:1 and 3:2. (Participants in treatments 3:1 and 3:2 were told to evaluate steaks based both on their taste experiences *and* on the visual appraisal and information provided.)

Steaks for taste treatments were prepared on a Hamilton-Beach indoor-outdoor grill at the experimental setup. All were cooked to an internal temperature of approximately 100^{o}F, flipped, then removed from the grill upon reaching 160^{o}F (this generally took between 12 and 14 minutes for each pair of samples). Cooked steaks were trimmed of any external fat, then cut into ½ inch cubes using a cutting board with a pre-measured ½ inch grid. Each participant in the taste treatments (3:1 and 3:2) was given two cubes of each sample in separate lidded sampling cups, labeled “A” and “B”, and toothpicks, water, and saltines were made available. Care was taken to serve all samples warm within two minutes of cooking. Rating for palatability characteristics was done immediately after tasting each individual sample. Inclusion of taste treatments in this analysis was based on the assumption that repeat purchases of grass-fed products in real markets would largely be contingent upon consumer satisfaction with experience attributes. Further, testing grass-fed products of two distinct quality grades should provide some insight into acceptable finish conditions for grass-fed animals.

Participants randomly selected to assess ground beef products were similarly assigned to treatments according to a 2X2 design, and treatments differed according to the level of process information provided and labeling of the grain-fed product (“100% Ground Beef” vs. “Certified Angus Beef”) (see Table 2 for treatment summary). As in the steak experiments, all participants were presented with raw one-pound grass-fed and grain-fed ground beef samples in overwrapped styrofoam trays labeled as “A” and “B” for visual appraisal. Regardless of treatment and according to analysis done at the processing facility, information cards for grass-fed samples revealed a lean:fat ratio of 85:15, while those for grain-fed samples were labeled as 80:20.

Table 2. Ground Beef Experimental Treatments (N=148)

Treatment	Evaluation Method	Grain-Fed Beef Label	Production Info Given?	Nutritional Info Given?
1:1	Visual Appraisal	100% Ground Beef	No	Yes
1:2	Visual Appraisal	Certified Angus Beef	No	Yes
2:1	Visual Appraisal	100% Ground Beef	Yes	Yes
2:2	Visual Appraisal	Certified Angus Beef	Yes	Yes

In ground beef treatment 1:1, information cards contained the same relative fat content and health information presented in the steak treatment discussion above and both grain-fed and grass-fed samples were labeled as “100% Ground Beef”. In treatment 1:2, grain-fed samples were labeled as "Certified Angus Beef" instead of "100% Ground Beef". Similar to the steak experiments, information cards in treatments 2:1 and 2:2 revealed production information ("Grain-fed" vs. "Grass-fed in Appalachia"). Taste treatments were not included in the ground beef assessment because of irremediable inconsistencies in within-sample meat doneness and between-sample cooking times. The "Certified Angus Beef" label was included for assessment because of its status as a well-established brand that has enjoyed notable success in recent years and that may, in and of itself, influence relative preferences for grass-fed and grain-fed products.

After being assigned to a treatment and assessing the products presented, respondents were then asked to state, based on the information provided, which sample they preferred overall ("A" or "B"), or if they were indifferent between the two. Participants were also asked to state the primary reason for their preference, which was recorded by the experimenter on each individual participant's Preference/Bid sheet. Finally, a variant of the BDM mechanism was employed to determine each respondent's willingness to pay for their preferred product. For consistency, the following instructions were given to all participants:

"You have indicated that you prefer product <u>(A or B)</u>. For your participation today, we will give you, free of charge, the <u>(steak or ground beef)</u> product that you *did not prefer*, plus a $5.00 gift card for <u>(venue)</u>. Or, you can tell me how much of the $5.00 gift card you would be willing to give up to exchange your free <u>(steak or ground beef)</u> product for the product that you actually preferred. If this bid to exchange is greater than an amount that we've determined ahead of time, you will receive your preferred product plus a gift card worth $5.00 minus our pre-set amount."

This procedure is similar to the BDM mechanism used in other in-store empirical applications in that participants are initially offered the product that they do not prefer and are asked to submit a bid to upgrade to their preferred product. In this manner, *magnitude* of preferences can be determined via elicitation of relative valuations for sample products. Use of gift cards is rather novel in such applications, though, and was employed here to account for situations in which respondents do not have cash on hand to pay for upgrades.

The “pre-set amount” alluded to above is equivalent to the market price in BDM applications, and it is generated independently of the bidder’s purchase offer. While market prices are typically drawn from a known distribution with each new bidder in conventional BDM applications, here, as in Lusk et al. (2001), market price was pre-set at $0.25 for all bidders in both ground beef and steak rounds. Therefore, those participants bidding $0.25 or more for the upgrade received their preferred product plus a gift card worth $4.75.

After stating their bids to exchange, participants were made aware of the pre-set market price to exchange ($0.25) and were given their beef product, gift card, and a letter explaining the study with researcher contact information for follow-up questions and comments.

After all experimental sessions were completed and collected data was coded and organized, various statistical analyses were performed. In order to define relative preferences for grass-fed and grain-fed beef products (both steaks and ground beef) as functions of participant characteristics and experimental treatments, probit models were constructed. In a binary response model such as the probit, interest lies primarily in the response probability

(5) $$P(y = 1 \mid \mathbf{x}) = P(y = 1 \mid x_1, x_2, \ldots, x_k),$$

where **x** is used to denote the full set of explanatory variables. The dependent variable, y, can be interpreted as the probability of an individual making a choice (e.g., voting for a particular candidate or, in this study, stating a preference for grass-fed beef) given their respective values for explanatory variables (Pindyck and Rubinfeld, 1981). The probit model translates the values of the explanatory variables, **x**, which may range in value over the entire real number line, into a probability which ranges from zero to one (Pindyck and Rubinfeld, 1981). The probit model takes on the following general form:

(6) $$P(y = 1 \mid \mathbf{x}) = G(\beta_0 + \beta_1 x_1 + \ldots + \beta_k x_k)$$

where G is a function taking on values strictly between zero and one, ensuring that the estimated response probabilities are strictly between zero and one, and β represents parameters (coefficients) for each of the k explanatory variables. Specifically, in the probit model, G is the standard normal cumulative distribution function (cdf), which is expressed as an integral:

$$(7) \qquad G(z) = \Phi(z) = \int_{-\infty}^{z} \varphi(v)\, dv,$$

where $\varphi(z)$ is the standard normal density

$$(8) \qquad \varphi(z) = (2\pi^{)-1/2}\exp(-z^2/2).$$

More simply put, the probability of outcomes in the probit model is given by

$$(9) \qquad P(y = 1) = \Phi(-X_i\, \beta_1),$$

where X_i is a row vector of K explanatory variables, β_1 is a column vector of K parameters (the probit estimators), and Φ is, again, the standard normal cumulative distribution function (CDF) (Lin and Schmidt, 1984).

In the current study, Y_i denoted participants' preference between test and control products and was assigned to take on the value 1 if respondents preferred the grass-fed product, and 0 if they preferred the grain-fed product. Explanatory variables included were those experimental, demographic, and consumption/shopping behavior variables that theoretically should have some impact on choices among beef products and that have been shown in other studies of consumer behavior to be important in determining preferences for specialty food products.

Specifically, the probit model for participant preferences in steak treaments was specified as follows:

$$(10) \qquad P(PREF = 1) = \beta_0 + \beta_1 TMT1X2 + \beta_2 TMT2X1 + \beta_3 TMT2X2 + \beta_4 TMT3X1 + \beta_5 TMT3X2 + \beta_6 PITT + \beta_7 AMOUNT + \beta_8 FREQUENCY + \beta_9 LOCAL + \beta_{10} PRICE + \beta_{11} KNOWLEDGE + \beta_{12} HEALTH + \beta_{13} CHOICE + \beta_{14} GRASSFED + \beta_{15} VENUE +$$

$\beta_{16}PRIMARY + \beta_{17}FEMALE + \beta_{18}AGE + \beta_{19}AG + \beta_{20}INCOME + \beta_{21}EDUCATION +$

$\beta_{22}HOUSEHOLD$

Similarly, the probit model for participant preferences in ground beef treatments was specified as follows:

$$\text{(11)} \quad P(PREF = 1) = \beta_0 + \beta_1 TMT1X2 + \beta_2 TMT2X1 + \beta_3 TMT2X2 + \beta_4 PITT + \beta_5 AMOUNT + \beta_6 FREQUENCY + \beta_7 LOCAL + \beta_8 PRICE + \beta_9 KNOWLEDGE + \beta_{10} HEALTH + \beta_{11} CHOICE + \beta_{12} GRASSFED + \beta_{13} VENUE + \beta_{14} PRIMARY + \beta_{15} FEMALE + \beta_{16} AGE + \beta_{17} AG + \beta_{18} INCOME + \beta_{19} EDUCATION + \beta_{20} HOUSEHOLD$$

Included variables are summarized in Table 3. Note that the model for ground beef preferences does not contain the variables *TMT3X1* or *TMT3X2* since taste treatments (3:1 and 3:2) were only carried out in steak sessions. It was expected in both steak and ground beef models that provision of production process information would positively affect preferences for the grass-fed products and that testing Select products in the steak treatments instead of Standard would have the same effect. It was also expected that labeling the grain-fed product as "Certified Angus Beef" in ground beef treatments (TMT 1:2 and TMT 2:2) would negatively impact the probability of preferring grass-fed.

Completed probit models were assessed according to the following indicators: the log-likelihood function, the McFadden R^2, and calculation of the percent of outcomes correctly predicted by the model. The Maximum Likelihood Estimation of $\boldsymbol{\beta}$ maximizes the log likelihood function, or, in other words, maximizes the probability of observing the given *Y*'s (Gujarati, 2004; Wooldridge, 2006). LIMDEP reports the log-likelihood function for probit models and automatically conducts a likelihood ratio (LR) test, which is essentially the same concept as the F test in linear models in that the significance of the model as a whole is being tested, as opposed to the statistical significance of individual explanatory variables.

Table 3. Variable Definitions

	Experimental Variables
BID	For grass-fed preferring respondents, the bid to upgrade to the grass-fed product ($0-$5); For grain-fed preferring respondents, the bid to avoid getting the grass-fed product (-$5-$0).
PITT	1 if respondent surveyed in Pittsburgh; 0 if in Morgantown
PREF	0 if respondent preferred grass-fed; 0 if respondent preferred grain-fed
TMT 1X2	1 if respondent assigned to treatment 1X2, 0 otherwise
TMT2X1	1 if respondent assigned to treatment 2X1, 0 otherwise
TMT2X2	1 if respondent assigned to treatment 2X2, 0 otherwise
TMT3X1	1 if respondent assigned to treatment 3X1, 0 otherwise
TMT3X2	1 if respondent assigned to treatment 3X2, 0 otherwise
	Demographic Variables
AG	1 if respondent/respondent's family involved in agriculture; 0 otherwise
AGE	Age (in years) of respondent
EDUCATION	Highest education level attained 1=Less than high school diploma; 2=High school diploma or GED; 3=Some college/technical school; 4=College degree; 5=Graduate school
FEMALE	1 if female; 0 if male
HOUSEHOLD	Number of persons in household
INCOME	Household annual after-tax income level 1=Less than $20,000; 2=$20,000-$39,999; 3=$40,000-$59,999 4=$60,000-$79,999; 5=$80,000-$99,999; 6=$100,000+
	Shopping/ Consumption Variables
AMOUNT	Amount ($) spent on meat per week
CHOICE	1 if respondent indicated that they look for USDA grade Choice or higher when purchasing beef products; 0 otherwise
FREQUENCY	No. of times per month that steak or ground beef is prepared in-home
GRASSFED	1 if respondent has purchased grass-fed products previously; 0 otherwise
PRIMARY	1 if respondent is primary decision-maker concerning meat purchases in household; 0 otherwise
SPECIALTY	Number of types of specialty meat previously purchased by respondent
VENUE	1 if respondent most often buys meat products from any venue except conventional retail grocery stores; 0 if most often buys from conventional store
	Other Variables
HEALTH	1 if respondent indicated concern for health; 0 otherwise
KNOWLEDGE	1 if respondent answered grass-fed knowledge question correctly *and* in treatments in which production process was revealed; 0 otherwise
LOCAL	Respondent's ranking of importance of local production 1=Not important; 2=Somewhat important; 3=Important; 4=Very important
PRICE	Respondent's ranking of importance of product price 1=Not important; 2=Somewhat important; 3=Important; 4=Very important
PRODUCTION	1 if respondent indicated concern for production practices; 0 otherwise

After probit models for ground beef and steak preference were completed according to the functional forms specified in (10) and (11), each individual variable was iteratively dropped from the models to test using the LR statistic and critical values for the χ^2 distribution whether the fall in the log likelihood attributed to the omission was large enough to conclude that the variable added any degree of explanatory power to the model. Those variables shown to provide no measurable effect on the modeling outcome were excluded from the final models that are reported in the results section.

Following construction of probability models for participants' preferences, attention was focused on modeling bidding behavior. Participants were asked, after stating their preference, to reveal how much of their complimentary $5.00 gift card they would be willing to give up to exchange their free beef product for the one that they actually preferred. Thus, all upgrade bids ranged from $0.00 to $5.00.

Differences in individual upgrade bids were assumed to reflect differences in underlying respondent characteristics and to speak to the *magnitude* of individual participants' preferences. For data analysis purposes, nonzero bids submitted to obtain grain-fed products were assumed equivalent to *negative* bids for the grass-fed product (or, in other words, positive bids for grain-fed products were considered a willingness to pay to *avoid* the grass-fed product). For instance, a grain-fed preferring participant's upgrade bid of $3.00 was assumed equivalent to a bid of -$3.00 for the grass-fed product. Thus, because of the nature of the data collection process, bids for grass-fed products were essentially left-censored at -$5.00 and right-censored at $5.00. This means, for instance, that if a participants' actual willingness to pay to obtain the grass-fed product was $6.00, their actual valuation would not be observed since his or her stated bid could not surpass \$5.00. Actual willingness to pay was only observed for those participants bidding within the -\$5.00 to \$5.00 range.

As is the case here, censoring in economic data is typically due to survey design or institutional constraints (Wooldridge, 2006). Rather than assessing censored data with conventional OLS methods or using the Tobit model, which is designed for datasets with a high proportion of limit outcomes (corner solutions), the problem is typically solved using a censored regression model. The particular issue addressed by a model of this type is one of missing data on the dependent variable—for those observations that fall at the limits of all possible values for *y* (e.g., -\$5.00 or \$5.00 for the current study), all that is known is that the observation is at least as large as the limit. An OLS regression using only uncensored observations, or, those that fall within the \$5.00 to -\$5.00 range, would yield inconsistent parameters (Wooldridge, 2006). Specifically, a censored *normal* regression model was used in this analysis, with both right and left censoring (at \$5.00 and -\$5.00).

In general form, the censored normal regression model with right censoring can be represented as follows (Wooldridge, 2006):

(12) $y_i = \beta_0 + \mathbf{x}_i \boldsymbol{\beta} + u_i,\ u_i \,|\, \mathbf{x}_i, c_i \sim \text{Normal}(0, \sigma^2)$

where y_i is the observation of the dependent variable for an individual, $\boldsymbol{\beta}$ represents model parameters, $\mathbf{x}_i$ represents the set of all explanatory variables, u_i is an error term, and c_i is the right-censoring value for y_i. As described above, y_i is only observed if it is less than c_i. It can be said that what is actually observed is a latent variable, w_i, which has the following relationship with y_i and c_i (Wooldridge, 2006):

(13) $w_i = \min(y_i, c_i)$

(Thus, when y_i is less than the censoring value, c_i, then y_i is actually observed. When it is not, c_i is observed.) Using (12) and (13), $\boldsymbol{\beta}$ can be estimated using Maximum Likelihood Estimation. To do this, the density of w_i given (x_i, c_i) must be calculated (Wooldridge, 2006). Again, for uncensored observations, $w_i = y_i$, and the density of w_i is the same as that for y_i [Normal ($\mathbf{x}_i \boldsymbol{\beta}$, σ^2)]. For censored observations, it is necessary to compute the probability that w_i actually equals the censoring value c_i, given x_i, as follows (Wooldridge, 2006):

$$(14)\ P(w_i = c_i \mid \mathbf{x}_i) = P(y_i \geq c_i \mid \mathbf{x}_i) = P(u_i \geq c_i - \mathbf{x}_i \boldsymbol{\beta}) = 1 - \Phi[(c_i - \mathbf{x}_i \boldsymbol{\beta})/ \sigma]$$

where P denotes probability, and Φ is the standard normal cumulative distribution function (CDF). From (14), the density of wi, given (xi, ci) can be obtained, as follows (Wooldridge, 2006):

$$(15)\ f(w \mid \mathbf{x}_i, c_i) = 1 - \Phi[(c_i - \mathbf{x}_i \boldsymbol{\beta})/ \sigma] \text{ for } w = c_i \text{ and}$$

$$= (1/ \sigma)\ \varphi\ [(w - x_i \boldsymbol{\beta})/ \sigma] \text{ for } w < c_i$$

where φ denotes the standard normal density. As discussed earlier in this chapter, the objective of Maximum Likelihood Estimation is to maximize the sum of the log likelihood values for each *i,* which are obtained by taking the natural log of (15). The parameters, $\boldsymbol{\beta}$, can be interpreted just as they are in linear regression models (Wooldridge, 2006). While the above represents the theoretical underpinning for right-censoring, the same logic holds for left-censoring and two-tailed (left *and* right) censoring, as was used in the current analysis.

Specifically, the censored normal regression models for bidding behavior in both the steak and ground beef groups were formulated using the same explanatory variables specified for the probit models, with the dependent variable BID left-censored at -$5.00 and right-censored at $5.00 (as defined in Table 3). As with the probit models, the censored normal regression models for bidding behavior were pared down after completion using the LR statistic to improve model diagnostics and to more precisely gauge the influences of explanatory variables.

Results and Conclusions

Across eight experimental sessions, a total of 351 shoppers were surveyed, with 203 assigned to steak treatments and 148 to ground beef. A majority of respondents in both participant groups were female. This result is not surprising, however, given the disproportionate share of household grocery shopping done by females, and is similar to the gender breakdown in other in-store surveys (e.g., Lusk et al., 2001). Over 90% of respondents were born in the U.S., while only a small portion reported a personal or family background in agriculture (16% for steak participants; 11% for ground beef participants). In general, participants represented a wide range of demographics. For example, ages across both groups ranged from 18 to 84, and educational attainment ranged from less than a high school diploma to at least some graduate school. Reported ranges and averages for the amount of money spent on meat per week are similar between the groups, as are average in-home preparation frequencies for steak and ground beef. Though participants were largely representative of the populations of interest (Morgantown, WV and Pittsburgh, PA), discrepancies between sample and population statistics in both study locations may be reflective of the fact that only *grocery shoppers* were sampled, and these persons may be somewhat different from the population at large in terms of educational attainment, age, and household size.

As can be seen in Table 4, an overwhelming majority of participants in both steak and ground beef treatments expressed preference for the grass-fed products.

Table 4. Stated Preferences*				
	STEAK		GROUND BEEF	
	N	Percentage	N	Percentage
Grass-Fed Preferring	150	73.9%	121	81.8%
Grain-Fed Preferring	53	26.1%	27	18.2%

*Percentage of respondents preferring grass-fed is not significantly different (p<.05) between steak and ground beef groups. A significantly higher (p<.05) percentage of respondents in both groups preferred grass-fed.

Participants assessing steak and preferring grain-fed were most frequently responding to visual appraisal of the relatively high degree of marbling therein, with a smaller proportion responding to the actual USDA grade label. Further, 38% of grain-fed preferring participants in the steak group cited taste as the primary reason for their preference. Approximately 34% of all participants in steak treatment 3 (taste treatment) preferred the grain-fed product, and 81% of these respondents cited "taste" as the primary reason for their preference. Grass-fed preferring participants in the steak group cited visual fat content (39%) and nutritional information (31%) as the most common primary reasons for stated preferences. Approximately 50% of grass-fed preferring respondents based their preferences upon visual appraisal of "appearance" or "visual fat content", suggesting that the appeal of grass-fed products may largely be rooted in core observed attributes. Numerous participants stated that the grain-fed product had too much intramuscular fat and subsequently chose the grass-fed product, regardless of additional offered information.

In total, 81% of grass-fed preferring respondents cited either observed (appearance and visual fat content) or nutritional (nutritional information) attributes as the primary determinants of their stated preferences, suggesting that marketing efforts for grass-fed products should be focused on embodied human health benefits and the composition of total fat content. Only 7% of grass-fed preferring respondents cited "taste" as the reason for their preference, while approximately 66% of all participants in treatment 3 (taste treatment) expressed overall preference for the grass-fed product (recall, those in treatment 3 received all product information offered in treatment 2 after tasting grain-fed and grass-fed samples). Of those in treatment 3 who preferred the grass-fed product overall, 29% cited taste as the primary reason for their preference (as opposed to the 81% of grain-fed preferring participants in treatment 3 cited above). Only 9% of all grass-fed preferring participants in steak treatments cited the grass-fed label as the primary reason for their preference (this figure is 11% when considering only those participants exposed to the "Grass-fed in Appalachia" label, i.e., participants in treatments 2 and 3). No grass-fed preferring participants in the steak group cited USDA grade as the primary determinant of their preference.

In the ground beef treatments, the "Certified Angus Beef" (CAB) label influenced grain-fed preferences more than other attributes (specifically, 52% of all grain-fed preferring respondents cited this as the primary determinant of their preference). Of those participants exposed to the CAB label (treatments 1:2 and 2:2), 20% preferred the grain-fed product, and 88% of these participants cited the label as the primary reason for their preference.

For grass-fed preferring individuals in the ground beef treatments, the lean:fat ratio was the single most commonly cited primary reason for stated preferences, while appearance and nutritional information together accounted for nearly 50% of all grass-fed preferences. This, as noted earlier, suggests that grass-fed products may be met with consumer acceptance at the retail level based solely on observed and nutritional attributes. As in the steak treatments, only a few respondents (14% overall) cited the grass-fed label as the primary reason for stated preferences (this figure is 15% when considering only those participants exposed to the "Grass-fed in Appalachia" label, i.e., participants in treatment 2).

In terms of palatability, Table 5 reveals that participant ratings of overall steak acceptance and juiciness were significantly higher ($p<.10$ and $p<.05$, respectively) for grain-fed samples than for grass-fed samples. However, ratings for flavor and tenderness were not significantly different. Confidence intervals suggest greater variability in grass-fed steak palatability. Despite this, a majority (66%) of participants in treatment 3 (taste treatment) preferred the grass-fed product overall, as noted earlier. This suggests that although experience attributes may be critical in determining consumer satisfaction, preferences here were based on consideration of *all* product attributes made known to participants.

Table 5. Steak Palatability Ratings*

Product	**Flavor**		**Juiciness**		**Tenderness**		**Overall**	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Grass-fed (*All*)	6.32_{ab}	1.12	5.95_{a}	1.35	6.39_{ab}	1.39	6.27_{a}	1.17
Standard	5.92_{a}	1.06	5.65_{a}	1.44	6.04_{a}	1.48	6.00_{a}	1.23
Select	6.89_{b}	0.96	6.39_{ab}	1.09	6.89_{b}	1.07	6.67_{ab}	0.97
Grain-fed (*Choice*)	6.50_{b}	1.00	6.64_{b}	0.99	6.66_{b}	0.89	6.66_{b}	0.83

*Means in the same column with different subscripts are significantly different

Between-grade differences in palatability ratings were also assessed, and those results are also presented in Table 5. As can be seen, no palatability ratings for Select grass-fed steaks were significantly different from those for Choice grain-fed steaks. However, ratings on *all* palatability attributes were significantly lower for Standard grass-fed steaks than for the grain-fed samples, and Standard steaks were rated significantly lower than Select steaks on all attributes except juiciness. Further, rating *ranges* indicate a higher probability of negative taste experiences with Standard steaks, given that ratings of "very undesirable" and "moderately undesirable" were reported only for these samples. It is likely that the differences in overall acceptability and juiciness between grass-fed and grain-fed steaks revealed in Table 5 are largely attributable to the inferior ratings given to Standard steaks within the grass-fed group, given that no significant palatability differences were found between *Select* grass-fed and Choice grain-fed samples. Overall, palatability tests suggest that the experience attributes embodied in grass-fed beef products are of sufficient quality to encourage repeat purchases, particularly if animals fed under such protocol are finished to a USDA quality grade of Select or better.

As discussed in the methodology section, probit models were constructed to explain participant preferences in both steak and ground beef groups. Probit estimators and marginal effects obtained in these models are reported in Tables 6 (steak) and 7 (ground beef). According to Wald Tests and Likelihood Ratio (LR) statistics, both models proved overall significant in explaining participant preferences, and each was able to correctly predict approximately 90% of observations.

Table 6 reveals that preferences for grass-fed steaks were significantly influenced by frequency of in-home steak preparation, amount spent on meat per week, gender, participant ranking of the importance of local production and price, whether the participant had purchased grass-fed meat previously, whether the participant typically looks for USDA Choice or higher when buying beef, whether participants described themselves as primary decision makers for meat purchase decisions, and whether participants were surveyed in Pittsburgh as opposed to Morgantown. As expected, modeling revealed that females and those who had previously purchased meat products labeled as "grass-fed" were significantly more likely to prefer the grass-fed steak. This result is in line with findings from numerous other studies of consumer preferences for organic and natural food products, including Byrne et al. (1991), Conner and Christy (2002), Wolf and Thulin (2000), and Ziehl, Thilmany, and Umberger (2005). Each of these authors reported significantly higher likelihoods of preferring the test (natural or organic) product for females and for those who had previously purchased items similar to the test product. In the current model, marginal effects reveal that being female increased the probability of

Table 6. Probit Model Results for Steak Preference (n=203)

Variable	Coefficient (Standard Error)	Marginal Effect
Constant	0.16 (0.69)	------
TMT1X2	-0.83 (0.51)	------
TMT2X1	-0.69 (0.48)	------
TMT2X2	-0.47 (0.46)	------
TMT3X1**	-1.24 (0.52)	-42.8%
TMT3X2	-0.60 (0.53)	------
Pitt**	0.57 (0.25)	14.4%
Amount**	-0.01 (0.00)	-0.3%
Frequency*	0.09 (0.05)	2.4%
Local*	0.22 (0.12)	5.8%
Price*	-0.23 (0.13)	-6.2%
Grassfed*	0.44 (0.26)	11.2%
Choice**	-0.63 (0.24)	-17.2%
Primary**	1.13 (0.39)	39.4%
Female**	0.92 (0.24)	26.1%

LR Stat = 60.12; Prob=.0000
McFadden $R^2 = 0.26$
Percent Correctly Predicted = 92%

*=p<.10; **=p<.05

Table 7. Probit Model Results for Ground Beef Preference (n=148)

Variable	Coefficient (Standard Error)	Marginal Effect
Constant	-0.58 (0.41)	------
Amount	0.01 (0.01)	------
TMT1X2	0.70 (0.48)	------
TMT2X1**	0.76 (0.38)	14.9%
TMT2X2*	0.66 (0.39)	12.6%
Female**	1.32 (0.29)	32.6%
LR Stat = 26.77; Prob=.0000		
McFadden R^2 = 0.19		
Percent Correctly Predicted = 86%		

*=p<.10; **=p<.05

preferring grass-fed by 26%, and that those who had previously purchased grass-fed products were 11% more likely than those who had not to prefer grass-fed steak.

Frequency of in-home steak preparation had a small but significant positive effect on preference for grass-fed, while amount spent on meat per week had a significant negative effect. These results imply that grass-fed products may find more favor with “beef eaters” than with those who spread their grocery dollars over a larger variety of meat types, and are similar to those reported by Menkhaus et al. (1988), who explored preferences for natural beef products. As expected, participants ranking “locally produced” as important were significantly more likely to prefer the grass-fed steak, while the opposite effect was found for those ranking “price” as important. Price-conscious consumers may be more accustomed to commoditized retail beef products and may, in general, be averse to specialty products that typically sell at price premiums. Marginal effects reveal that participants who reported that they look for USDA grade Choice or higher were 17% less likely than others to prefer the grass-fed product. This result confirms expectations, but it should be noted that a majority of participants who reported looking for Choice or higher still chose the grass-fed product.

Underhill and Figueroa (1996) found that urban dwellers were more likely than suburban or rural households to purchase organic meat products, and the result here is similar. Specifically, participants surveyed in Pittsburgh were 14% more likely than those surveyed in Morgantown to prefer grass-fed. However, this result may be attributable to the fact that one of the Pittsburgh venues was a food cooperative, and shoppers at such venues may be intrinsically more likely to prefer non-commoditized, process conscious products. However, the dummy variable “VENUE”, which was coded as 1 if participants indicated that they bought most meat products at venues other than conventional supermarkets, and 0 otherwise, proved insignificant in the model as originally constructed and was omitted from the final reported version based on results of likelihood ratio tests. That those participants reporting themselves to be the primary household decision-makers for meat purchases were significantly (39%) more likely than others to prefer the grass-fed steak may indicate that those who are familiar with the selection of steaks available for purchase in retail and the palatability experiences associated with them find the relative leanness of the grass-fed product novel but acceptable.

In terms of experimental treatment variables, Table 6 reveals that the probability of preferring grass-fed steak in treatments 1:2, 2:1, 2:2, and 3:2 was not statistically different from that associated with treatment 1:1 (which was used as the base for this series of dummy variables). However, those in treatment 3:1, in which respondents tasted Standard-grade grass-fed steak, were significantly less likely to prefer grass-fed than all others (specifically, 43% less likely). This result is not surprising, given that palatability ratings for Standard grass-fed steaks were significantly lower than those for Choice grain-fed or Select grass-fed samples. It can be said, then, that negative reactions to the experience attributes associated with the Standard-grade steaks led respondents to choose the grain-fed samples, regardless of the nutritional and production information presented. This speaks to the assertion in the introduction that dissatisfaction with experience attributes may preclude consideration of any of the other attribute types in purchasing decisions. Further, in conjunction with palatability rating data, these results suggest that producers of grass-fed beef should strive to achieve quality grades higher than Standard in order to ensure consumer acceptability and repeat purchases.

The above results imply that offering information about production process and local origin did not positively affect perceptions of the grass-fed product. As discussed previously, the two most common primary reasons given for preferring grass-fed were nutritional information and visual fat content, confirming the result reported here that participants were swayed largely by the appearance of the product and the elucidated nutritional information, not by the grass-fed label in and of itself. This is perhaps not surprising in light of the fact that a large majority of participants in this study could not correctly identify the definition of "grass-fed" and thus likely did not find the label meaningful. Educating the consumer base about differences between grass-fed and conventional production practices may therefore prove a critical facet of marketing efforts.

Unlike in the steak group, participant preferences for ground beef products (Table 7) were determined largely by differences in treatments. Specifically, participants in treatments 2:1 and 2:2 were found significantly more likely to prefer the grass-fed product (15% and 13% more likely, respectively) than those in treatment 1:1 (used as a base for this series of dummy variables). Thus, production information provided to participants in these treatments had a positive effect on their relative perceptions of grass-fed beef. That those in 1:2 were no less likely than those in 1:1 to prefer the grass-fed product indicates that the "Certified Angus Beef" label used for the grain-fed sample in 1:2 did not have any effect on relative preferences. This result is surprising, given the notable market success of Certified Angus Beef products over the past few years and the mass familiarity with the brand name.

That treatment variables appear to be more important in determining preferences in the ground beef group than in the steak group may be explained by the fact that test and control ground beef products offered for assessment were more similar to each other, in terms of appearance, than test and control steaks. Therefore, respondents in the ground beef group may have given more consideration to the production technique label in order to differentiate between the test and control products. Alternatively, beef consumers may perceive the core observed attributes to be more important in determining the eating quality of steaks (which are typically consumed as stand-alone dishes) than in that for ground beef, which is typically served as part of multiple-ingredient recipes (e.g., hamburgers, casseroles, etc.). Thus, preferences in the steak group may have been relatively more influenced by the appearance of the product and relatively less influenced by production process labels. Nonetheless, the two primary reasons given most frequently for grass-fed preferences in the ground beef group were similar to those given in the steak group (nutritional information and fat content).

As discussed earlier, upon revelation of participants' preferences, a variant of the BDM mechanism was used to elicit bids to upgrade to preferred products. Overall, 73% of participants in the steak group submitted non-zero upgrade bids, indicating that a majority was willing to give up income to acquire their preferred product. Table 8 reveals that bids in the steak experiments submitted by grass-fed preferring respondents were significantly higher than those submitted by their grain-fed preferring counterparts. Specifically, bids to upgrade to grass-fed steaks averaged $2.28, while those to upgrade to grain-fed steaks averaged $1.57. Further, a greater percentage of grain-fed preferring respondents offered bids of zero, while a greater percentage of grass-fed preferring respondents offered bids equal to the upper bound of the bid distribution ($5.00). That grass-fed preferring participants registered their preferences with higher willingness to pay values suggests that the *magnitude* of preferences for grass-fed products is greater than that for grain-fed products, and it can be assumed that grass-fed products would appeal to a substantial consumer segment in the retail sector, even if sold at a price premium.

Table 8. Participant Bidding Behavior (Steak)

Participant Preference	Bid Means*		95% CI		Zero Bids		$5.00 Bids	
	Non-Zero Bids	All Bids	Lower Bound	Upper Bound	N	%	N	%
Grass-Fed	$2.98	$2.28	$1.97	$2.59	35	23%	39	27%
Grain-Fed	$2.45	$1.57	$1.05	$2.09	19	36%	10	19%

*Grass-fed and Grain-fed bid means are different (p<.05)

Results reveal that at a premium of at least $1.00/lb. over and above conventional retail grain-fed beef steaks, approximately 53% of the total population sample surveyed in this experiment would assumedly purchase the grass-fed product when shopping for steaks. At a premium of at least $2.00/lb., the proportion of the entire sample that would purchase the grass-fed steak drops to approximately 40%. Interestingly, the figure reveals that at premiums of as much as $4.00/lb., at least 20% of the sample would choose and purchase the grass-fed product. The revenue-maximizing premium was computed to be $5.00/lb.

Bidding patterns in ground beef experimental rounds were similar to those for steak rounds discussed above. Table 9 reveals that, in particular, bids to upgrade to grass-fed products were significantly higher than those submitted to upgrade to grain-fed products. Further, as in the steak group, a larger proportion of grain-fed preferring participants submitted bids of zero while a larger proportion of grass-fed preferring participants submitted $5.00 bids.

Table 9. Participant Bidding Behavior (Ground Beef)								
Participant Preference	Bid Means*		95% CI		Zero Bids		$5.00 Bids	
	Non-Zero Bids	All Bids	Lower Bound	Upper Bound	N	%	N	%
Grass-Fed	$1.79	$1.23	$0.95	$1.51	38	31%	13	11%
Grain-Fed	$1.07	$0.44	$0.15	$0.72	16	59%	0	0%

*Grass-fed and Grain-fed bid means are different (p<.05)

Ground-beef bidding results reveal that at a premium of at least $1.00/lb over and above conventional grain-fed retail ground beef, approximately 38% of the participants sampled would choose to purchase the grass-fed product. Similarly, over 20% of the sample would purchase grass-fed at premiums of $2.00/lb. or more. The revenue-maximizing premium level for grass-fed ground beef was $2.00/lb.

Censored normal regression models were constructed using upgrade bid data to explain the *magnitude* of respondent preferences for or aversions to grass-fed beef. Post-likelihood ratio test results of these models are presented in Tables 10 (steak) and 11 (ground beef). Inexplicably, Table 10 reveals that participant bids for the grass-fed product in treatment 1:2, in which participants assessed Select grass-fed steaks as opposed to the Standard grade steaks assessed in treatment 1:1, were significantly less than those submitted in 1:1 (used as the base for this series of dummy variables). However, as expected and similar to results of the probit model for steak preference discussed above, those in treatment 3:1 bid significantly less than those in 1:1. This indicates that the less positive taste experiences associated with the Standard-grade grass-fed steaks translated into lower upgrade bids for grass-fed steaks (or, alternatively, higher upgrade bids for grain-fed steaks). Bids in all other treatments were not significantly different from those submitted in treatment 1:1.

As was the case with steak preferences, the variables PITT, PRIMARY, and LOCAL positively influenced bids for grass-fed steaks. It can be said, then, that these variables not only significantly influenced preferences for grass-fed, but also significantly impacted the magnitude of those preferences, as revealed in submitted upgrade bids. Also, as expected, those rating price as an important factor in beef purchase decisions (PRICE) bid significantly less than those rating price as "somewhat important" or "not important".

Table 10. Censored Regression Model Results for Steak Bidding Behavior (n=203)

Variable	Coefficient (Standard Error)
Constant	0.40 (1.15)
TMT1X2*	-1.64 (0.86)
TMT2X1	-0.21 (0.79)
TMT2X2	-1.01 (0.77)
TMT3X1**	-1.83 (0.88)
TMT3X2	-1.22 (0.94)
Pitt**	1.65 (0.46)
Local**	0.73 (0.21)
Price**	-0.57 (0.23)
Primary**	1.79 (0.76)

*=p<.10; **=p<.05

Table 11. Censored Regression Model Results for Ground Beef Bidding Behavior (n=148)

Variable	Coefficient (Standard Error)
Constant**	-1.64 (0.73)
TMT1X2	-.01 (0.49)
TMT2X1*	0.65 (0.40)
TMT2X2*	0.61 (0.35)
Primary**	1.20 (0.54)
Income**	0.41 (0.09)

*=p<.10; **=p<.05

Table 11 reveals, in line with results of the ground beef preference model, that the magnitude of preferences for the grass-fed products was significantly and positively impacted by offering additional production information (treatments 2:1 and 2:2). Though not significant in the preference model, income was found to significantly and positively impact the magnitude of preferences (bids) for grass-fed beef. This result is not surprising, given that numerous other authors (Umberger and Feuz, 2000; Feuz et al., 2004; Menkhaus et al., 1992) have found income to positively influence willingness to pay for non-commoditized food items.

Overall, results suggest that significant market potential exists for grass-fed products in the Appalachian region and, more specifically, that the *observed* and *nutritional* attributes of these products largely determine their consumer appeal. Only 9% and 14% of those who preferred grass-fed in the steak and ground beef treatments, respectively, cited the actual "grass-fed" label as the basis of their preference. These findings indicate that the intrinsic nutritional qualities of grass-fed beef, especially relative leanness and beneficial fatty acid composition, are perceived as more important than the production process itself. This assertion is further supported by results from statistical models that revealed no significant positive effects of offering production information on preferences for grass-fed steak. It is perhaps the case that most consumers have only a cursory knowledge of the conventional beef production process and therefore do not recognize the novelty of and benefits offered by grass-finishing. Only 15% of the sample in the current study could correctly identify the meaning of "grass-fed", and numerous participants informally stated that they were under the impression that *all* cattle were grass-fed. Marketing efforts for grass-fed beef products should be focused, therefore, on objectively educating the consumer base about the environmental and animal welfare impacts of conventional and grass-fed systems and on conveying critical nutritional information in labeling.

In contrast to current industry standards that place premiums on cuts with "small" to "abundant" amounts of marbling (i.e., USDA grades Choice and Prime), consumers in the current study seemed to find favor with and express relatively higher willingness to pay for steaks with less intramuscular fat (i.e., grass-fed steaks graded Select or Standard). In fact, even a majority (67%) of those respondents claiming to typically search out steaks graded Choice or higher expressed preference for the lesser-marbled grass-fed steaks. As asserted by other authors, this result indicates that the average consumer does not understand the information being relayed through the quality grading system and that industry pricing practices may not fully reflect actual consumer preferences for fat content. Although Choice grain-fed steaks sampled in this study were rated significantly higher on palatability attributes than Standard grass-fed steaks, there were no significant differences in ratings between Choice and grass-fed Select steaks. Thus, given that overall participant preferences for grass-fed beef were not negatively impacted by tasting Select-grade grass-fed steaks, it does not seem critical for consumer acceptance that grass-finishing operations strive for Choice quality grades. Instead, a target carcass endpoint of Select would satisfy consumer preferences for a leaner, yet highly palatable cut, and would also decrease the amount of finishing time necessary, which would in turn have significant positive impacts on producers' risk and financial performance.

While grass-fed products are currently not available in mass retail across the country, the growing number of internet suppliers of these products and producers devoting at least some of their marketing efforts to grass-fed cattle (approximately 1200, Spiselman, 2006) supports the results found in this analysis that consumers find appeal with the attributes of these products. Given that respondents in this study were surveyed in the retail setting, results suggest that expansion of this market into the retail sector could propel market growth significantly and that consumers, in general, would not be opposed to paying price premiums for these products. While it is difficult to estimate regional or national demand for grass-fed beef from the results produced here, it is clear that these products would meet with some success if production thereof becomes substantial enough to facilitate a consistent, 12-month supply that is readily available to even those consumers who typically purchase meat in conventional supermarkets.

References

Baker, G. and P. Crosbie. 1993. Measuring food safety preferences: Identifying consumer segments. *Journal of Agricultural and Resource Economics*, 18(2): 277-287.

Balistreri, E., G. McClelland, G. Poe, and W. Schulze. 2001. Can hypothetical questions reveal true values? A laboratory comparison of dichotomous choice and open-ended contingent values with auction values. *Environmental and Resource Economics,* 18: 275-292.

Basmann, R. 1956. A theory of demand with variable consumer preferences. *Econometrica*, 24: 47-58.

Becker, G., M. DeGroot, and J. Marschak. 1964. Measuring utility by a single-response sequential method. *Behavioral Science*, 9: 226-232.

Bidner, T., A. Schupp, R. Montgomery, and J. Carpenter, Jr. 1981. Acceptability of beef finished on all forage, forage plus grain, or high energy diets. *Journal of Animal Science*, 53 (5): 1181-1187.

Bjerklie, S. 2006. High on grass-fed beef: Cashing in on the "graze craze". *Meat & Poultry*, September Issue: 46-50.

Bowling, R., J. Riggs, G. Smith, Z. Carpenter, R. Reddish, and O. Butler. 1978. Production, carcass and palatability characteristics of steers produced by different management systems. *Journal of Animal Science*, 46(2): 333-340.

Bowling, R., G. Smith, Z. Carpenter, T. Dutson, and W. Oliver. 1977. Comparison of forage-finished and grain-finished beef carcasses. *Journal of Animal Science*, 45(2): 209-216.

Buhr, B., D. Hayes, J. Shogren, and J. Kliebenstein. 1993. Valuing ambiguity: The case of genetically engineered growth enhancers. *Journal of Agricultural and Resource Economics*, 18: 175.

Byrne, P., U. Toensmeyer, C. German, and H.R. Muller. 1991. Analysis of consumer attitudes toward organic produce and purchase likelihood. *Journal of Food Distribution Research*, 22(2): 46-62.

Cheng, K., T. McAllister, J. Popp, A. Hristov, Z. Mir, and H. Shin. 1998. A review of bloat in feedlot cattle. *Journal of Animal Science*. 76: 299-308.

Codron, J., K. Grunert, E. Giraud-Heraud, L. Soler, and A. Regmi. 2004. Retail sector responses to changing consumer preferences: The European experience, in *New Directions in Global Food Markets,* Chapter 3. USDA/Economic Research Service/AIB-794.

Conner, D. and R. Christy. 2002. Consumer preferences for organic standards: Guiding demand-expansion strategies for organic food. *Journal of Food Distribution Research*, 33(1): 46-51.

Coppinger, V., V. Smith, and J. Titus. 1980. Incentives and behavior in English, Dutch, and sealed-bid auctions. *Economic Inquiry,* 18: 1-22.

Cross, H., and D. Dinius. 1978. Carcass and palatability characteristics of beef steers finished on forage diets. *Journal of Animal Science*, 47(6): 1265-1271.

Cummings, R., G. Harrison, E. Rustrom. 1995. Homegrown values and hypothetical surveys: Is the dichotomous choice approach incentive-compatible? *The American Economic Review,* 85: 260-266.

Davis, D. and C. Holt. 1993. *Experimental Economics.* Princeton, NJ: Princeton University Press.

Dhiman, T., G. Anand, L. Satter, and M. Pariza. 1999. Conjugated linoleic acid content of milk from cows fed different diets. *Journal of Dairy Science*, 82: 2146-2156.

Dickinson, D. and D. Bailey. 2002. Meat traceability: Are U.S. consumers willing to pay for it? *Journal of Agricultural and Resource Economics*, 27: 348-364.

Eales, J., and L. Unnevehr. 1988. Demand for beef and chicken products: Separability and structural change. *American Journal of Agricultural Economics*, 70(3): 521-532.

Feldkamp, T., T. Schroeder, and J. Lusk. 2003. Consumer valuation of steaks with different quality attributes. In *Cattleman's Day*, Kansas State University Agricultural Experiment Station and Cooperative Extension Service, Report of Progress No. 908: 1-4.

Feuz, D., W. Umberger, C. Calkins, and B. Sitz. 2004. U.S. consumers' willingness to pay for flavor and tenderness in steaks as determined with an experimental auction. *Journal of Agricultural and Resource Economics,* 29: 501-516.

French, P., C. Stanton, F. Lawless, O'Riordan, E., F. Monahan, P. Caffrey, and A. Moloney. 2000a. Fatty acid composition, including conjugated linoleic acid, of intramuscular fat from steers offered grazed grass, grass silage, or concentrate-based diets. *Journal of Animal Science*, 78: 2849-2855.

French, P., E. O'Riordan, F. Monahan, P. Caffrey, M. Vidal, and M. Mooney. 2000b. Meat quality of steers finished on autumn grass, grass silage or concentrate-based diets. *Meat Science*, 56: 173-180.

Goss, J., R. Holcomb, and C. Ward. 2002. Factors influencing consumer decisions related to natural beef in the Southern Plains. *Journal of Food Distribution Research*, 33(1): 73-84.

Grannis, J., D. Thilmany, and E. Sparling. 2001. Shopping for meat: Empirical demand estimation for natural beef across store choices. Western Agricultural Economics Association Selected Paper, Logan, UT, July 20-24.

Gujarati, D.N. 2004. *Basic econometrics*, 4th Ed. Tata McGraw-Hill: New York, NY.

Hayes, D., J. Shogren, S. Shin, and J. Kliebenstein. 1995. Valuing food safety in experimental auction markets. *American Journal of Agricultural Economics*, 77: 40-53.

Hennessy, D. 2006. Economies of feedlot scale, biosecurity, investment, and endemic livestock disease. Working Paper 06-WP 433, Iowa State University Center for Agricultural and Rural Development.

Horrigan, L., R. Lawrence, and P. Walker. 2002. How sustainable agriculture can address the environmental and human health harms of industrial agriculture. *Environmental Health Perspectives*, 110(5): 445-456.

Kagel, A. C. Harstad, and T. Levin. 1987. Information impact and allocation rules in auctions with affiliated private values. *Econometrica,* 55: 1275-1304.

Kinnucan, H., H. Xiao, C. Hsia, and J. Jackson. 1997. Effects of health information and generic advertising on U.S. meat demand. *American Journal of Agricultural Economics*, 79: 13-23.

Lanari, M., M. Brewster, A. Yang, and R. Tume. 2002. Pasture and grain finishing affect the color stability of beef. *Journal of Food Science*, 67(7): 2467-2474.

Lancaster, K. 1966. A new approach to consumer theory. *Journal of Political Economy*, 74(2): 132-157.

Lin, T. and P. Schmidt. 1984. A test of the Tobit specification against an alternative suggested by Cragg. *The Review of Economics and Statistics*, 66(1): 174-177.

List, J. and J. Shogren. 1998. Calibration of the difference between actual and hypothetical valuations in a field experiment. *Journal of Economic Behavior and Organization,* 37: 193-205.

List, J. and J. Shogren. 1999. Calibration of the difference between actual and hypothetical valuations in a field experiment. *Journal of Economic Behavior and Organization,* 37: 193-205.

Lusk, J., M. Daniel, D. Mark and C. Lusk. 2002. Alternative calibration and auction institutions for predicting consumer willingness to pay for nongenetically modified corn chips. *Journal of Agricultural and Resource Economics,* 26: 40-57.

Lusk, J., T. Feldkamp, and T. Schroeder. 2004. Experimental auction procedure: Impact on valuation of quality differentiated goods. *American Journal of Agricultural Economics,* 86: 389-405.

Lusk, J. and J. Fox. 2000. Consumer valuation of beef ribeye steak attributes. American Agricultural Economics Association Selected Paper, Tampa, FL, July 30-Aug.2.

Lusk, J., J. Fox, T. Schroeder, J. Mintert, and M. Koohmaraie. 2001. In-store valuation of steak tenderness. *American Journal of Agricultural Economics*, 83(3): 539-550.

Mandell, I., J. Buchanan-Smith, and C. Campbell. 1998. Effects of forage vs. grain feeding on carcass characteristics, fatty acid composition, and beef quality in Limousin-cross steers when time on feed is controlled. *Journal of Animal Science*, 76: 2619-2630.

May, S., H. Dolezal, D. Gill, F. Ray, and D. Buchanan. 1992. Effects of days fed, carcass grade traits, and subcutaneous fat removal on postmortem muscle characteristics and beef palatability. *Journal of Animal Science*, 70: 444-453.

Maynard, L., K. Burdine, and A. Meyer. 2003. Market potential for locally produced meat products. *Journal of Food Distribution Research*, 34(2): 26-37.

McCluskey, J., T. Wahl, Q. Li, and P. Wandschneider. 2005. U.S. Grass-fed beef: Marketing health benefits. *Journal of Food Distribution Research*, 36(3): 1-8.

Menkhaus, D., G. Borden, G. Whipple, E. Hoffman, and R. Field. 1992. An empirical application of laboratory experimental auctions in marketing research. *Journal of Agricultural and Resource Economics,* 17: 44-55.

Menkhaus, D., G. Whipple, R. Field, and S. Moore. 1988. The impact of a price premium on sales of branded, low fat, fresh beef. *Agribusiness*, 4(6): 521-534.

Mercier, Y., P. Gatellier, and M. Renerre. 2004. Lipid and protein oxidation in vitro, and antioxidant potential in meat from Charolais cows finished on pasture or mixed diet. *Meat Science*, 66: 467-473.

Moon, W., and R. Ward. 1999. Effects of health concerns and consumer characteristics on U.S. meat consumption. American Agricultural Economics Association Selected Paper, Nashville, TN, Aug.8-11.

Neely, T., C. Lorenzen, R. Miller, J. Tatum, J. Wise, J. Taylor, M. Buyck, J. Reagan, and J. Savell. 1998. Beef customer satisfaction: Role of cut, USDA quality grade, and city on in-home consumer ratings. *Journal of Animal Science*, 76: 1027-1032.

Noci, F., F. Monahan, P. French, and A. Moloney. 2005. The fatty acid composition of muscle fat and subcutaneous adipose tissue of pasture-fed beef heifers: Influence of the duration of grazing. *Journal of Animal Science*, 83: 1167-1178.

Noelke, C. and F. Caswell. 2000. A model of the implementation of quality management systems for credence attributes. American Agricultural Economics Association Selected Paper, Tampa, FL, July30-Aug.2.

Oberholtzer, L., C. Dimitri, and C. Greene. 2005. Price premiums hold on as U.S. organic produce market expands. USDA/ERS Research Document VGS-308-01.

O'Sullivan, A., K. Galvin, A. Moloney, D. Troy, K. O'Sullivan, and J. Kerry. 2003. Effect of pre-slaughter rations and or concentrates on the composition and quality of retail packaged beef. *Meat Science*, 63: 279-286.

Owens, F., D. Secrist, W. Hill, and D. Gill. 1998. Acidosis in cattle: A review. *Journal of Animal Science*, 76: 275-286.

Patterson, P., H. Olofsson, T. Richards, and S. Sass. 1999. An empirical analysis of state agricultural product promotions: A case study of "Arizona grown". *Agribusiness*, 15(2): 179-196.

Pindyck, R. and D. Rubinfeld. 1981. *Econometric Models and Economic Forecasts*, 2nd Edition. New York, NY: McGraw-Hill, Inc.

Purchas, R., T. Knight, and J. Busboom. 2005. The effect of production system and age on concentrations of fatty acids in intramuscular fat of the longissimus and triceps brachii muscles of Angus-cross heifers. *Meat Science*, 70: 597-603.

Realini, C., S. Duckett, G. Brito, M. Dalla Rizza, and D. De Mattos. 2004. Effect of pasture vs. concentrate feeding with or without antioxidants on carcass characteristics, fatty acid composition, and quality of Uruguayan beef. *Meat Science*, 66: 567-577.

Robinson, J. 2007. Grass-fed: The basics. www.eatwild.com accessed July, 2007.

Roosen, J., D. Hennessy, J. Fox, and A. Schreiber. 1998. Consumers' valuation of insecticide use restrictions: An application to apples. *Journal of Agricultural and Resource Economics*, 23: 367-384.

Rule, D., K. Broughton, S. Shellito, and G. Maiorano. 2002. Comparison of muscle fatty acid profiles and cholesterol concentrations of bison, beef cattle, elk, and chicken. *Journal of Animal Science*, 80(5): 1202-1211.

Schaake, S., G. Skelley, E. Halpin, L. Grimes, R. Brown, D. Cross, and C. Thompson. 1993. Carcass and meat sensory traits of steers finished on fescue and clover, summer forage, or for different periods in drylot. *Journal of Animal Science*, 71: 3199-3205.

Schroeder, J., D. Cramer, R. Bowling, and C. Cook. 1980. Palatability, shelf life, and chemical differences between forage and grain-finished beef. *Journal of Animal Science*, 50(5): 852-859.

Schroeter, C. and K. Foster. 2004. The impact of health information and demographic changes on aggregate meat demand. American Agricultural Economics Association Selected Paper, Denver, CO, Aug. 1-4.

Schupp, A., T. Binder, and N. Clark. 1980. Consumer acceptance of beef produced under alternative feeding systems. *Southern Journal of Agricultural Economics*, 12: 31-35.

Scollan, N., J. Hocquette, K. Nuernberg, D. Dannenberger, I. Richardson, and A. Moloney. 2006. Innovations in beef production systems that enhance the nutritional and health value of beef lipids and the relationship with meat quality. *Meat Science*, 74: 17-33.

Shogren, J., M. Margolis, C. Koo, and J. List. 2001. A random nth-price auction. *Journal of Economic Behavior and Organization,* 46: 409-421.

Simmone, A., N. Green, and D. Bransby. 1996. Consumer acceptability and B-Carotene content of beef as related to cattle finishing diets. *Journal of Food Science*, 61(6): 1254-1256.

Simmone, A., N. Green, J. Bannon, and D. Bransby. 1995. Pasture finished beef pleasing to the palate: Consumers find little difference between pasture and feedlot finished beef. Alabama Agricultural Experiment Station *Highlights of Agricultural Research* publication.

Snowder, G., L. Van Vleck, L. Cundiff, and G. Bennett. 2006. Bovine Respiratory Disease in feedlot cattle: Environmental, genetic, and economic factors. *Journal of Animal Science*, 84: 1999-2008.

Spiselman, A. 2006. Is grass-fed greener? *Meatingplace*, “In the Aisles” section, September issue: 74-77.

The Federal Register. 2007. United States standards for livestock and meat marketing claims, grass-fed claim. Volume 72(199).

Tversky, A. and D. Kahneman. 1991. Loss aversion in riskless choice: A reference-dependent model. *Quarterly Journal of Economics*, 106: 1039-1061.

Umberger, W. and D. Feuz. 2000. The usefulness of experimental auctions in determining consumers’ willingness-to-pay for quality-differentiated products. *Review of Agricultural Economics*, 26 (2): 170-185.

Umberger, W., D. Feuz, C. Calkins, and K. Killinger-Mann. 2002. U.S. consumer preference and willingness to pay for domestic corn-fed beef versus international grass-fed beef measured through an experimental auction. *Agribusiness*, 18(4): 491-504.

Underhill, S. and E. Figueroa. 1996. Consumer preferences for non-conventionally grown produce. *Journal of Food Distribution Research*, 27(2): 56-66.

Union of Concerned Scientists. 2001. *Hogging It: Estimates of Antimicrobial Abuse in Livestock*, Chapters II & III. UCS.

USDA/Economic Research Service (ERS). 2007. Selected data. Available on the web at www.ers.usda.gov

Vickrey, W. 1961. Counterspeculation, auctions, and competitive sealed tenders. *The Journal of Finance,* 16: 8-37.

Wolf, M. and A. Thulin. 2000. A target consumer profile and positioning for promotion of a new locally braded beef product. *Journal of Food Distribution Research*, 31(1): 193-197.

Wooldridge, J. 2006. *Introductory Econometrics: A modern approach*, 3rd Ed. Thomson South Western: Mason, Ohio.

Ziehl, A., D. Thilmany, and W. Umberger. 2005. A cluster analysis of natural beef product consumers by shopping behavior, importance of production attributes, and demographics. *Journal of Food Distribution Research*, 36(1): 209-217.