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

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The focus of the current study was on the market potential for grass-fed beef in the Appalachian region, given that these products embody observed, experiential, nutritional, and process attributes that may appeal to a large consumer base. An in-store variant of the Becker-DeGroot-Marschack experimental auction mechanism was employed in the region to determine consumer preferences and willingness to pay. A majority of respondents preferred the grass-fed product over conventional grain-fed samples and were willing to pay a price premium to obtain it. Preferences for grass-fed were rooted largely in the associated superior nutritional content and core observed attributes.

Key Words: Appalachia, Becker-DeGroot-Marschack, beef, experimental auction, grass-fed

Producers and other actors in the beef sector continually face challenges posed by an ever-changing and often turbulent economic environment. From structural shifts in the demand for beef during the 1970s to modern concerns over higher and more volatile input prices, the industry has relied upon the research community to explore and validate novel production and marketing protocols that enhance profitability and satisfy consumer expectations (Eales and Unnevehr 1988, Kinnucan et al. 1997, Moon and Ward 1999, Horrigan, Lawrence, and Walker 2002, Scollan et al. 2006). Improvements in cow inventory productivity, feed conversion, packer efficiency, and heightened understanding and the use of genomic technology all serve as evidence of the industry's adaptability to a dynamic marketplace (USDA/NASS 2009, KSU 2009). However, longstanding and new issues alike continue to press on industry participants, as indicated by findings in both the pilot 1991 National Beef Quality Audit and the most recent 2005 Audit (Lorenzen et al. 1993, Smith et al. 2005), which suggest that consumers and downstream wholesalers and retailers have unmitigated concerns over product consistency and excess external fat. Further, consumer desires for "natural" products, traceability, and products that address concerns over hormone/antibiotic residues and animal welfare remain prevalent themes (Smith et al. 2005), and feedlot economic losses continue to mount in the face of a worldwide recession and developments in energy markets (Feuz 2009).

Against this backdrop, it is critical that consumer perceptions of existing commodity beef products be understood relative to novel specialty products that embody *observed*, *experiential*, *nutritional,* and *process* attributes that find favor with both consumers and supply-side market participants and facilitate progress toward sustained or increased market volume and economic returns that encourage continued production.

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This research was made possible by a grant from the U.S. Department of Agriculture's Agricultural Research Service (Specific Cooperative Agreement No. 58-1932-8-836) and funds from the West Virginia Experiment Station.

Process Attributes

Changes in "process" attributes, i.e., the production protocol used to bring a product to market, typically cause fundamental changes in other attribute types as well, since appearance, taste, and nutritional content are all inexorably linked to growing and finishing regimes. Process attributes should therefore be explored as a primary means for addressing the aforementioned market concerns over commodity beef products. The potential economic merit of differentiating products according to process attributes is perhaps best exemplified by the current market for organic products in the United States and the emergent prevalence of these items on supermarket shelves (Oberholtzer, Dimitri, and Greene 2005). In addition to organic production, research of the process attributes associated with beef products has focused on consumer and industry perceptions of products identified 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 and imply potential economic rewards for producers (Lusk and Fox 2000, Grannis, Thilmany, and Sparling 2001, Goss, Holcomb, and Ward 2002, Maynard, Burdine, and Meyer 2003, Patterson et al. 1999, Evans et al. 2007).

Each of the value creation opportunities for beef producers cited 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 accelerated cattle finishing toward "back to the land" principles of intensive pasture resource management. Research indicates that grass-fed beef embodies observed, experiential, and nutritional attributes that may at least in part address industry challenges of excessive fat, volatile grain markets, and trends in consumer tastes for heart-healthy proteins, animal welfare, and product safety (Noci et al. 2005, Purchas, Knight, and Busboom 2005, Realini et al. 2004, Rule et al. 2002, French et al. 2000a, French et al. 2000b, Dhiman et al. 1999). Further, forage-based production systems seem well suited to regions of the country, such as Appalachia, where a comparative advantage exists for pasture production and where corn deficiencies translate into high grain prices relative to those in the major cattle feeding regions of the country. To be a viable production option for the industry, forage-based systems must concurrently produce end products with consumer appeal and address increasing concerns over production costs and risk. Research has consistently shown that forage-only diets translate into longer finish times and lower average daily gains for cattle, thus implying an unavoidably higher opportunity cost of time for producers (May et al. 1992, Mandell, Buchanan-Smith, and Campbell 1998, Schaake et al. 1993, Realini et al. 2004, Lanari et al. 2002, Ferrell et al. 2006). Further, animal performance and consequently the finish weights of grass-fed cattle are contingent upon the quality and quantity of forage that is available, which in turn is subject to the vagaries of weather and other variables. Longer retention periods and vulnerability to natural conditions suggest a higher level of overall production risk for forage-based versus conventional production systems. However, this can be mitigated with proper pasture management and the identification of an economically sensible end point for finishing. Recent work has also suggested that the explicit costs of forage finishing are lower than those associated with grain finishing when grain prices hold at the high levels now ubiquitous in the market (Sithyphone et al. 2011, Evans et al. 2007, Berthiaume et al. 2006). Yet, since both forage and grain prices have historically exhibited notable year-over-year volatility, this conclusion begs further exploration.

Although there is evidence to suggest that the market for grass-fed beef is substantial and expanding (Spiselman 2006), a thorough assessment of consumer attitudes toward and willingness to pay for these products is needed to more fully understand the 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, often with conflicting results (French et al. 2000b, Mandell, Buchanan-Smith, and Campbell 1998, Schaake et al. 1993, May et al. 1992, Bidner et al. 1981, Schroeder et al. 1980, Cross and Dinius 1978, Bowling et al. 1977), no such assessments for region-of-origin labeled grass-fed beef with elicitation of willingness-to-pay values have been made in active market environments (supermarkets). To that end, the current study employs a variant of the Becker-DeGroot-Marschak pseudo-auction mechanism to determine consumer perceptions of and willingness to

pay for Appalachian grass-fed beef and to ultimately draw conclusions regarding the overall market potential for these specialty products in the retail sector and the implications for potential producers. Experimental treatments were designed to allow a determination of the demographic and behavioral characteristics that affect relative preferences and willingness to pay for Appalachian grass-fed beef, along with the marginal influences of various grass-fed beef attributes (observed, experiential, nutritional, and process) on consumer choice.

Results indicate that grass-fed beef products would be well received in the region's retail sector, given the preference expressed by a majority of respondents. This preference may indeed translate to significant market potential for grass-fed beef products, since respondents were generally willing to pay a premium over the price of conventional retail beef to acquire this alternative. Preferences for grass-fed beef were largely rooted in nutritional and observed attributes, and sensory evaluations suggest that finishing grass-fed animals to a USDA quality grade of at least "Select" would facilitate *repeat* purchases.

Experimental Auctions

In economics, as in other scientific disciplines, it is difficult to evaluate complex phenomena using data from natural markets or "field" observations, where the effects of interrelated variables or other confounding issues may be unaccounted for (Davis and Holt 1993). Because controlled experimentation facilitates valid ceteris paribus analyses, economists have begun to utilize experimental methods in an increasingly broad array of inquiries in recent decades (Davis and Holt 1993).

Experimental auctions, which are broadly defined as noncooperative games among competitive bidders, account for a large proportion of all the work done in the experimental economics arena. Such auctions are used to assess consumers' willingness to pay for novel private market goods or nonmarket public goods, or to otherwise elicit true, privately held values that cannot be validly obtained via *hypothetical* research instruments (Balistreri et al. 2001). In the laboratory, auction mechanisms such as the Vickrey second-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 outbidding fellow participants. Vickrey (1961) asserted that, just as in English auction formats, the dominant strategy in the second-price mechanism would be to reveal true willingness to pay, without any consideration of the bidding strategies employed by competitors.

A noncompetitive pseudo-auction structure, the Becker-DeGroot-Marschak (BDM) mechanism, has also been used in experimental setups. BDM is not an auction per se because subjects do not bid against one another; instead, they submit sealed bids to experiment proctors and purchase the good in question if their bid is greater than a selling price randomly drawn from a distribution that is known to the bidder. Becker, DeGroot, and Marschak (1964) suggested that, just as in the Vickrey and English formats, the dominant strategy would be to reveal true willingness to pay (WTP) (i.e., the auction is "incentive compatible"). Intuitively, a truthful revelation of a privately held value is optimal under the BDM mechanism because the submitted bid affects only the probability of making the purchase, not the distribution from which selling prices are drawn. In other words, bids are divorced from the ultimate market price, and subjects should therefore bid to maximize individual consumer surplus; 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 purchase that would yield positive consumer surplus. Irwin et al. (1998) found that bids elicited via the BDM mechanism were indeed consistent with the dominant value-revealing strategy.

In another study aimed at comparing actual auction outcomes to those predicted by theory, Lusk, Feldkamp, and Schroeder (2004) conducted English, Vickrey second-price, random n^{th} price, and BDM auctions for generic, guaranteed tender, natural, USDA Choice, and Certified Angus Beef (CAB) steaks. The effect of an initial endowment on bidder behavior was also considered, because often in experimental auctions (especially BDM), subjects are endowed with a good and are asked to bid to upgrade to the novel product of primary research interest in order to elicit *relative* valuations. Bids were not significantly different across the BDM and English auctions in either endowment treatment (as theory would predict), and endowment was found to have no significant effect on bid levels in these two mechanisms. In both

"no endowment" and "endowment" treatments, however, bids elicited from the second-price auction were generally higher than those from other mechanisms, especially in later bidding rounds. Rutstrom (1998) similarly found that bids generated from the second-price mechanism were significantly higher than those from English or BDM auctions.

While this result does not fully confirm theoretical expectations, there is no overwhelming evidence that the BDM mechanism, as used in experimental applications, yields inaccurate estimates of true willingness to pay. Further, BDM offers clear administrative advantages in conducting experiments in actual market settings, where competitive auctions would be impractical.

The capacity of experimental auction procedures to mimic natural market conditions through active market feedback, incentive-compatible design, and the imposition of actual monetary consequences for bidding behavior makes them ideal for determining consumer preferences for novel private market goods. While traditional mailed or electronic survey procedures may allow for broader sampling, experimental procedures naturally yield higher response rates and better facilitate concomitant sensory analyses that are often critical in market research. Recent applications of experimental auctions conducted in *laboratory* settings include an assessment of snack foods with varying levels of safety guarantees (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 nongenetically modified corn chips (Lusk et al. 2002). Lusk et al. (2001) used a variant of the BDM mechanism *outside* of the laboratory in an active market environment (supermarket) to estimate consumer WTP for "guaranteed tender" steaks and to assess the influence of economic and demographic factors on WTP values.

Methods

As noted in the introduction, beef products embody four general types of attributes: observed, experiential, nutritional, and process. A theory espoused by Lancaster (1966) and others 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 attributes, which are in turn influenced by demographic and psychographic characteristics of the consumers themselves. Therefore, an experimental analysis of the 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 the determination of marginal valuation of individual product attributes and the identification of potential market segments.

Experimental Procedures

Supermarket shoppers in one urban area (Pittsburgh, Pennsylvania) and one urbanizing area (Morgantown, West Virginia) of the Appalachian region were the focus of an experiment designed to facilitate the 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 at two conventional retail grocery stores in Morgantown, a retail grocery store in Pittsburgh, and a large food cooperative in Pittsburgh. 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 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 rib eye steaks. Rib eyes are high-value cuts with which most consumers are familiar. Unlike other studies, ground beef was also used, since many beef consumers who do not typically purchase steaks may frequently purchase ground beef because of its availability, ease of preparation, versatility, and relative inexpensiveness (Eales and Unnevehr 1988). Procedures used in and results from the ground beef assessment were not appreciably different from those associated with steaks, and hence discussion in this article will be limited to

the steak assessment.

Grain-fed rib eye steaks were fabricated from the right 107 rib primal of 12 Angus/Angus-cross steers that were wintered on harvested forage and finished on a high-energy, 70 percent corn silage diet. Grass-fed rib eyes were fabricated from the same rib section of 12 Angus/Angus-cross steers that were finished on alfalfa. Rib eyes were cut to one inch thick, trimmed to approximately one-eighth inch of external fat, vacuum sealed, and flash frozen at 0^{o} F. All grain-fed carcasses received USDA quality grades ranging between Choice^{-} and Choice^{+}, while grass-fed carcass grades ranged from Standard^{+} to Select^{+}.

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. 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 the general procedure and participant compensation, was placed in front of the setup (two 24-inch by 48-inch 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. 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 the respondents and the USDA quality grade of the grass-fed test product. It can be said, in general, that treatments 1:1 and 1:2 facilitate the 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).

All participants in steak treatments were presented with raw grain-fed and grass-fed rib eye samples of similar size and shape in overwrapped Styrofoam trays labeled as "A" and "B" for visual appraisal, with laminated 6-inch by 10-inch information cards placed below each sample. In treatments 1:1 and 1:2, USDA quality grades were included on the information cards (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 nutritional information derived from studies of relative fatty acid analyses of grass-fed and grain-fed beef products published in the meat science literature (Duckett et al. 1993, French et al. 2000b, Rule et al. 2002, Realini et al. 2004, Purchas, Knight, and Busboom 2005). Nutritional elements included for each sample were the percentage of total fat as saturated fat, percentage of total fat as conjugated linoleic acid (CLA), and percentage of total fat as omega-3 fatty acids. 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. 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 blindly tasted

Table 1. Experimental Treatments (N=203)

Tmt.	N	Evaluation Method	Grass-Fed USDA Grade	Information Provided
1:1	30	Visual Appraisal	Standard	USDA grade; Nutritional
1:2	30	Visual Appraisal	Select	USDA grade; Nutritional
2:1	40	Visual Appraisal	Standard	USDA grade; Nutritional; Production
2:2	42	Visual Appraisal	Select	USDA grade; Nutritional; Production
3:1	30	Visual Appraisal +Taste	Standard	USDA grade; Nutritional; Production
3:2	31	Visual Appraisal +Taste	Select	USDA grade; Nutritional; Production

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 treatments 2:1 and 2:2. Again, grass-fed steak quality grades differed between 3:1 and 3:2. After rating for taste and palatability, participants were made aware of the process/identity of each sample and were told to evaluate steaks based both on their taste experiences *and* on the visual appraisal and information provided.

Steaks were cooked in-store to a uniform internal temperature and cut into one-half inch cubes. 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 participants tasted 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 points for grass-fed animals.

After assessing the steak samples, respondents in all treatments were then asked to state, based on the information provided, which sample they preferred overall ("A" or "B"), or if they had no preference 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 his or her preferred product. For consistency, the following instructions were given to all participants:

> "You have indicated that you prefer product (A or B). For your participation today, we will give you, free of charge, the (steak or ground beef) product that you did not prefer, plus a $5.00 gift card for (venue). Or, you can tell us how much of the $5.00 gift card you would be willing to give up to exchange your free (steak or ground beef) 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 preset amount."

The use of gift cards is rather novel in such applications and was employed here to account for situations in which respondents do not have cash on hand to pay for upgrades. Given that participants were bidding with a portion of their free gift card as opposed to out-of-pocket cash, bids were based on what is known in the literature as windfall, or transitory, income. Friedman's Permanent Income Hypothesis (PIH) (Friedman 1957) postulates that transitory income and consumption are uncorrelated and that the marginal propensity to consume (MPC) out of transitory income is essentially zero, as opposed to the MPC

of 0.60-0.90 often cited for permanent income. If PIH holds, the bidding behavior elicited in the current study may not reflect how participants would, in reality, spend money on beef products. Unfortunately, empirical testing of the theory has not proven conclusive. While no such tests have yielded an MPC of zero for transitory income, several (Bird and Bodkin 1965, Taubman 1965, Laumus 1969, Holmes 1970, Peterson 1972, Laumus and Mohabbat 1972, Lee 1975) have shown that although transitory income *does* affect consumption, MPC thereof is significantly less than that of permanent income, suggesting what the authors call a "loose version of PIH." MPC transitory income in these studies ranged from 0.37 to 0.65, with significant variability attributable to the data set and modeling procedures employed. On the other hand, Bodkin (1959) and Klein and Liviatan (1957) found MPC transitory income to be between 0.72 and 0.97, not statistically different from MPC permanent income.

Overall, findings suggest that transitory income and consumption are indeed related, even though the MPC of transitory income may be smaller than that of permanent income. However, given that results of tests of PIH are inconclusive, and given that $5.00 is not a significant windfall, there is no reason to believe that bidders' decisions about how to spend the income gained in the experiment will be different from those made in real world market transactions.

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 preset 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. This predetermined price for upgrading was not revealed to participants prior to revelation of their willingness to pay. There is no reason to believe that utilizing a uniform market price instead of a randomly drawn value from a specified distribution in the BDM application should impact willingness to pay values in any way, since the participant, without knowledge of the market price, cannot bid strategically. Before bidding, participants were only aware that there existed real monetary consequences to their bidding behavior and that underreporting their willingness to pay may preclude them from receiving their preferred product. The justification for using a relatively low uniform market price was simply to ensure that a majority of respondents expressing a bid to upgrade to their preferred product would indeed receive that product as proper compensation for participation.

It was assumed that upgrade bids from respondents who preferred grass-fed beef would be offered such that:

$$(1) \qquad u_i(a_1, \text{M-Bid}) = u_i(a_2, M)$$

where u_i represents the individual's utility level, a_j refers to the attribute bundle offered by the grass-fed product (j=1) or grain-fed product (j=2), M represents the windfall income ($5.00) obtained in the experiment, and *Bid* is the individual's bid to upgrade to the grass-fed product. Given the incentive-compatible structure of the experimental auction employed, equation (1) implies that bid levels should be equal to the amount that makes the respondent indifferent to whether he or she receives the grass-fed product plus a discounted windfall income or the grain-fed product plus the full $5.00 windfall.

After stating their bids to exchange, participants were made aware of the preset 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.

Estimation Procedures

Following experimental trials, a probit model with dependent variable Y_i coded as "1" for grass-fed preferring respondents and "0" for grain-fed preferring respondents was constructed to elucidate relationships between stated preferences and demographic, psychographic, and experimental variables. Explanatory variables used in addition to experimental variables (treatment assignment and experiment location) are summarized in Table 2, along with within-treatment variable means.

Each individual variable included in the initial model specification was iteratively dropped from the model 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 showing no measurable

Table 2. Variable Definitions and Within-Treatment Means

Variable	Definition	Treatment Means*		
		1	2	3
Ag	1 if respondent/respondent's family involved in agriculture; 0 otherwise	0.17	0.15	0.18
Age	Age (in years) of respondent	49.98	46.88	44.21
Education	Highest education level attained 1=Less than high school diploma; 2=High school graduate; 3=Some college/technical school; 4=College degree; 5=Graduate school	3.35	3.45	3.47
Gender	1 if female; 0 if male	0.60	0.64	0.48
Household	Number of persons in household	2.67	2.69	2.41
Income	Household after-tax annual 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=$100,000+	2.88	3.00	2.55
Amount	Amount ($) spent on meat per week	31.71	33.35	29.89
Grade	1 if respondent indicated that they look for USDA grade Choice or higher when purchasing beef products; 0 otherwise	0.44	0.49	0.43
Frequency	No. of times per month that steak is prepared in-home	2.83	3.47	2.84
Grass-Fed	1 if respondent indicated previous purchase of grass-fed products; 0 otherwise	0.46	0.35	0.39
Primary	1 if respondent is primary decision maker concerning meat purchases in household; 0 otherwise	0.87	0.93	0.93
Venue	1 if respondent indicated that they most often buy meat products from any venue except retail grocery stores; 0 otherwise	0.23	0.16	0.27
Health	1 if respondent indicated concern for health; 0 otherwise	0.35	0.42	0.39
Knowledge	1 if respondent answered grass-fed definition question correctly and was in a treatment in which production process was revealed; 0 otherwise	NA	0.17	0.16
Local	Respondent's ranking of importance of local production in beef purchase decisions 3=Very Important; 2=Important; 1=Somewhat Important; 0=Not Important	2.28	2.10	2.32
Price	Respondent's ranking of importance of price in beef purchase decisions 3=Very Important; 2=Important; 1=Somewhat Important; 0=Not Important	3.25	3.18	3.18
Pittsburgh	1 if respondent was surveyed in Pittsburgh; 0 otherwise	0.49	0.47	0.47

*Means for Venue are significantly higher in TMT 3 than in TMT 2. No other significant differences across treatments.

effects on the modeling outcome were excluded from the final model that is presented in the Results section.

Following the construction of probability models for participants' preferences, attention focused on modeling the 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.

For data analysis purposes, nonzero bids submitted to obtain grain-fed products were assumed to be equivalent to *negative* bids for the grass-fed product. 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 to be 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.

As is the case here, censoring in economic data is typically due to the survey design and consequent missing data on the dependent variable (Wooldridge 2006). 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, respectively.

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

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

where y_i is the observation of the dependent variable for an individual, $\boldsymbol{\beta}$ represents model parameters, $\boldsymbol{x}_i$ 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):

$$(3) \qquad w_i = \min(y_i, c_i) .$$

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 equations (2) and (3), model parameters ($\boldsymbol{\beta}$) can be estimated using Maximum Likelihood Estimation once the density of w_i, given (x_i, c_i), is calculated. 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 the 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):

$$(4) \qquad \begin{aligned} P(w_i = c_i \mid \mathbf{x}_i) &= P(y_i \geq c_i \mid \mathbf{x}_i) \\ &= P(u_i \geq c_i - \mathbf{x}_i \boldsymbol{\beta}) \\ &= 1 - \Phi[(c_i - \mathbf{x}_i \boldsymbol{\beta})/\sigma] \end{aligned}$$

where P denotes probability, and Φ is the standard normal cumulative distribution function (CDF). From equation (4), the density of w_i, given (x_i, c_i), can be obtained as follows (Wooldridge 2006):

$$(5) \quad f(w \mid \mathbf{x}_i, c_i) = 1 - \Phi[(c_i - \mathbf{x}_i \boldsymbol{\beta})/\sigma] \quad \text{for } w = c_i ,$$

and

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

where φ denotes the standard normal density. The parameters, $\boldsymbol{\beta}$, can be interpreted just as they are in linear regression models. 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.

The censored normal regression model for bidding behavior was specified using the same explanatory variables cited for the probit model. As with the probit model, the censored normal regression model was pared down after completion, using the LR statistic to improve model diagnostics and to more precisely gauge the influences of explanatory variables.

Results

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 percent of respondents were born in the United States, and 16 percent reported a personal or family background in agriculture. In general, participants represented a wide range of demographics. For example, ages across both groups ranged from 18 years to 84

years, and educational attainment ranged from less than a high school diploma to at least some graduate school. Though participants were largely representative of the populations of interest (Morgantown, West Virginia, and Pittsburgh, Pennsylvania), 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.

Of the 203 participants in the steak experimental trials, 74 percent of them expressed a preference for the grass-fed product. In treatments 1, 2, and 3, respectively, 75 percent, 77 percent and 66 percent of respondents preferred the grass-fed steak. Differences across treatments are not statistically significant, though it should be noted that the lower proportion of grass-fed preferring respondents in treatment 3 is likely indicative that several respondents in this treatment reported negative sensory experiences with the grass-fed product.

Respondents were asked via the survey instrument whether they seek out a particular USDA grade when purchasing beef products. A large majority (79 percent) of those who indicated that they do not look for a particular grade and 85 percent and 67 percent, respectively, of those who search out Select or Choice products, preferred the grass-fed samples. It is reasonable to assume that those who look for USDA Select products would prefer the grass-fed steaks (given that they graded either Select or Standard), but it is surprising that 67 percent of those who stated that they look for USDA Choice also preferred the grass-fed steaks (given that only grain-fed samples graded as Choice). However, this finding supports the notion posited by Branson et al. (1986), Lusk and Fox (2000), and Lusk et al. (2001) that beef consumers do not fully understand the quality grading system, nor the information that it is designed to relay, and they consequently reveal inconsistent preferences. Results here indicate that a majority of consumers, regardless of a stated preference for USDA quality grades, react positively to the leaner appearance of steaks that have only slight marbling.

Approximately 39 percent of all grass-fed preferring participants cited visual fat content as the primary reason for their stated preference, and another 11 percent cited "appearance." This means that a full 50 percent of participants who preferred grass-fed were responding largely to 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. This result is not surprising, given the long-established tenet in industry literature that beef consumers typically prefer leaner cuts on visual appraisal (McCoy 1979) and the notion that there are regional consumer segments in the United States that traditionally prefer Select beef or cannot readily distinguish between quality grades (Neely et al. 1998). The finding is also supported by the fact that survey respondents rated "appearance" as the most important beef attribute in making beef purchase decisions.

Nutritional information was the second most frequently given primary reason, accounting for approximately 31 percent of all grass-fed preferring respondents. This, together with the large proportion of respondents who cited observed attributes as the primary driver of their preference, suggests that marketing efforts for grass-fed products should focus on embodied human health benefits and the products' overall relative leanness. Of the 66 percent of respondents in treatment 3 who preferred grass-fed, 29 percent cited taste as the primary reason for their preference.

Of those participants exposed to production information (treatments 2 and 3), approximately 11 percent cited the "Grass-fed in Appalachia" label as the primary reason for their preference. This finding is in line with the fact that only 15 percent of respondents correctly identified the USDA AMS definition of "grass-fed" in a multiple-choice survey item and implies that consumer education about the differences between conventional and grass-fed production should be a critical component of marketing strategy.

Grain-fed preferring participants most often cited visual appraisal of the relatively high degree of fat marbling as the root of their preference (51 percent), with a smaller proportion (11 percent) responding to the actual USDA Choice grade label. Of the 34 percent of respondents in treatment 3 who preferred grain-fed, 81 percent cited taste as the primary reason for their preference.

In terms of palatability, Table 3 reveals that participant ratings of overall steak acceptance and

Table 3. Steak Palatability Rating Means* (Based on 8-Point Scale†)

Product	Flavor	Juiciness	Tenderness	Overall
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)

Note: Standard deviations in parentheses.
*Means in the same column with different subscripts are significantly different at the 5 percent level or better.
†8=Extremely Desirable; 7=Very Desirable; 6=Moderately Desirable; 5=Slightly Desirable; 4=Slightly Undesirable; 3=Moderately Undesirable; 2=Very Undesirable; 1=Extremely Undesirable.

juiciness were significantly higher ($p<0.10$ and $p<0.05$, 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 percent) of participants in treatment 3 (taste treatment) preferred the grass-fed product overall, as noted earlier. This suggests that although experiential attributes may be critical in determining consumer satisfaction, preferences here were based on consideration of *all* product attributes made known to participants.

Between-grade differences in palatability ratings were also assessed, and those results are also presented in Table 3. 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 4 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 experiential attributes embodied in grass-fed beef products are of sufficient quality to encourage repeat purchases, particularly if animals fed under such protocols are finished to a USDA quality grade of Select or better.

Probit estimators and marginal effects obtained from the model for steak preference are reported in Table 4. According to Wald Tests and Likelihood Ratio (LR) statistics, overall the model proved to be significant in explaining participant preferences, and it was able to correctly predict steak preference for approximately 90 percent of observations.

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 preferring grass-fed by 26 percent, and that those who had previously

Table 4. Probit Model Results for Steak Preference

(Dependent Variable = 1 if grass-fed preferring; 0 if grain-fed preferring)

Independent Variable	Coefficient (Std. Error)	Marginal Effect
Constant	0.16 (0.69)	------
Treatment 1:2	-0.83 (0.51)	------
Treatment 2:1	-0.69 (0.48)	------
Treatment 2:2	-0.47 (0.46)	------
Treatment 3:1**	-1.24 (0.52)	-42.8%
Treatment 3:2	-0.60 (0.53)	------
Pittsburgh**	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%
Grass-Fed*	0.44 (0.26)	11.2%
Grade**	-0.63 (0.24)	-17.2%
Primary**	1.13 (0.39)	39.4%
Gender**	0.92 (0.24)	26.1%
LR Stat = 60.12; Prob=0.0000		
McFadden $R^2 = 0.26$		
Percent Correctly Predicted = 92%		

*=p<0.10; **=p<0.05

purchased grass-fed products were 11 percent more likely than those who had not to prefer grass-fed steak.

The frequency of in-home steak preparation had a small but significant positive effect on the preference for grass-fed, while the 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 who ranked "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 percent less likely than others to prefer the grass-fed product. This result confirms expectations, but the reader should recall 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 percent more likely than those surveyed in Morgantown to prefer grass-fed. However, this result may be attributable to the fact that 47 percent of the respondents from Pittsburgh were surveyed in a food cooperative, and shoppers at such venues may be intrinsically more likely to prefer non-commoditized, process-conscious products. Those participants reporting themselves as the primary household decision makers for meat purchases were significantly (39 percent) more likely than others to prefer the grass-fed steak; this 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 4 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), indicating that provision of production information did not affect relative preferences. However, those in treatment 3:1, in which respondents tasted Standard-grade grass-fed steak, were 43 percent less likely to prefer grass-fed than those in treatment 1:1. 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 result also suggests that the long-term marketability of grass-fed beef products in the retail setting will hinge largely on producers' capacity to deliver uniform and acceptable experiential quality.

As previously discussed, the model describing steak preference was pared down by iteratively dropping independent variables that added no explanatory power. Specifically, the education, income, age, household size, and experiment venue variables were removed in this fashion from the model, along with those indicating whether the respondent had health concerns or knew what the "grass-fed" designation meant. It was concluded that there was likely too little observed variation in the venue and too few "knowledge" variables for either to prove statistically significant. Specifically, 85 percent of participants reported usually purchasing meat products at conventional retail stores, and 81 percent did not know or incorrectly identified the definition of "grass-fed." That the "health" variable did not prove significant may have been an unintended consequence of survey design, since participants were asked only if they had health concerns related to the meat products they currently purchase. The lack of any significant effect of income, education, age, and household size on steak preference was surprising yet may suggest that steak preference is generally less influenced by basic demographics than by shopper-specific meat buying behavior and perceptions.

While the survey results regarding steak preference have important implications for the market

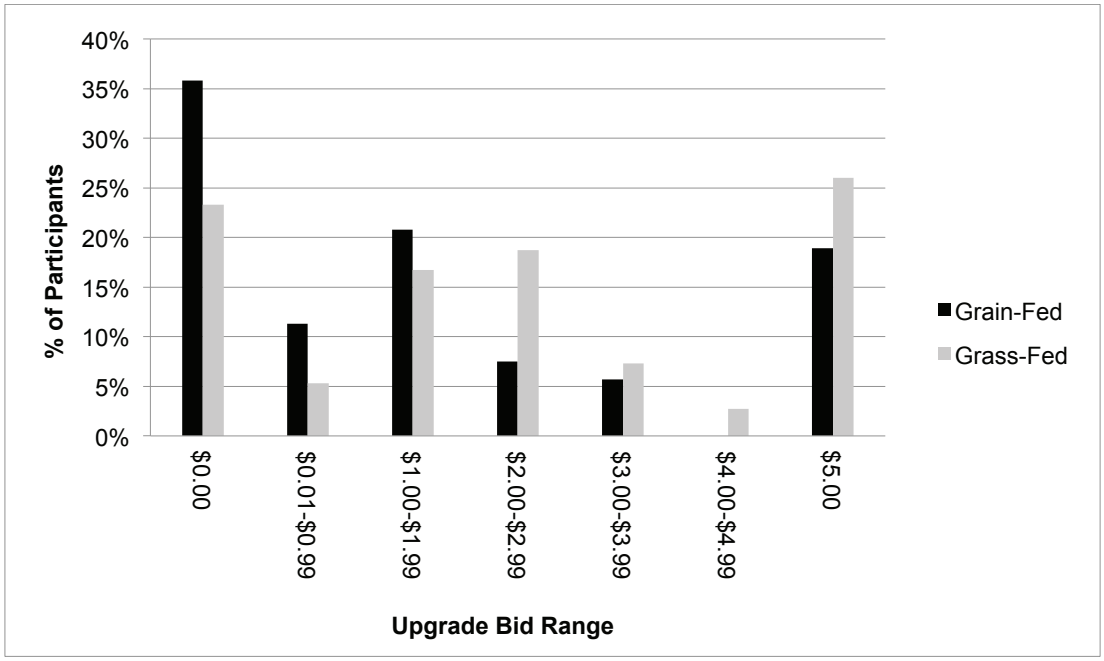

Figure 1. Dispersion of Upgrade Bids for Steak

participants, willingness to pay as an expression of those preferences must be considered to form a clearer rendering of future retail potential and ultimately system profitability. Approximately 73 percent of participants submitted nonzero upgrade bids, indicating that a majority was willing to give up income to acquire their preferred product. Bids 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, 36 percent of grain-fed preferring respondents offered upgrade bids of zero, while only 23 percent of grass-fed preferring respondents did so. Approximately 27 percent and 19 percent of grass-fed preferring and grain-fed preferring respondents, respectively, offered bids equal to the upper bound of the bid distribution ($5.00). The dispersion of upgrade bids for grass-fed and grain-fed preferring respondents is shown in Figure 1. That grass-fed preferring participants registered their preferences with higher willingness to pay values suggests that the *intensity* of preferences for grass-fed products is greater than that for grain-fed products.

Results suggest that at a premium of at least $1.00/lb. over and above conventional retail grain-fed beefsteaks, approximately 53 percent of the total 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 percent. Interestingly, at premiums of as much as $4.00/lb., at least 20 percent of the sample would choose and purchase the grass-fed product.

Post-likelihood ratio test results of the censored regression model are presented in Table 5. Inexplicably, upgrade bids for the grass-fed product in treatment 1:2 were significantly less than those submitted in treatment 1:1. However, as expected and aligned with the results of the probit model for steak preference discussed above, those in treatment 3:1 bid significantly less than those in treatment 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 of the other treatments were not significantly

Table 5. Censored Regression Model Results for Steak Bidding Behavior

(Dependent Variable = Bid to upgrade to grass-fed product)

Independent Variable	Coefficient† (Std. Error)
Constant	0.40 (1.15)
Treatment 1:2*	-1.64 (0.86)
Treatment 2:1	-0.21 (0.79)
Treatment 2:2	-1.01 (0.77)
Treatment 3:1**	-1.83 (0.88)
Treatment 3:2	-1.22 (0.94)
Pittsburgh**	1.65 (0.46)
Local**	0.73 (0.21)
Price**	-0.57 (0.23)
Primary**	1.79 (0.76)

*=p<0.10; **=p<0.05

† Coefficients are equivalent to dollar values; coefficients on treatment variables should be interpreted as upgrade bids for grass-fed steak relative to those submitted by respondents in treatment 1:1.

different from those submitted in treatment 1:1.

As was the case with steak preferences, the variables PITTSBURGH, 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 intensity of those preferences. Also, as expected, those respondents who rated price as an important factor in beef purchase decisions (PRICE) bid significantly less than those rating price as "somewhat important" or "not important."

Conclusions

Given that the beef industry continues to face challenges in conforming to trends in consumer tastes, and in operating under highly volatile feed input markets, exploration of consumer perceptions of novel process-differentiated products is critical. Overall, results of the current analysis 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.

The intrinsic nutritional qualities of grass-fed beef, especially relative leanness and beneficial fatty acid composition, seem to be 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. Clearly, though, perceptions were not *negatively* affected by the "grass-fed" label either. 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 grass-finishing. Only 15 percent 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 implications of conventional and forage-based finishing 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). In fact, even a majority (67 percent) of those respondents claiming to typically search out steaks graded Choice or higher expressed preference for the less-marbled grass-fed steaks. As asserted by other authors, this result indicates 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 the participant preferences for grass-fed beef were not negatively impacted by tasting Select-grade, grass-fed steaks, this seems an appropriate target quality endpoint. This would satisfy consumer preferences for a more lean, yet highly palatable, cut and would also decrease the amount of finishing time necessary, which would in turn have significant impacts on producers' profitability, risk, and opportunity costs.

While grass-fed products are currently not available in mass retail across the country, the growing number of Internet suppliers and producers devoting at least some of their marketing efforts to grass-fed cattle (Spiselman 2006) supports the results found in this analysis that consumers find appeal with these products' attributes. Given that the respondents in this study were surveyed in a retail setting, the results suggest that an expansion of this market into the retail sector could propel market growth significantly. The willingness to pay values elicited here should be interpreted with caution, though, given the uncertainties regarding marginal propensity to consume from transitory income. Future research that utilizes pilot products in retail markets will be critical in supporting the evidence of willingness to pay that is found using experimental methods. Further, because respondents in this analysis were not made aware of the dollar value of their complimentary non-preferred steak product and were asked for absolute dollar bids to upgrade, computation of premiums for grass-fed beef as percentages over and above conventional prices was not possible. This may be an important consideration in future work aimed at assessing production system profitability.

Consumer preferences and willingness to pay for grass-fed beef will likely differ *across* regions of the United States due to heterogeneous attitudes toward and knowledge of beef production in general. Additional research will be necessary to qualify those differences and to assess implications for producers nationwide. A comprehensive understanding of the potential of grass-fed production as a viable alternative to conventional methods will also necessitate analysis of restaurateur preferences and ultimately a look at the potential for international trade.

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