FORAGE-FED BEEF ATTRIBUTES:

CUSTOMER PREFERENCES AND WILLINGNESS-TO-PAY

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Forage-Fed Beef Attributes: Consumer Preferences and Willingness-to-Pay

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INTRODUCTION

In the past decade, consumers have substantially increased their demand for products that provide additional health benefits. In most cases, consumers are willing to pay a premium for products that are considered healthier. However, an extremely limited amount of market-level data is available on consumer demand for pasture-fed, hormone-free, traceable beef.

This study estimates the consumer demand associated with individual beef attributes, provides vital pricing information, and identifies the target demographic for alternative beef products. This analysis aims to evaluate the feasibility of production of forage-fed beef in Alabama as an alternative to the traditional system used by beef producers.

METHODS

In this study, hypothetical and non-hypothetical conjoint experiments were utilized to estimate demand for several beef attributes (see appendix for econometric model formulation). In a conjoint experiment, products or gift options are constructed by combining different levels of each possible product attribute. The hypothetical or traditional conjoint method involves individual's ranking a series of product descriptions (hypothetical products) according to their relative desirability. In the non-hypothetical method, individuals receive real money and real products based on their specified preferences. The allocation of real money to products in varying amounts allows for a value to be estimated for the attributes of the beef products. The non-hypothetical approach is designed to more closely resemble an actual shopping experience.

A conjoint experiment was constructed in which beef products were described by attributes, including whether the animal was pasture grazed, whether growth hor-

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mones and antibiotics were used, and whether the meat was traceable back to the farm where the animal was raised. Two additional attributes were also evaluated: package size (which varied between the levels of 1 and 2 pounds) and price (cash offered). Since a component of the analysis used real money and real food, the price variable represented the amount of cash that would be given to the individual rather than the traditional amount the consumer paid for the particular product. Offering cash is likely to drastically increase the survey response rate compared to a study without such an incentive, and it also avoids the bias of cash-constrained customers in a store setting, e.g., many consumers come to a store planning to pay by credit card or check and do not have any cash to participate in a value elicitation experiment.

Table 1 lists the attributes and attribute levels investigated. In this study, combining every possible attribute level would result in a total of 64 alternatives or product descriptions for a consumer to evaluate. Rather than presenting the respondents with all possible product descriptions, 16 product profiles that provide a representative sample of all possible products were created. In order to reduce the burden on respondents, these 16 profiles were blocked into sets of eight. A ninth profile was also added, which was a "no steak" or "no ground beef" option that consisted simply of an offer of an amount of cash ($13 in the case of steaks and $5 in the case of ground beef). Each respondent was asked to rank the desirability of the nine profiles from most desirable to least desirable.

Survey data were collected via in-person interviews at Bruno's grocery store in Auburn, Alabama (Lee County). Numerous studies document the advantages of conducting in-person interviews in a similar setting *(4,3)*. The Auburn Bruno's store is a 65,000 square foot grocery store with approximately 850 square feet of meat market space. The store carries a relatively large selection of specialty products that appeal to health conscience consumers; therefore, a portion of the store's customers regularly purchase specialty products. An average of 9,200 shoppers visits this Bruno's location each week.

Table 1. Meat Attributes and Attribute Levels Used in Conjoint Study

Attributes	Attribute levels
Forage-fed	Cattle grazed in pasture only
	[nothing mentioned about how animal was fed]
Antibiotic and hormone use	Cattle raised without antibiotics,
	No growth hormones added
	[nothing mentioned about growth hormones or antibiotics]
Traceability	Cattle traceable back to farm
	[nothing mentioned about how animal was fed]
Size	One 1-lb steak (or 1 lb ground beef)
	Two 1-lb steaks (or 2 lbs ground beef)
Cash Offered	$3 (or $1 if ground beef)
	$5 (or $2 if ground beef)
	$7 (or $3 if ground beef)
	$9 (or $4 if ground beef)

A booth was set up near the meat counter, and as individuals passed, they were asked to take part in the study and informed of the reward associated with their participation. In the hypothetical experiment, each subject had a chance to win $250 in free groceries, and in the non-hypothetical experiment each respondent received one of the gift options presented. Upon agreeing to participate, individuals were randomly assigned to one of the eight treatments shown in Table 2. Treatments varied according to whether (1) individuals completed the conjoint task with beef steaks (ribeyes) or ground beef, (2) the conjoint ranking was real or hypothetical, and/or (3) whether information was provided about the health benefits of pasture-grazed beef.

In the hypothetical conjoint treatment, individuals were presented nine cards each containing a product description and were asked to rank them according to their desirability. Figure 1 provides an example of the cards with the product descriptions provided to respondents. Although it is assumed that individuals do their best and rank products according to their preferences, there is neither monetary cost to individuals deviating from their true preferences nor monetary reward for individuals putting cognitive effort into their decisions. Thus, the hypothetical context may lend itself to outright deception by participants and/or may fail to encourage some individuals to put cognitive effort into their decisions. To alleviate these concerns, we introduced a new method: non-hypothetical conjoint analysis.

In the non-hypothetical treatments, individuals were, again, presented nine cards to rank, but in this case they were informed that their ranking would correspond

TABLE 2. EXPERIMENTAL TREATMENTS

Treatment	Meat type	Nature of decision task	Information provided about benefits of pasture-grazed cattle?
1	Steak	Hypothetical ranking	Yes
2	Steak	Hypothetical ranking	No
3	Steak	Non-hypothetical ranking	Yes
4	Steak	Non-hypothetical ranking	No
5	Ground beef	Hypothetical ranking	Yes
6	Ground beef	Hypothetical ranking	No
7	Ground beef	Non-hypothetical ranking	Yes
8	Ground beef	Non-hypothetical ranking	No

Figure 1. Examples of product profiles individuals were asked to rank.

GIFT OPTION A	GIFT OPTION C	GIFT OPTION G
One ribeye steak (1 lb) Cattle grazed in pasture only Cattle raised without antibiotics; no growth hormones added Cattle traceable back to farm + $5 cash	One ribeye steak (1 lb) Cattle grazed in pasture only Cattle raised without antibiotics; no growth hormones added + $3 cash	One ribeye steak (1 lb) Cattle grazed in pasture only + $5 cash

to a space on a wheel. The wheel was divided into nine varying size slices where the option they found most desirable occupied the largest slice on the wheel marked with a number 1, the second most desirable option held the second largest slot marked 2, and so on. Once all nine cards were allocated, the wheel was spun about a fixed pointer. Where the pointer stopped indicated the option that was actually received. Thus, the task was a real decision-making exercise, and individuals were actually given the meat and/or the cash associated with the option selected by the wheel. Since respondents actually received the product, this method provided an incentive for respondents to place the most desired item in the largest slice that had the greatest chance of being selected, the second most desired item in the second largest slice, and so on.

In some treatments, individuals were not given any information about the product attributes. These treatments reflected what would happen when a consumer encountered a new product or brand in the marketplace and had to make a purchase decision based on whatever information was available at the time. To investigate the effect of advertising or providing information on the benefits of certain attributes, individuals were given the following information in some treatments:

> Note: Some gift options indicate that the meat is from cattle grazed in pasture only. Research has shown that cattle fed a diet of grass from pastures have higher levels of omega-3 fatty acid, conjugated linoleic acid, and vitamin E than grain-fed beef. Research has also shown that human consumption of omega-3 fatty acid, conjugated linoleic acid, and vitamin E is associated with reduced risk of heart disease, reduced body weight, and other health benefits that result from consumption of antioxidants.

CHARACTERISTICS OF SURVEY PARTICIPANTS

It is important to describe the sample of participants to determine how they compare to the average consumer. A description of questionnaire respondents helps to define the target demographic for alternative beef products. A total of 515 respondents ranked products and completed a questionnaire over four consecutive days.

Given the ranking challenge presented to each subject, we were interested in the level of difficulty perceived and the amount of thought put into answering the survey. The vast majority of respondents felt the survey was relatively easy to complete with 46 percent and 21 percent indicating the survey was “somewhat easy” and “very easy,” respectively. Less than 2 percent of respondents indicated that the survey was very difficult to complete, while an additional 31 percent felt the survey was somewhat difficult. Almost all respondents took the evaluation seriously with 73 percent indicating they gave “some thought” and an additional 20 percent indicated that they put “a lot of thought” into ranking products. Only 6 percent and 1 percent of respondents indicated that they gave “little thought” and “no thought” to ranking products, respectively.

The majority of respondents were female (60 percent), which was expected given that females typically do the larger portion of the household grocery purchases.

Overall, respondents were relatively young with an average age of 44 across all respondents. More than 33 percent of respondents were 30 years of age or less. This result was expected given the large percentage of college students residing in the area. The percentage of respondents between the ages of 31 and 50 as well as between the ages of 51 and 70 was almost equal at about 30 percent each. Less than 7 percent of respondents were over the age of 70 (See Figure 2). About 81 percent of respondents were White, while 15.5 percent and 3.5 percent were African American and other, respectively.

The respondents in the sample typically had higher levels of formal education than the general population: 39 percent and 20 percent of respondents had an undergraduate degree and/or a postgraduate degree, respectively. About 32 percent indicated they had a high school diploma and less than 2 percent had less than a high school diploma. About 6 percent indicated some other education, such as an associates degree and/ or vocational training. A large portion of respondents, who indicated they had a high school diploma, was likely to be college undergraduate students. In Alabama and Lee County, there are approximately 19 percent and 28 percent of residents who have at least an undergraduate degree, respectively (2000 U.S. Census).

In line with the higher education levels, the sample indicated rather high levels of income. About 12 percent of respondents indicated their household income was $80,000 to $100,000, and an additional 21 percent had a household income of greater than $100,000. On the other end of the spectrum approximately 20 percent of respondents indicated their income was less than $20,000. College students are likely to make up the majority of this group (See Figure 3).

The beef-eating habits of respondents were also investigated. Most respondents were consistent consumers of beef products with 48 percent and 74 percent indicating that they eat steak and ground beef, respectively, at least once per week. About

Figure 2. Age of categories of survey respondents.

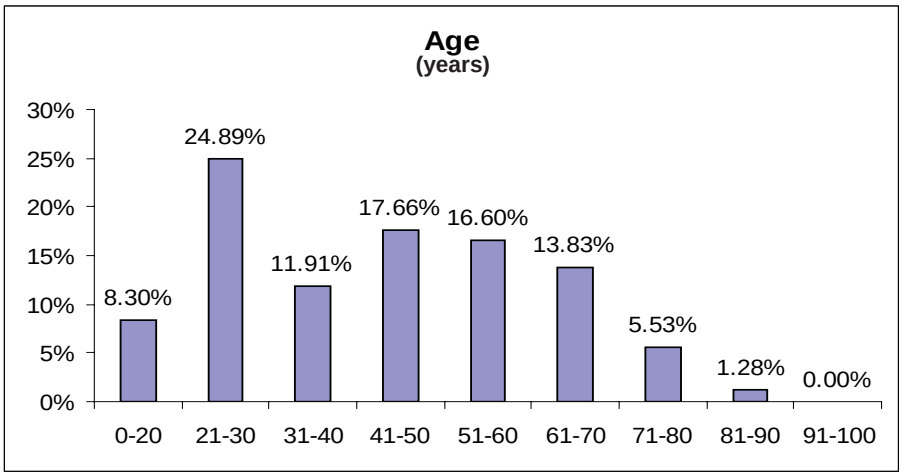
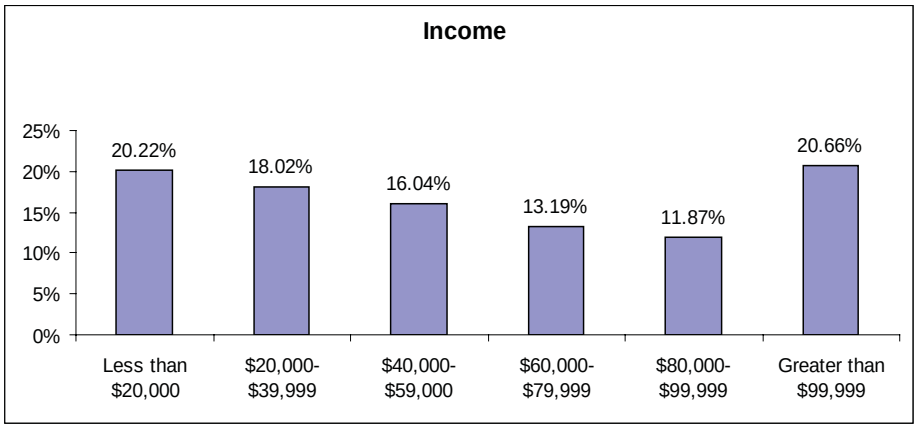


Figure 3. Income categories of survey respondents.



42 percent indicated that they eat steak about once per month, and an additional 10 percent indicated that they rarely or never eat steak. Approximately 19 percent of respondents indicated that they eat ground beef about once per month, and 6 percent rarely or never ate ground beef. This group of consumers was commonly unsure of whether the grocery store carried beef products that were either traceable back to the farm, produced with no antibiotics or growth hormones, or grazed in pasture. When asked how likely beef found in grocery stores was from cattle with these characteristics, about 60 percent indicated that they were unsure. Between 17 and 21 percent of respondents indicated that it was not likely at all to find beef products with these characteristics, and less than 7 percent felt that it was very likely that these products could be found in grocery stores.

RESULTS

A total of 515 respondents took part in the study, each providing nine rankings for a grand total of 4,635 observations. The fewest number of individuals assigned to any one treatment was 59 (the steak, hypothetical, no information treatment) and the most individuals assigned to any one treatment was 75 (the ground beef, hypothetical, no information treatment).

Tables 3 and 4 report results from the random parameter model estimation. Table 3 presents results relating to the means of the meat preference parameters and the effect of the treatment variables on the means. The first column of results corresponds to the mean preferences when all treatment variables are zero; i.e., the treatment that used ground beef, was hypothetical, and presented no information on pasture-fed beef. All results are consistent with *a priori* expectations. The results indicate individuals preferred the following: pasture-grazed ground beef over ground beef that did not have such an attribute, ground beef from cattle that were not administered growth hormones or antibiotics over hormone- and antibiotic-treated cattle, ground beef that was trace-

able back to the farm versus non-traceable beef, two pounds instead of one pound of ground beef, more cash to less, and having a pound of ground beef to no beef at all. The relative size of the coefficients suggests individuals valued the hormone attribute more than pasture or traceability, at least in the ground beef, hypothetical, no information treatment. The next several columns of results show the effect of the various treatments on the mean preference parameters. Results indicate that the pasture attribute was less preferred in the steak treatments than in the ground beef treatments and consistent with *a priori* expectations that individuals were more averse to not obtaining any beef when the option was a steak versus ground beef.

Moving the decision context to a non-hypothetical setting had a significant influence on several preference parameters, and, in particular, results indicate an interaction effect between the non-hypothetical and information treatments, meaning information had differing effects depending on whether individuals' decisions were binding. Information affected preferences in a way consistent with expectations. Providing information about the health benefits of pasture-fed beef increased preferences for beef with that attribute (although less so in the non-hypothetical treatment than in

Table 3. Parameter Preference Estimates from Random Parameter Model

Random utility parameters	Mean	——Variables affecting heterogeneity in means—— Steak	Non-hyp	Info	Steak* non-hyp	Steak* info	Non-hyp* info	Implied standard deviation
Constant	1.513**[1]	-0.447*	0.112	-0.099	-0.195	0.272	-0.183	0.845
	(0.126)[2]	(0.197)	(0.158)	(0.154)	(0.214)	(0.215)	(0.148)	
Forage-fed	0.986**	-0.396**	0.149	0.507**	0.122	-0.019	-0.225*	0.981
	(0.067)	(0.094)	(0.090)	(0.088)	(0.107)	(0.107)	(0.106)	
Hormone	1.203**	-0.075	0.284**	0.355**	0.324**	-0.536**	-0.251*	1.565
	(0.066)	(0.093)	(0.090)	(0.086)	(0.107)	(0.107)	(0.107)	
Trace	0.594**	0.114	0.049	-0.269**	0.032	-0.154	0.533**	0.915
	(0.068)	(0.090)	(0.090)	(0.088)	(0.105)	(0.105)	(0.106)	
Size	0.761**	-0.110	0.047	-0.638	-0.362	0.265	0.260*	1.396
	(0.140)	(0.203)	(0.173)	(0.170)	(0.223)	(0.223)	(0.136)	
Cash	0.825**	-0.358**	-0.170*	0.035	0.120	-0.036	0.012	0.034
	(0.059)	(0.067)	(0.069)	(0.068)	(0.075)	(0.075)	(0.029)	
None	-6.270**	-1.456**	0.806**	-0.301	-0.690	0.786	-0.258	2.496
	(0.248)	(0.403)	(0.312)	(0.299)	(0.431)	(0.433)	(0.257)	

[1] One (*) and two (**) asterisks represent 0.05 and 0.01 levels or statistical significance, respectively.

[2] Numbers in parentheses are standard errors.

Table 4. Correlation Coefficients between Random Parameters

	Constant	Pasture	Hormone	Trace	Size	Price	None
Constant	1.000						
Forage-fed	-0.332	1.000					
Hormone	-0.668	0.078	1.000				
Trace	-0.229	0.298	0.139	1.000			
Size	-0.132	0.555	0.413	0.689	1.000		
Price	0.291	0.411	0.219	0.342	0.771	1.000	
None	0.254	0.240	0.165	0.357	0.808	0.632	1.000

the hypothetical treatments). Information also tended to increase preferences for beef with no hormones and antibiotics, but decreased preferences for traceability, at least in the hypothetical treatment. The last column of results in Table 3 presents the implied standard deviations of the random parameters. Results indicate significant heterogeneity in the population for every preference parameter except for preferences for cash. For example, the mean preference for forage-fed beef was 0.986 in the ground beef, hypothetical, no information treatment and the standard deviation was 0.981, implying that 95 percent of the population has a preference parameter of between -0.942 and 2.915 (e.g., 0.986 ± 1.96*0.981) for pasture-raised beef. The wide range of the preference measurements suggests that consumers in the study did not exhibit a uniform preference for a given beef attribute, except for the cash parameter. Additionally, that some portion of the population preferred non-forage-fed beef (grain-fed) to forage-fed beef is plausible given that grain-feeding is the industry standard and grain-fed beef generates a taste for which many consumers are more accustomed.

Table 4 reports the implied correlation coefficients between the random steak preference parameters. The results indicate that preferences for all steak attributes are positively correlated. This implies, for example, that an individual who has higher preferences for forage-fed beef is also likely to have higher preferences for beef that is traceable back to the farm.

Table 5 reports mean willingness-to-pay for each beef attribute and the associated standard deviations segregated by treatment. These statistics were calculated by randomly drawing 5,000 observations from the estimated parameter distribution and calculating willingness-to-pay for each attribute at each random draw. Willingness-to-pay for an attribute is calculated as the ratio of the particular attribute parameter and the cash parameter and represents the dollar amount that would make an individual indifferent to having the particular attribute. For steaks, when information was provided, and the decision task was non-hypothetical, individuals were willing to pay $2.56 more for a forage-fed steak than a non-forage-fed steak. When information was not provided about the benefits of forage-fed meat, this figure dropped to $1.99. On average, individuals were willing to pay more for meat without growth hormones or antibiotics than for forage-fed and traceable beef—more than $2.00 more in the steak, non-hypothetical treatments without information. Overall, consumers were less willing to pay for traceability on average than forage-fed or non-hormone treated beef. Providing information about pasture-fed beef tended to increase willingness-to-pay for that attribute, but not by a substantial margin. In general, moving from the non-hypothetical decision task to the hypothetical decision task tended to reduce the amount individuals were willing to pay for a given attribute. The willingness-to-pay measures for individual attributes were not additive due to some interaction effects. The total willingness-to-pay for a product with all of these attributes was expected to be significantly lower than the sum of the willingness-to-pay for individual attributes due to the interaction effects.

To further investigate the implications of the results, a number of market share simulations were conducted. To carry out the simulations, 5,000 simulated individuals were created by randomly drawing preference parameters from estimated random parameter distribution assuming the task was non-hypothetical and that consumers

did not have information about forage-fed beef. Then, a scenario was created that contained one, two, or three products from which the individual could choose. Then it was assumed that each simulated individual chose the product that generated the highest level of utility. Market shares were calculated by determining the percentage of individuals that would choose a given alternative.

Table 6 reports market shares from a number of simulated scenarios. Results reported are based upon responses provided by respondents in this study. It is important to note that consumers in this survey do not represent the average consumer. The consumers in this sample are relatively well-educated, high-income consumers. This group is expected to be more health conscience and have more buying power than the general population. In the first scenario, it was assumed a conventional product (not pasture-fed, produced with growth hormones and antibiotics, and not traceable) was the only product for sale. If it were the only product for sale, by definition, it would generate 100 percent market share. Scenario 2 shows what would happen if both conventional and forage-fed steak (ground beef) were available for sale at $8.00 per pound ($2.25) and $10.00 per pound ($4.25), respectively. In the steak market, the forage-fed product would pick up about 51 percent market share whereas it would only garner about 43 percent market share in the ground beef market. Scenario 3 shows the effect of increasing the price of forage-fed steak (ground beef) to $12.00 per pound ($5.00

TABLE 5. MEAN WILLINGNESS-TO-PAY FOR VARIOUS MEAT ATTRIBUTES

	Non-hypothetical		—Hypothetical—	
Willingness-to-pay for . . .	Info	No info	Info	No info
Steak				
Forage-fed	$2.555	$1.989	$2.249	$1.196
	(2.196)[1]	(2.275)	(2.019)	(2.047)
No hormones	$2.957	$4.084	$1.946	$2.335
	(3.615)	(3.705)	(3.326)	(3.320)
Traceable back to farm	$2.040	$1.833	$0.550	$1.463
	(2.088)	(2.153)	(1.946)	(1.925)
Two pounds versus one pound	$0.262	$0.536	$0.373	$1.178
	(3.246)	(3.323)	(2.967)	(2.922)
One pound versus no steak	$17.787	$18.852	$15.980	$17.022
	(6.882)	(7.146)	(6.208)	(6.262)
Ground Beef				
Forage-fed	$1.989	$1.698	$1.713	$1.170
	(1.339)	(1.442)	(1.095)	(1.151)
No hormones	$2.220	$2.220	$1.775	$1.420
	(2.198)	(2.358)	(1.795)	(1.875)
Traceable back to farm	$1.264	$0.951	$0.356	$0.698
	(1.275)	(1.373)	(1.050)	(1.091)
Two pounds versus one pound	$0.502	$1.112	$0.062	$0.838
	(1.954)	(2.073)	(1.605)	(1.650)
One pound versus no ground beef	$8.788	$8.578	$7.786	$7.760
	(3.856)	(4.130)	(3.116)	(3.250)

Note: statistics in this table were generated by randomly drawing 5,000 observations from the estimated random parameter distribution.

[1] Numbers in parentheses are standard deviations of willingness-to-pay.

Table 6. Market Share Simulations

	Scenario					
	1	2	3	4	5	6
Products in choice set	Current situation	Baseline: Introduce forage-fed beef [1]	Increase price of forage-fed beef [2]	Provide info about forage-fed beef	Introduce forage-fed no-hormone traceable beef [3]	Introduce both products
Steak						
Conventional	100.00%	49.09%	81.52%	39.21%	13.72%	11.46%
Forage-fed	n.a.	50.91%	18.48%	60.79%	n.a.	3.76%
Forage-fed, no hormones, traceable	n.a.	n.a.	n.a.	n.a.	86.28%	84.78%
Ground Beef						
Conventional	100.00%	57.29%	76.46%	49.79%	19.74%	16.84%
Forage-fed	n.a.	42.71%	23.54%	50.21%	n.a.	4.60%
Forage-fed, no hormones, traceable	n.a.	n.a.	n.a.	n.a.	80.26%	78.56%

Note: Statistics in this table were generated by randomly drawing 5000 observations from the estimated random parameter distribution and by using the "first choice rule" where it is assumed an individual chooses the product generating the highest level of utility.

[1] Assumes conventional steak (ground beef) is $8.00 per pound ($2.25 per pound) and pasture-fed is $10.00 per pound ($4.25 per pound) and assumes consumers do not have information about pasture-fed beef.

[2] Assumptions same as baseline except price of pasture-fed steak (ground beef) is $12.00 per pound ($5.00).

[3] Assumes conventional steak (ground beef) is $8.00 per pound ($2.25 per pound) and pasture, no hormone, traceable beef is $10.00 per pound ($4.25 per pound) and assumes consumers do not have information about pasture-fed beef.

per pound) while the conventional price remained unchanged. In this case, the pasture-fed steak (ground beef) market share fell from 51 percent (43 percent) to 18 percent (23 percent) as compared to scenario 2. Scenario 4 illustrates the effect of providing information about the benefits of pasture-fed beef. Providing such information increases market share of forage-fed steak about 10 percent (from 51 percent to 61 percent) and forage-fed ground beef about 7 percent (from 43 percent to 50 percent). Scenario 5 shows the effect of introducing a meat product that is pasture-fed, has no growth hormones or antibiotics, and is traceable back to the farm at a price of $10.00 per pound ($4.25 per pound for ground beef). Such a product would be expected to pick up more than 80 percent market share in both the steak and ground beef markets. Finally, scenario 6 shows the market shares that would arise if all three products were available for sale. As might be expected, pasture-fed beef obtains a very small market share, less than 5 percent, if a pasture-fed, no growth hormones or antibiotics, and traceable product is also available. Respondents to this survey represent a relatively small segment of the overall population. This analysis also assumes that taste and tenderness are equal across all products.

In general, females had higher utility parameters for forage-fed, no added hormones, and traceability than males. This result is consistent with the view that females are more risk averse than males. Providing information to the respondents increased their utility for the various beef attributes. Higher income individuals had higher utility parameters for forage-fed, no added hormones, and traceability than low-income individuals. Additionally, higher income individuals were less responsive to changes in coupon values than lower income individuals. Relating to size/quantity of beef, females have a lower preference for larger cuts. Individuals who put more thought into the survey questions also placed higher values on package size.

CONCLUSIONS

The results of this study indicate definite market potential for beef produced using alternative methods. Consumers in this study indicated a willingness-to-pay a premium for products that were either grazed in pasture (forage-fed), traceable back to the farm where produced, or produced without antibiotics or growth hormones. Although survey respondents do not represent the typical consumer in the state, they are likely to be the best demographic to target for marketing alternative, high-valued beef products.

The study also suggests that providing information or educating consumers on health benefits of these products will add to the market potential of these products. This study provides some evidence that developing and marketing alternative beef products has the potential to add to the bottom line of beef producers in the state.

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APPENDIX

Econometric Model

Individuals are assumed to derive utility or satisfaction from the attributes that compose meat products. In particular, a random utility function may be defined by a deterministic (V_{ij}) and a stochastic (ε_{ij}) component:

(1) $$U_{ij} = V_{ij} + \varepsilon_{ij}$$

where U_{ij} is the i^{th} consumer's utility from receiving option j, V_{ij} is the systematic portion of the utility function determined by the meat attributes and their values for alternative j, and ε_{ij} is a stochastic element. An individual will rank alternative j higher than alternative k if

(2) $$V_{ij} + \varepsilon_{ij} \geq V_{ik} + \varepsilon_{ik} .$$

Assuming V_{ij} is linear in parameters, the functional form of the utility function may be expressed as:

(3) $$V_{ij} = \beta_0 + \beta_1 x_{ij1} + \beta_2 x_{ij2} + \ldots \beta_n x_{ijn}$$

Where x_{ijn} is the n^{th} attribute value for alternative j for consumer i, and β_n represents the coefficients to be estimated. More explicitly, equation (3) can be written as follows for our particular application:

(4) $$V_{ij} = \beta_0 + \beta_1 Pasture_j + \beta_2 Hormone_j + \beta_3 Trace_j + \beta_4 Size_j + \beta_5 Cash_j + \beta_6 None_j$$

where *Pasture* takes the value of 1 if meat option j was from cattle that were pasture fed only and 0 otherwise, *Hormone* takes the value of 1 for meat products from cattle that were not administered growth hormones or antibiotics, *Trace* takes the value of 1 for meat products that are traceable back to the farm and 0 otherwise, *Size* takes the value of 1 for package sizes of two pounds and 0 otherwise, *Cash* is the amount of money offered to the individual in option j, and *None* takes the value of 1 for the option where no meat product was offered and 0 for all other options.

Following traditional conjoint analytic methods, one could simply use ordinary least squares to estimate the parameters (4), where the dependent variable would be the ranking of the alternatives and the independent variables would be the meat attributes associated with the ranked alternatives. A typical approach is to estimate (4) for each individual in the sample to recover individual-specific estimates. However, because each individual only ranks a few options (nine in this case), the efficiency of the estimates is likely to be low. To address this concern and to provide a convenient means of investigating treatment effects, a hierarchical random parameter model is used that permits one to estimate the distribution of the parameters in (4) in the sample, conditional on treatment effects.

Following Greene, the model can be written as:

(5) $$f(y_{ij} | X_{ij}, Z_i, v_i, \beta_i, \theta) = g(y_{ij}, X_{ij}, \beta_i, \theta)$$

(6) $$\beta_i = \beta + \Delta Z_i + \Gamma v_i$$

where y_{ij} is the i^{th} individual's ranking of option j, X_{ij} is a matrix representing the attributes and attributes levels defining option j, β_i is a vector of the i^{th} individuals marginal utilities, β is the mean of the random parameters, Z_i is a set of alternative invariant variables (in this case they are the treatment variables, *Steak* that equals 1 for treat-

ments that used steaks and 0 for ground beef, *Non-Hyp* that equals 1 for non-hypothetical treatments and 0 for hypothetical treatments, *Info* that equals 1 for treatments that provided information about pasture-fed beef and 0 otherwise, and interactions between these treatment variables) that affect the mean of the random parameters via the coefficient matrix Δ, v_i is a vector of random standard normal deviates, Γ is unrestricted lower triangle matrix of parameters to be estimated where $\Omega = \Gamma'\Gamma$ represents the variance-covariance matrix associated with the random parameters β_i, and θ is the standard deviation of the overall disturbance.

Conditional on v_i, the likelihood function for individual i is

$$(7) \qquad L_i(\beta, \Delta, \Gamma, \theta \mid y_i, X_i, Z_i, v_i) = \prod_{j=1}^{J} g(y_j, X_j \beta_i, \theta)$$

In order to estimate (7), one must transform the above equation to an unconditional likelihood function where v_i contained within β_i is integrated out. The unconditional likelihood function is

$$(8) \qquad L_i(\beta, \Delta, \Gamma, \theta \mid y_i, X_j, Z_i) = \int \prod_{j=1}^{J} g(y_j, X_j \beta_i, \theta) f(v_i) dv_i$$

Because the integral in (8) does not exist in closed form, the parameters can be estimated by simulation. The simulated log likelihood for a sample of N individuals is

$$(9) \qquad \log L_i = \sum_{i=1}^{N} \log \frac{1}{R} \sum_{r=1}^{R} \prod_{j=1}^{J} g(y_j, X_j \beta_{i,r}, \theta)$$

In the simulation, $v_{i,r}$ is drawn R times, creating R draws of $\beta_{i,r}$ via equation (6). The values of β, Δ, Γ, and θ are chosen so as to maximize equation (9). In this application, we utilize 200 "intelligent" Halton draws of $v_{i,r}$. See Train *(5)*, Greene *(2)* and Gourieroux and Monfort *(1)* for more theory and details on this estimation method.

To summarize, this model estimates a joint-normal distribution for the meat preference parameters in the sample population, allowing for the calculation of the mean preferences, conditional on the treatment variables, and the variation and covariation in meat preferences.

Alabama's Agricultural Experiment Station
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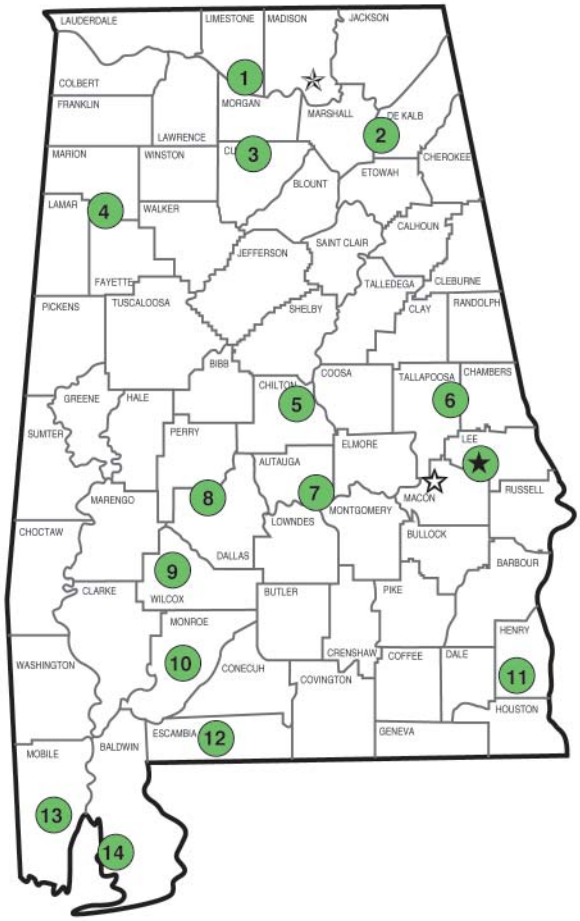
With an agricultural research unit in every major soil area, Auburn University serves the needs of field crop, livestock, forestry, and horticultural producers in each region in Alabama. Every citizen of the state has a stake in this research program, since any advantage from new and more economical ways of producing and handling farm products directly benefits the consuming public.



Research Unit Identification

★ Main Agricultural Experiment Station, Auburn.
☆ Alabama A&M University.
☆ E. V. Smith Research Center, Shorter.

1. Tennessee Valley Research and Extension Center, Belle Mina.
2. Sand Mountain Research and Extension Center, Crossville.
3. North Alabama Horticulture Research Center, Cullman.
4. Upper Coastal Plain Agricultural Research Center, Winfield.
5. Chilton Research and Extension Center, Clanton.
6. Piedmont Substation, Camp Hill.
7. Prattville Agricultural Research Unit, Prattville.
8. Black Belt Research and Extension Center, Marion Junction.
9. Lower Coastal Plain Substation, Camden.
10. Monroeville Agricultural Research Unit, Monroeville.
11. Wiregrass Research and Extension Center, Headland.
12. Brewton Agricultural Research Unit, Brewton.
13. Ornamental Horticulture Research Center, Spring Hill.
14. Gulf Coast Research and Extension Center, Fairhope.