Value Added to the Beef Cattle Chain through Genetic Management

By:
Jessica Robertson
and
Joe Parcell*

Selected Paper prepared for presentation at the
Southern Agricultural Economics Association Annual Meetings
Orlando, Florida, February 5 – 8, 2006

Abstract:
Genetics have a direct impact on the carcass quality of an animal. The objective of the study is to determine whether managing genetics has an impact on quality of beef carcasses. Genetic management was found to have a positive impact on quality grade and no impact on yield grade.

*Jessica Robertson is a graduate research assistant at the University of Missouri. Robertson can be reached by postal mail at Mumford Hall, Room 327, University of Missouri, Columbia, MO, 65211, or by email at jlr26c@mizzou.edu. Joe Parcell is an associate professor at the University of Missouri. Parcell can be reached by postal mail at Mumford Hall, Room 143a, University of Missouri, Columbia, MO 65211 or by email at ParcellJ@missouri.edu.

Value Added to the Beef Cattle Chain through Genetic Management

The beef cattle industry is a constantly changing industry. Twenty years ago, calves were sold off the farm with little or no thought to what the characteristics of the end beef product would be. Now, the look and taste of beef products are crucial in the market place. Lusk et al. (1999) researched consumer opinions by talking with shoppers in several grocery stores. The study found that 69% of participants in a blind taste test preferred a tender steak to a tough steak. Also, in blind tests, consumers consistently showed a preference for high marbling in steaks. Lusk (2001) found that consumers ranked the color of a steak as its most important attribute, along with marbling. These physical characteristics of the final beef product help determine how much consumers will buy and what price they will pay. Genetics have been proven to directly influence carcass traits. These traits tend to have moderate to high heritability. Ribeye area, fat thickness, marbling, and tenderness all have a heritability between 40% - 60% (Anderson 1990). As a result, producers can directly alter the type of cattle they are sending to the packer by altering the type of sires and dams used. Genetic management is becoming a part of the total farm management plan. But few producers make management decisions for female animals (e.g. culling or retaining) based on genetic related information feedback. Instead production information is often used. So, what is the value of genetic information in making management decisions?

The objective of the study is to determine whether or not the process of managing genetics has a positive impact on the quality of beef carcasses. For example, higher quality carcasses sold through a value based pricing system, such as grid pricing, might signal for a cow-calf producer to keep future heifer calves for retention back into the herd. Beef producers will more likely incorporate genetic performance capabilities into their herd management decisions if it is proven that this planning will provide a net increase in the value of the final product, *ceteris paribus*.

The information from this research will help beef producers better assess the value of managing for genetics versus managing the selection of genetics. That is, some producers may approach genetic management from the standpoint of retaining heifers from dams with a history of superior quality- and yield-grade calves. Other producers may manage the selection of genetics by paying closer attention to the sire and maternal grandsire EPDs. This research investigates the value of allowing market performance to determine heifer calf retention.

Literature Review

The majority of previous research done on genetics in beef cattle has been conducted from a scientific or biological perspective. However, several studies have been conducted from an economic perspective on how genetics could be used to increase net profit for a group of cattle. Research has been conducted on areas that will influence how producers look at genetic management including consumer preferences, grid pricing, and alliances.

Carcass quality has a direct link to how beef will look and taste. These characteristics of beef products are crucial in the market place. Lusk et al. (1999) researched consumer opinions by talking with shoppers in several grocery stores in Kansas. Two treatments were used during the study. With the first treatment, shoppers at the meat counter were asked to participate in an experiment. They were asked to sample two different types of steak, which were labeled “Red” and “Blue.” The Red was actually a guaranteed tender steak and the Blue was a tough steak according to a slice shear force test. Consumers were not told that the samples differed in tenderness. After tasting the steaks, the consumers were asked questions regarding taste, tenderness, texture, juiciness, and overall palatability. The second treatment was identical to the first except that the steaks were labeled “Guaranteed Tender” and “Probably Tough” instead of Red and Blue. A statement was also provided that explained that the USDA divided steaks into tenderness categories based on a shear force test. Both treatments in the study resulted in the majority of the consumers choosing the more tender steak. In the first treatment, 69% of participants preferred the Red (guaranteed tender) steak and in the second treatment, 84% preferred the Guaranteed Tender (red) steak. So, when the differences in steak tenderness were revealed to the consumers, more preferred the tender steak. Lusk (2001) sent a mail survey to a random sample of consumers in the U.S. The consumers were asked to rank six quality characteristics that were important in making the decision whether or not to purchase a steak. The six characteristics were price, external fat, USDA quality grade, brand (label), color, and marbling. The survey found that consumers ranked the color of a steak as its most important attribute, along with marbling.

Richards and Jeffrey (1996) sought a method of measuring and reporting the genetic value of dairy bulls. The researchers wanted to use an alternative approach to the normal measure of genetic valuation used in Canada, which is the Lifetime Profit Index (LPI). Statistical analysis of market price data for semen was done and hedonic pricing was the method used to determine the value of genetic traits in Holstein bulls in Alberta.

Hedonic pricing models say that demand for a product, in this case genetic value, is a function of its characteristics. Researchers stated that the market price of a bull's semen is a function of the values of the genetic characteristics. Data was obtained from the July 1994 volume of the Who's Who sire guide for 692 purebred Holstein bulls on production characteristics such as milk, fat, and protein. Prices of semen, in dollars per straw, were obtained from SEMEX Canada. The empirical model consisted of a Cobb-Douglas function, where the semen price index is a function of the proof characteristics. A Tobit model is also used to estimate marginal characteristic values. The study found that the hedonic pricing method provides a better explanation for market prices of semen than does the LPI. Researchers concluded that the hedonic pricing model accomplishes all of the objectives of the LPI, but at a lower cost and in a way that is easier to comprehend.

Dhuyvetter et al. (1996) estimated market values for bulls based on specific bull attributes, expected progeny differences (EPDs), and bull sale marketing efforts. The researchers decided that important bull price determinants are bull color, polled, conformation, muscling, disposition, age, birth weight, weaning weight, milk EPD, birth and weaning weight EPDs, sale location, order bull was sold, whether the bull had a picture in the sale catalog, and whether a percentage of semen rights were retained by the seller. Data was collected from 26 purebred beef bull sales in Kansas during spring 1993. A total of 1,650 observations were used, representing seven beef breeds. A hedonic pricing model was used. Bull characteristics were categorized as either physical and genetic characteristics or expected performance characteristics. The physical and genetic characteristics refer to the bull itself, while the expected performance characteristics refer to future progeny of the bull. Bull price was specified as a function of physical and genetic characteristics, expected performance characteristics, and marketing factors. Two different models were used to determine the importance of EPDs. One model contained weights without EPDs and the other included weights and EPDs. The study found that EPDs were statistically significant in explaining the price of three breeds, but less significant in the other breeds. Several characteristics of the bulls resulted in the buyers paying premiums, including polled, high subjective ratings for conformation, muscling, and disposition. Marketing factors were also relevant. Prices paid for bulls decreased as sales progressed. A premium was paid for a bull with a picture in the sale catalog and one where a portion of semen rights were retained. The study found that quantifying values of specific bull characteristics is necessary to determine the economic importance of these factors. This study estimated the marginal contribution of various bull traits to the bull's overall value. Researchers concluded that expected performance variables were important in explaining price variability among bulls from the same breed. Prices were positively correlated with weaning weight EPDs in all breeds. Prices were also positively correlated with milk EPDs in three of the breeds. For most breeds, the birth weight EPDs were not seen as providing new information to buyers compared with the actual birth weights so they and were only significant in three of the breeds.

Radke et al. (2000) studied the value of genetic information in selection of replacement Holstein heifers. The study compared competing information systems (IS), which were defined as a "set of messages and associated decision rule." The objective of the study was to determine what the economic value of using genetic information would be and whether this value was adequate for producers to select replacement heifers on this basis. The data consisted of Michigan Holstein heifers born within a six month period that had also calved within a six month period. The two IS used were a complex genetic message and a simple genetic message. The complex genetic message was based on parents' PTAs of milk, fat, protein, and associated reliabilities and the simple genetic message was based only on parents' PTAs of milk. It was found that the two messages were essentially equivalent so it was suggested that the simpler method be used. The researchers concluded that it was profitable to use genetic information as selection criteria as opposed to random selection. For the average Michigan producer, improved heifer selection increased farm profitability approximately 3% – 5%.

Purcell (2002) found that cash market pricing systems fail to send the correct signals to producers about what quality characteristics consumers desire from the beef they purchase. As a result, the quality of beef available in stores may not be consistent with the quality of beef that consumers demand. The outcome of this situation is that consumer demand for beef will not be stable because consumers will only buy the beef that meets the quality characteristics they desire. Producers have explored new opportunities to better serve consumers. However, producers are not willing to invest in these new opportunities without incentives. Producers seek ways to market their product that will provide rewards for higher quality. Some of these alternative marketing methods include pricing grids, contracts, and vertical alliances. Non-price coordination such as the methods listed previously is the main process in which producers can be paid for value. For this process to be successful, feedback on individual animals is essential.

Ward, Schroeder and Feuz (2001) explain that grid pricing is becoming more common in the fed cattle market. With grid pricing, producers are rewarded for high quality cattle and penalized for low quality cattle. This is achieved through a system of premiums and discounts. With grid pricing, an incentive is present for producers to use genetic selection to enhance carcass traits. Packers typically set a standard set of quality specifications and assign a base price for an average carcass. Carcasses that are above average will receive the base price plus a specified premium. Carcasses that are below average will receive the base price minus a specified discount. Most base prices are tied to an external market price through some type of formula, unless the base price is determined through negotiation. The formulas may be very different depending on the external price used. For example, a base price that is tied to the futures market could be different than a base price tied to the cash market or the wholesale market.

McDonald and Schroeder (2000) determined the relative impacts of several factors on profit per head of cattle marketed through a grid structure. Price, cattle quality, and feeding performance factors were examined. Two distinctly different grid structures were analyzed to determine whether factors affecting profit vary based on the type of grid used. Grid A used a weighted plant average base price. The base price is derived from the price paid for and carcass characteristics of all cattle bought live in the previous week. Grid B used a base price based on the western Kansas direct weekly fed cattle price reported by USDA converted. This was converted to a carcass price using the average hot yield for the plant from the previous week. For Grid A, the same premium was paid for yield grades 1 and 2, while yield grades 4 and 5 had separate discounts. Premiums were paid for prime carcasses and discounts given for Select. For Grid B, premiums were paid only on the percent of the pen that were above pre-set requirements for quality traits and discounts were given for pens having undesirable traits above a certain level. Ordinary Least Squares regression was used to explain the differences in profit per head for cattle sold on grids. Two data sets were used, one for a group of cattle (3,483 pens of cattle) sold using Grid A and one for a group of cattle (1,011 pens of cattle) sold using Grid B. When considering all variables, feeder cattle price and grid base price were found to have the greatest impact on cattle profit per head in both grid structures over time. Researchers found that when considering only non-price variables, the cumulative quality of cattle in a pen is the most important factor influencing profit. Genetics influence the quality of cattle and thus influence profit as well.

Conceptual Model

Data should be evaluated to discover what factors are most important in determining the final merit of the carcass. Two main components of carcass merit are yield grade and quality grade. These components are influenced by several factors including dam stacked generation, sire, lot number, marbling, back fat, rib-eye area, internal fat, and hot weight. The model will determine which of these factors influence carcass merit and to what extent do they influence it.

A binomial logit analysis is performed on the data to determine the marginal effects of the independent factors on the dependent variables. The independent variables include dam stacked generation (DSG), sire, and lot number (LN). Dam stacked generation and sire are used to show the effect of genetics, while lot number will show the effects of environmental and management factors in the feedlot. Marbling, back fat, rib-eye area, internal fat, and hot weight were not included in the final model due to their endogeneity. Marbling is a direct component of quality grade, while the other four characteristics are direct components of yield grade.

The dependent variables are selected to determine how well the independent variables affect final carcass quality though yield grade and quality grade. If a positive coefficient is estimated, then that means that the independent variable has a positive impact on the final grade. If the result is negative, then the variable has a negative impact on the final grade. A separate analysis was performed for each yield grade and quality grade.

YG1 = f(DSG, Sire, LN)

YG2 = f(DSG, Sire, LN)

YG3 = f(DSG, Sire, LN)

YG4 = f(DSG, Sire, LN)

YG5 = f(DSG, Sire, LN)

QPrime = f(DSG, Sire, LN)

QChoice = f(DSG, Sire, LN)

QSelect = f(DSG, Sire, LN)

Definitions of the variables used in the logit analysis are provided in Table 1. Dam stacked generation (DSG) represents the number of generations on the dam side in which genetics is known. DSG is a binary variable such that each equation is estimated seven times to represent from a one stacked generation to a seven stacked generation dam. It is important to point out that any animal that has more than one stacked generation of genetics also is a stacked generation in the levels below that stack. For example, an animal with five stacked generations of genetics also has four stacked generations, three stacked generations, and so on. To take this into account, a separate model is run for each level of stacked genetics, i.e. seven stacked generations is the maximum so there are seven sets of equations. Sire is used to distinguish the sires from one another in the analysis. A series of binary independent variables is used. A total of 67 different sires are represented in this group of data. Lot number is used to show what contemporary group each animal is a member of. Thirteen different lots exist in the group of data and series of binary variables distinguish one lot from another.

Data

Data for this paper was obtained from a Southeast Missouri beef cattle producer. The producer kept an extensive record of his herd for several years. Two types of data were used. The first type used was carcass kill sheets. Carcass sheets were available for 13 lots of cattle killed between 1999 and 2005. Most of the cattle in this data set originated from the producer's herd, but some were alliance calves that the producer gained ownership of through the alliance. The carcass sheets were not all from the same feedlot and so the information was provided in different types of tables. For the most part, all of the information in the tables was the same. Three of the lots did not have information directly from the feedlot. Instead, the carcass data was presented through the Angus Herd Improvement Record Carcass Summary (American Angus Association). Some differences existed between the information presented in these summaries and the summaries from the other ten lots. The differences were in how marbling score, quality grade, and yield grade were reported. For ten of the lots, marbling was listed as the one of the ten degrees of marbling ranging from very abundant to practically devoid. Within the data set, marbling scores ranged from abundant to trace. On the three remaining lots, marbling was shown as a number. To convert the number to a degree of marbling, a graph was used from a "Study Guide for the Ultrasonic Evaluation of Beef Cattle for Carcass Merit" from the Ultrasound Guidelines Council Study Guide Sub-Committee. This graph showed the relationship between the numeric value from ultrasound and the degree of marbling. So, each numeric value was converted to the degree of marbling for each animal in the three lots based on this graph. Quality grade was reported as the actual quality grade (i.e. prime, choice, select, standard) for ten of the lots. The remaining three lots with the carcass summaries from the American Angus Association show quality grade as a numeric value. Bill Bowman, Vice President of Information and Data Programs with the American Angus Association, explained the difference. The numeric values were on a scale of 17, where three numbers represented each quality grade. For example, 17 equaled prime plus, 16 equaled prime, and 15 equaled prime minus. Using this scale, each numeric value was converted to the actual quality grade. The final area where differences existed between the carcass summaries from the American Angus Association and those from the feedlots was yield grades. Yield grades from the majority ten lots were listed on the typical scale of one to five. The three remaining lots showed yield grades with decimals used and not as whole numbers. Also, a few of the yield grades were actually larger than six. Bill Bowman also explained the yield grade differences. The American Angus Association figures the yield grade from information provided from the carcass data. They want to provide more detailed information to the producers so yield grade is figured with the decimals and not just a whole number. It was decided that the few animals with yield grades larger than six should be considered a yield grade five. When the yield grades were figured by the

American Angus Association, these animals mathematically were larger than five, but since this is the highest yield grade on the USDA scale, it will be used.

The second set of data used in this analysis was genetic information or the pedigree of the animal. The producer kept these records through the AIMS, or Angus Information Management System, software program. The AIMS program is available through the American Angus Association. The software keeps track of each animal in the herd and all important information pertaining to that animal from birth. The pedigree profile for each animal was used to determine whether genetic management had been used. A stacked generation of dam side information was looked for on each animal used in the study. A stacked generation was categorized as knowing genetic information for more than one previous generation. For example, an animal in which just the dam information was known would have zero stacked generations. An animal in which the dam information was known and the dam's dam information was known would have one stacked generation. For this set of animals, there was a range of zero to seven stacked generations.

Each animal with carcass data in the summary sheets was looked up in the AIMS program to determine genetic information on that animal. Then all the information for the animals was entered into a large spreadsheet to be used for analysis. A total of 860 observations were available for the final analysis.

Summary statistics are reported in Table 1. About half of the animals had at least one stacked generation of dam genetics. Thirty percent had one stacked generation and 13% had two stacked generations. Few animals had over four stacked generations. Regarding quality grades, the majority of animals graded Choice (73%). Eleven percent graded Prime and 15% graded Select. Just over half of the animals received a yield grade 3. Twenty nine percent were yield grade 2 and 10% were yield grade 4.

Results

Table 2 through Table 7 show the coefficients, standard errors, and marginal effects for the quality grades and yield grades that were run. Logit analysis was not run for the quality grades and yield grades that had too few observations, which includes quality grades select and utility as well as yield grades 1 and 5.

No significant effects were seen from dam stacked generation on yield grade. This could be because of environmental factors and feedlot management having a greater impact on yield grade than genetics. Lot number was a significant explanatory variable in several instances. This variable takes into account how the animal was managed at the feedlot, i.e. days on feed, amount fed, disease prevention.

Prime was the only quality grade in which dam stacked generation seemed to have a significant effect. The marginal effects of stacking generations of dams on whether or not an animal will grade Prime are shown in Table 2. Quality grades Choice and Select were not affected. The relationship between DSG2 and Select is shown as significant, but it is believed that this is an anomaly. A possible reason for the lack of relationship between DSG and Choice and Select may be found in the selection of breeding animals by the cow-calf producer. The producer was striving to increase the number of prime carcasses marketed by his operation. If the producer was purposefully selecting animals that he thought would produce prime, this could account for some of the relationship between DSG and Prime and account for the lack of relationship between

DSG and Choice and Select. Also, the cow-calf producer has a high quality of cattle to begin with in the herd. A majority of the cattle in the data set were grading choice. This may mean that the level of cattle a producer begins with has an impact on how long it will take to increase the number of primes. For example, if a producer had lower quality cattle that typically grade select, then results may show that DSG has an impact on increasing the number of cattle that grade choice in his herd and may not impact prime as much.

The results of this study can help the producer assess if managing genetics of the herd is helping the producer reach his goals for the carcass merit of cattle marketed. It may make heifer retention decisions easier. If stacking dam genetics increases the likelihood of carcasses grading primes, then the producer may want to hold on to heifers from known lines of genetics. The results show that the effects of stacking genetics on the dam side may not be significant after four generations. With this in mind, the producer should not put much quality value on stacking dam generations beyond the fourth generation on.

Summary

This paper represents a first step in determining the value added to the beef cattle chain through genetic management. The objective of the study is to determine whether or not the process of managing genetics has a positive impact on the quality of beef carcasses. It was found that managing genetics does increase the likelihood of having a carcass with a quality grade of Prime, but may not affect the likelihoods of a Choice or Select. Genetic management does not seem to have any impact on what type of yield grade a carcass will receive. So, if the goal of a cow-calf producer is to produce carcasses that meet the criteria for Prime quality grade, then genetic management should be used.

This data was obtained from one beef producer. This could be a shortcoming of the study in that the addition of data from other producers may change some results. No feed-out data was available so there is no information on how cattle were managed at the feedlot. It is known that feedlot management and other environmental factors influence carcass quality and yield grades. In this study, it was assumed that the changes in carcass quality and yield grades were due only to the management of genetics and not due to other factors such as management of the feedlot.

The process of managing genetics through retaining heifers from superior quality dams (thus stacking generations of genetics) and its effect on carcass merit was analyzed and not the selection of genetics through EPDs. The next step will be to analyze the selection of genetics used based on EPDs to determine the final affect this type of selection has on carcass merit. Then a comparison will be available between the two types of management to determine which is more effective in improving the final value of carcasses. This information will be useful to beef producers in determining how to manage the genetics of their herd to maximize carcass value.

References

Bowman, Bill. Personal Communication. American Angus Association, July, November, and December 2005.

Burson, D. E. *Quality and Yield Grades for Beef Carcasses*. North Central Extension Publication #357. April 1997.

Dhuyvetter, K.C., T.C. Schroeder, D.D. Simms, R.P. Bolze Jr, and J. Geske. "Determinants of Purebred Beef Bull Price Differentials." Journal of Agricultural and Resource Economics 21(1996):396-410.

Lusk, J.L. "Branded Beef: Is it What's For Dinner?" *Choices*. 2nd Quarter. 2001.

Lusk, J., J. Fox, T. Schroeder, J. Mintert, and M. Koojmaraie. *Will Consumers Pay for Guaranteed Tender Steaks?* Research Institute on Livestock Pricing, Virginia Tech University. Research Bulletin 3-99. 1999.

McDonald, R. A. and T. Schroeder. "Determinants of Profit Variability in Fed Cattle Grid Pricing." Paper presented at the 2000 Western Agricultural Economics Association Annual Meeting, Vancouver, British Columbia, June 29-July 1, 2000.

Parcell, J. and D. Patterson. "Assessing New Market Opportunities for Process and Source Verified Replacement Heifers." Unpublished Report, Department of Agricultural Economics, University of Missouri. 2004.

Parcell, J., M. Cox, D. Patterson, and R. Randle. "Buyer Preference and Willingness-to-pay for Source and Processed Verified Bred Heifer Characteristics." Unpublished manuscript, University of Missouri. 2004.

Perkins, T., A. Meadows, and B. Hays. "Study Guide for the Ultrasonic Evaluation of Beef Cattle for Carcass Merit." Ultrasound Guidelines Council Study Guide Sub Committee. Unpublished manuscript, Ultrasound Guidelines Council, Iowa Falls, Iowa.

Purcell, W.D. "Communicating Value to Cattle Producers: Issues, Opportunities, and Looking Ahead." *Journal of Animal Science* 80(2002):E87-E93.

Radke, B.R., J.W. Lloyd, J.R. Black, and S. Harsh. "The Value of Genetic Information in Selection of Replacement HolsteinHeifers." Unpublished manuscript, Michigan State University, December 2000.

Richards, T., and S. Jeffrey. "Establishing Indices of Genetic Merit Using Hedonic Pricing: An Application to Dairy Bulls in Alberta." Paper presented at the Western Canadian Dairy Seminar, Alberta, Canada, 1996.

Ward, C.E. and J.E. Butcher. "Formula Pricing Fed Cattle with Wholesale and Futures Markets." Oklahoma State University Extension Guide F-574. 2004.

Ward, C.E., T.C. Schroeder, and D.M. Feuz. "Grid Pricing of Fed Cattle: Base Prices and Premiums-Discounts." Oklahoma State University Extension Guide WF-560. 2001.

Table 1: Summary Statistics and Definitions of Variables used in Logit Analysis, Genetic Management and Beef Carcasses, 2006.

Variables	% of Data	Definition
Quality Grade		
Prime	10.92%	Binary variable; = 1 if prime, = 0 ow
Choice	72.80%	Binary variable; = 1 if choice, = 0 ow
Select	15.37%	Binary variable; = 1 if select, = 0 ow
Standard	0.30%	Binary variable; = 1 if standard, = 0 ow
UB	0.61%	Binary variable; = 1 if UB, = 0 ow
Yield Grade		
YG1	1.82%	Binary variable; = 1 if yield grade 1, = 0 ow
YG2	29.12%	Binary variable; = 1 if yield grade 2, = 0 ow
YG3	56.72%	Binary variable; = 1 if yield grade 3, = 0 ow
YG4	10.11%	Binary variable; = 1 if yield grade 4, = 0 ow
YG5	2.22%	Binary variable; =1 if yield grade 5, = 0 ow
Sire	n/a	0 or 1 binary variables to distinguish sire (67 sires)
No DSGB (default)	51.46%	n/a
DSG1	29.63%	Binary variable; = 1 if one, = 0 ow
DSG2	13.15%	Binary variable; = 1 if two, = 0 ow
DSG3	2.43%	Binary variable; = 1 if three, = 0 ow
DSG4	2.02%	Binary variable; = 1 if four, = 0 ow
DSG5	0.51%	Binary variable; = 1 if five, = 0 ow
DSG6	0.40%	Binary variable; = 1 if six, = 0 ow
DSG7	0.40%	Binary variable; = 1 if seven, = 0 ow
LN1 (default)	8.59%	Binary variable; = 1 if animal is in 1st lot, = 0 ow
LN2	7.79%	Binary variable; = 1 if animal is in 2nd lot, = 0 ow
LN3	8.19%	Binary variable; = 1 if animal is in 3rd lot, = 0 ow
LN4	7.28%	Binary variable; = 1 if animal is in 4th lot, = 0 ow
LN5	6.88%	Binary variable; = 1 if animal is in 5th lot, = 0 ow
LN6	7.48%	Binary variable; = 1 if animal is in 6th lot, = 0 ow
LN7	6.37%	Binary variable; = 1 if animal is in 7th lot, = 0 ow
LN8	12.84%	Binary variable; = 1 if animal is in 8th lot, = 0 ow
LN9	7.79%	Binary variable; = 1 if animal is in 9th lot, = 0 ow
LN10	6.37%	Binary variable; = 1 if animal is in 10th lot, = 0 ow
LN11	8.49%	Binary variable; = 1 if animal is in 11th lot, = 0 ow
LN12	4.25%	Binary variable; = 1 if animal is in 12th lot, = 0 ow
LN13	7.68%	Binary variable; = 1 if animal is in 13th lot, = 0 ow

Table 2: Coefficients, Standard Errors, and Marginal Effects of Factors Influencing Whether Carcass **Quality Grade** is **Prime**, Logit Analysis, 2006*

Variable	Coefficient	Standard Error	Marginal Effect
DSG1	0.55392	0.27496	0.10511
DSG2	0.84687	0.28860	0.18755
DSG3	1.0076	0.43033	0.23029
DSG4	0.97120	0.53629	0.22294
DSG5	0.57628	0.86321	
DSG6	-25.844	0.38435E+06	
DSG7	1.0021	1.3966	

*Separate models estimated for each level of stacked generations.

Table 3: Coefficients, Standard Errors, and Marginal Effects of Factors Influencing Whether Carcass **Quality Grade** is **Choice**, Logit Analysis, 2006*

Variable	Coefficient	Standard Error	Marginal Effect
DSG1	-0.24625	0.18802	
DSG2	-0.19370	0.21776	
DSG3	-0.33610	0.34739	
DSG4	-0.65004	0.44163	
DSG5	-0.38546	0.70599	
DSG6	-0.34229	1.1990	
DSG7	-0.50394	1.2511	

*Separate models estimated for each level of stacked generations.

Table 4: Coefficients, Standard Errors, and Marginal Effects of Factors Influencing Whether Carcass **Quality Grade** is **Select**, Logit Analysis, 2006*

Variable	Coefficient	Standard Error	Marginal Effect
DSG1	-0.19781	0.26349	
DSG2	-0.73558	0.38682	-0.95664E-02
DSG3	-0.45610	0.63435	
DSG4	-0.25701E-01	0.77232	
DSG5	0.12856	1.0950	
DSG6	1.3026	1.2155	
DSG7	-29.941	0.35842E+06	

*Separate models estimated for each level of stacked generations.

Table 5: Coefficients, Standard Errors, and Marginal Effects of Factors Influencing Whether Carcass **Yield Grade** is **2**, Logit Analysis, 2006*

Variable	Coefficient	Standard Error	Marginal Effect
DSG1	0.13853	0.19646	
DSG2	-0.43072E-01	0.22876	-0.43028E-02
DSG3	0.11447	0.35497	
DSG4	0.34322	0.44557	
DSG5	-0.40650	0.80135	
DSG6	-26.672	0.29222E+06	
DSG7	-26.295	0.28974E+06	

*Separate models estimated for each level of stacked generations.

Table 6: Coefficients, Standard Errors, and Marginal Effects of Factors Influencing Whether Carcass **Yield Grade** is **3**, Logit Analysis, 2006*

Variable	Coefficient	Standard Error	Marginal Effect
DSG1	-0.11922	0.17160	
DSG2	-0.53009E-01	0.19138	
DSG3	-0.22292	0.30193	
DSG4	-0.46539	0.38785	
DSG5	-0.47262	0.60201	
DSG6	-0.64795	1.0407	
DSG7	0.82939	1.1844	

*Separate models estimated for each level of stacked generations.

Table 7: Coefficients, Standard Errors, and Marginal Effects of Factors Influencing Whether Carcass **Yield Grade** is **4**, Logit Analysis, 2006*

Variable	Coefficient	Standard Error	Marginal Effect
DSG1	0.18581	0.27358	
DSG2	0.10017	0.28535	
DSG3	0.42699	0.42198	
DSG4	0.39568	0.54985	
DSG5	1.1609	0.72615	
DSG6	1.8045	1.2794	
DSG7	0.99668	1.2223	

*Separate models estimated for each level of stacked generations.