ESTIMATING THE VALUE OF CARCASS DNA AND PERFORMANCE EPD'S FOR GELBVIEH BULLS AT AUCTION

by

CLAY MEAD

B.S., University of Nebraska – Lincoln, 2002

A THESIS

Submitted in partial fulfillment of the requirements

for the degree

MASTER OF AGRIBUSINESS

Department of Agricultural Economics

College of Agriculture

KANSAS STATE UNIVERSITY

Manhattan, Kansas

2008

Approved by:

Major Professor
Dr. Ted Schroeder

ABSTRACT

For the industry to be able to produce a higher performing and consistent quality product, evaluation of performance and information needs to be collected and available for producers to make more informed beef cattle production management decisions. In recent history, the cattle industry has taken on the complex job of maintaining and recording performance records through programs and efforts such as breed association data bases, and herd health data bases. The constant evaluation of performance and genetic records has supplied producers with data resulting in performance, maternal and carcass statistical records such as Expected Progeny Differences (EPDs). Additionally, developing technology is helping the industry through selection and decision tools such as Carcass DNA marker identification.

This study evaluates how the selection tools of EPDs and DNA affect the value of Gelbvieh / Balancer bulls at auction. Data collected for this study is from various Gelbvieh / Balancer bull sales throughout Nebraska in the spring of 2008. Variables evaluated in the study were data and information provided to potential buyers before the auctions to be able to observe how this information affected the value of the purchased bull for each buyer. Variables evaluated were Igenity Profile Carcass DNA values of Ribeye Area, Marbling, and Tenderness. Additionally, Performance EPDs of Calving Ease Direct, Birth Weight, Weaning Weight, Yearling Weight, Ribeye Area, and Marbling were evaluated. The only actual measurement observed was Scrotal Circumference.

The hedonic models developed for this study suggest that the selected bull data provided to potential buyers before sale are not the only significant determinants affecting price. Statistical measurements and technologies developing the industry are having a profound and positive effect on production and as selection tools however, are not the only potential variables affecting the value of a sire at auction. Other possible variables effecting auction value can also include evaluation of phenotype, pedigree, and buyer benefits. The data and variables evaluated in the study should still be used as valuable additions to other selection tools and observations when selecting a future beef sire.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGMENTS

The author wishes to thank my family for their support in this endeavor to pursue my Master of Agribusiness degree. Especially my wife Lindsay, without her unending guidance and support, this program, project, and degree would never have been possible.

The faculty and staff of the KSU MAB program without a doubt held the program to the highest standard with professionalism, support, guidance, and kindness. A special thanks in their leadership through this needs to be addressed to Dr. Allen Featherstone, Lynnette Brummett, Mary Bowen, and Dr. Ted Schroeder.

I would also like to acknowledge Igenity and the American Gelbvieh Association for their help and guidance in the development of this study.

CHAPTER I: INTRODUCTION

Consumer demand is the ultimate goal and factor that drives the beef industry, through all segments from conception to the dinner table. To be able to drive the markets and supply in a positive direction for producers, they must provide a product that the consumer will demand at the retail level. It will be economically important in the near future for beef producers to gain and maintain a competitive advantage in the meat and protein industry. Other protein industries such as the poultry and pork sectors have been able to produce a stream line, consistent product through production and harvesting phases. The 2005 Beef Quality Audit ranks “lack of uniformity and consistency” as the number one defect in the US beef supply.

For the industry to be able to produce a higher performing and consistent quality product, performance information needs to be collected and available for producers to make more informed beef cattle production management decisions. In recent history, the cattle industry has taken on the complex job of maintaining and recording performance records through programs such as breed association data bases and herd health data bases. The constant evaluation of performance and genetic records has supplied producers with data that has created performance, maternal and carcass statistical records such as Expected Progeny Differences (EPDs). EPDs are complex statistical estimates of performance for a given animal’s progeny (Beef Improvement Federation, 2002). EPDs are the predicted performance of the future offspring of an animal for a particular trait, calculated from measurement(s) of the animal's own performance and/or the performance of one or more of its relatives, for the trait in question and/or for one or more correlated traits. Typically, the prediction is expressed as a deviation from a well-defined base population, assuming the animal in question is mated to a sample of animals whose average genetic merit equals that of the base population. The predicted performance of the offspring of the mating between any two animals is the sum of their EPDs (Food and Agricultural Organization of the United Nations).

As the beef industry progresses forward with technological advances that provide producers management information, this will help with genetic and breeding decisions. Another tool that is in it infancy is DNA marker identification technology. A producer can now use genetic information along with EPD statistical analysis to refine production decisions.

The objective of this thesis is to determine whether prices of Gelbvieh and Balancer bulls at auction are affected by performance EPD statistics and carcass DNA information by providing potential buyers with the information before auction. In the study a Purebred will be considered a Gelbvieh, whereas a Balancer is registered animal with Gelbvieh influence. A Balancer has both parents registered and is a combination of ¼ to ¾ Gelbvieh and ¼ to ¾ Angus or Red Angus. The study will estimate the value of bulls through different techniques. Performance EPDs are provided on all bulls analyzed in this study and that information remains constant through accomplishment of both objectives. First, Gelbvieh and Balancer bulls with DNA information are compared together. Second, the study will estimate models with Gelbvieh and Balancer bulls' separately to observe whether there are different price impacts associated with carcass DNA values and performance EPDs across breed. EPDs averages and bases for both breeds are different as each breed is calculated within its own breed. Finally, the study will remove Carcass DNA from the estimate to evaluate the effect DNA would solely have on the Bull Price.

To develop the model for estimating the economic value of Gelbvieh and Balancer bulls with carcass DNA information and Performance Expected Progeny Differences, the input variables will quantify the marginal prices paid by buyers for six performance EPDs and three major carcass DNA categories.

CHAPTER II: LITERATURE REVIEW

Technology in the beef industry is going through major changes and improvements as the industry modernizes. Many of these technologies are effecting how cattle are being developed and marketed. Expected Progeny Differences (EPDs) have had a profound and positive effect on management decisions and genetic selection. EPDs are complex statistical estimates of performance for a given animal's progeny (Beef Improvement Federation, 2002). The impact all EPDs have had on the market place is not fully clear however. Dhuyvetter et al. (1996) were some of the first to look at EPDs as determinants of bull values. Their results suggested that EPD information had some market value, but the price impacts of EPDs on bulls differed across breeds and across EPD measures. Other technologies are now working into the market place for selection and decision criteria such as DNA identification and information. DNA sampling can help a beef producer make more informed and confident decisions about breeding, managing, and marketing earlier then ever before; and through an animal's lifetime (Igenity). DNA profiling of an animal in purebred or commercial beef herds can potentially help enhance management decisions and will improve quality of the herds and create a positive long term economic impact. To quantify how certain technologies are economically effecting industry management and livestock value, a model needs to be structured to determine the impact. Little information has been compiled to date about how DNA information affects value of cattle at time of sale. Dhuyvetter et al. (1996) examined how EPD statistics affect a bull's value using a hedonic model in a study of data collected from twenty-six multi-breed Kansas bull sales during the spring of 1993. The model was represented as:

Bull Price = f (Physical and Genetic Characteristics, Expected Performance Characteristics, Marketing Factors)

In this model estimating bull price at auction, models including and excluding EPDs were estimated. Chvosta, Rucker, and Watts examined EPDs using a hedonic modeling technique to measure and compare values for EPDs and simple performance measures (SPMs). The model represented in the Chvosta et al. study was:

Bull Price = f (Beef Price, Feed Price, Age, Performance Measures)

Models including both EPDs and SPMs together and separately were estimated using OLS for both sets of data. The R^2 value for the model including both EPDs and SPMs was 0.40. For the model using only SPMs, the R^2 was 0.37, this value dropped to 0.25 for the model that contained only the EPDs. Chvosta et al. concluded that both EPDs and SPMs are significant priced determinants. However, SPMs hold more economic information than EPDs relative to price. This was shown despite the fact that EPDs contain a superior amount of genetic information.

Another study that estimated the value of bulls at auction was conducted by Walburger (2002). This study examined the relationship between price and attributes of bulls sold in Alberta, Canada. Nearly 800 bulls of various breeds during three time periods were studied. Variables examined were, price, birth and sale weight, average daily gain (ADG), backfat, scrotal circumference, ribeye area, and lean meat yield. Different variables were statistically significant in each time period. Birth weight, sale weight and scrotal circumference were significant in all three time periods. Walburger interpreted that producers have adopted genetic technology according to ribeye and backfat being significant in the last time period.

A study conducted by Turner et al. 2004, examined two separate objectives. First, this study re-examined the economic values of production EPDs and how they relate to the values assigned to actual weights. The final objective was to assess the impact that ultrasound EPDs have on Angus bull prices. The first objective revealed that the predicted premiums/discounts for birth EPDs were greater than those associated with actual birth weight. These results indicate that buyers consider birth EPDs more important than its actual measure when selecting breeding stock. The same conclusions did not hold true for remaining performance and production EPDs.

Observing the second objective of the research showed that all four carcass ultrasound EPDs were highly significant. The findings in this objective suggested that buyers understand and place a high value on ultrasound data when making breeding decisions.

Turner et al. also looked at various marketing factors considered when making breeding and buying decisions. Certain marketing factors bring premiums and discounts in addition to those received for EPDs and actual weights. The pedigree of the bull and reputation of the seller are significant to the purchaser of stock. Other variables significant to the potential buyer were an inclusion of a sale catalog picture, the order of the sale, and the retention of semen rights.

The study was able to develop an estimate of bull prices at auction. Other variables observed that are significant to buyers are the bull's physical appearance and structure correctness. These two variables were not evaluated in the research. It was stated by Turner et al. that these subjective measures might be as important to bull buyers as the genetic information contained in EPDs and actual weights.

It should be noted that in the reviewed research, hedonic pricing models were used to determine the economic value of the cattle and their genetics. An hedonic pricing model represents a simple, powerful method of determining the value of the contribution for each component of bull's genetic proof (Richards and Jeffrey, 1995). Richards and Jeffrey noted that hedonic pricing models generally require price data obtained from competitive bidding in an open market framework. This form of measuring economic value will be used in the research provided within this thesis.

After reviewing the following literature about determining the economic value of bulls in relation to their EPDs, actual performance and any presale information provided, it is important to look at other technological variables that may be factors influencing genetic change and value of auctioned bulls. In the research examined in this thesis we will be estimating the economic value associated with carcass DNA and Performance EPDs for Gelbvieh and Balancer bulls at auction. Carcass DNA is another tool provided by producers to potential buyers that can potentially affect the value of the bulls marketed. This technology can be used for mating and management decisions to improve carcass quality, tenderness, yield, etc. As stated in the 2004 research by Turner et al. (pg. 15), "Finding an economically significant means of conveying a bull's genetic carcass potential will further the cattle industry's drive to improve carcass quality." It is important for producers and the industry to find economically influential ways to improve the beef product. The 2005 Beef Quality Audit stated, the "lack of uniformity and consistency" as the number one defect in the US beef supply. The four factors that made up this category were marbling, tenderness, palatability and consistency within and between grades. By improving the US beef supply, the value of the product and industry should ultimately increase on the whole. This shall in turn have an impact on the value of making genetic changes in a herd or the value of bulls at auction.

CHAPTER III: MODEL AND THEORY

3.1 Introduction

This study is interested in designing an hedonic model that will focus on determining the value of Gelbvieh and Balancer bulls at auction. The objective will be to build a model that will estimate the impact Expected Progeny Differences (EPDs) combined with carcass DNA values will have on bull prices. The independent variables are information provided to potential Gelbvieh buyers and demand will be estimated in relation to bull price, the dependent variable. Additionally, we will discuss the theory of regression and why it is important to the analysis of the models estimated.

In economics, hedonic regression, or more generally hedonic demand theory, by definition is a method of estimating demand or value. Hedonic models are most commonly estimated using regression analysis. Regression analysis can be used as a descriptive method of data analysis. This form of analysis is used in economic analysis to determine the strength and direction of the quantitative relationships between the dependent variable and the independent variables (Studemund). Regression modeling is a useful predictive tool, however it has potential limitations to be aware of during data analysis. The regression model's effectiveness can be limited from possible heteroskedasticity, autocorrelation, and/or multicollinearity.

It is expected that the hedonic model derived through the regression analysis will be able to estimate the demand and value of a Gelbvieh or Balancer bull from the information provided to buyers. It will estimate the value through provided production EPDs and carcass DNA values. This information will help a buyer in a more informed management decision during the purchase of a bull, thus creating a premium or discount for the bull analyzed. Even though numerous production EPDs and carcass DNA values can impact the demand and value of a bull, the study will simply look at basic estimated production traits and carcass values that commonly represent a bull at auction.

CHAPTER IV: DATA AND PROCEDURES

4.1 Introduction

The present study will build on previous cow-calf and bull hedonic studies by developing a model of performance information-price relationships. The study will look at different phases of bull pricing estimates. The first objective will be to evaluate a regression with both Gelbvieh and Balancer bulls together. All carcass DNA and Performance EPDs will be included. The carcass DNA provided will estimate how valuable the DNA traits are in relationship to bull value. Between both sets of bulls, Expected Progeny Difference (EPD) values will be included in comparisons. Objective two will analyze the same information; however, Gelbvieh data and Balancer data will be observed separately to evaluate any differences between breeds. A dummy variable to indicate the difference between Gelbvieh bulls and Balancer bulls will be used for the first objective. A dummy variable will be used for each sale where data was gathered to account for variation between sales, marketing schemes, etc. The final objective will take out all Carcass DNA data but still evaluate all EPD variable values in the model. The objectives will estimate how the presence of carcass DNA information and selected EPDs affects value of bulls marketed when this information is provided before the sale.

Similar to previous studies estimating bull value, the data used described two different types of genetic measurements, actual production measures and EPDs. This study will use genetic measurements of EPDs and carcass DNA values, not actual production performance measurements, except scrotal measurements. The objectives will use selected Expected Progeny Differences and Carcass DNA values as independent variables. Dummy variables will also be used to indicate whether data information is for a Balancer or Gelbvieh bull. Additionally, a dummy variable will be used for each of the six sales to remove potential differences between sales. To estimate the dependent variable, Bull Price, the following will create an hedonic model specified as:

Bull Price = *f* (Carcass DNA Values, Balancer Performance EPDs, Scrotal Circumference, Gelbvieh Performance EPDs, Balancer/Purebred Dummy, Sale Dummy)

Production EPDs will include birth weight, weaning weight, yearling weight, ribeye area, and marbling. Carcass DNA will include values for ribeye, marbling, and tenderness. Scrotal Circumference will be an actual measurement.

The next models will separate the Balancer and Purebred bulls into two different regressions to evaluate whether there is any effect between breeds. This will create hedonic models specified as:

Bull Price = *f* (Carcass DNA Values, Balancer Performance EPDs, Scrotal Circumference, Sale Dummy)

Bull Price = *f* (Carcass DNA Values, Purebred Performance EPDs, Scrotal Circumference, Sale Dummy)

The previous models will be compared against the following model to estimate how the changing values of carcass DNA are economically important:

Bull Price = *f* (Performance EPDs, Scrotal Circumference, Balancer/Purebred Dummy, Sale Dummy)

An hedonic modeling approach, using OLS regression, is applied to the data to obtain estimates for each of the variables presented in the regression models above. This modeling provides a simple yet powerful method of determining the value of the genetic contributions of the marketed bull. This economic model that expresses genetic worth as a function of individual production characteristics would be appropriate for use. An hedonic pricing model considers the demand for a product or input as a function of its characteristics.

4.2 Data

This thesis proposes that there is an economic effect on the sale value of Gelbvieh and Balancer bulls at auction when performance EPDs and DNA data are presented to buyers before auction. In the commercial and seed stock cattle industry, potential future genetic information can be vital to business measures to be able to understand how the cattle will potentially and actually perform. To obtain the genetic knowledge of how a calf can perform from ease of birth to growth through the feed yard will be ever more important to producers to enable them to reduce costs, labor, feed intake, days on feed, and increase pounds of beef; which the producer in the end is ultimately paid for.

To try and understand what effects this information had on bull prices, performance EPDs and actual carcass DNA data were collected from 330 yearling Gelbvieh and Balancer bulls from 6 different 2008 spring production sales across Nebraska. This thesis is solely observing potential performance traits through EPDs, actual DNA carcass values, and Scrotal Measurements. By observing performance and carcass DNA, the major and most widely used EPDs and DNA values were collected for this study. These traits and values are the most commonly used in sale catalogs and information provided to potential buyers before auction. The Expected Progeny Difference's observed in the data for each individual bull were calving ease, birth weight, weaning weight, yearling weight, ribeye area, and marbling. Carcass DNA observed in the data included ribeye area, marbling, and tenderness.

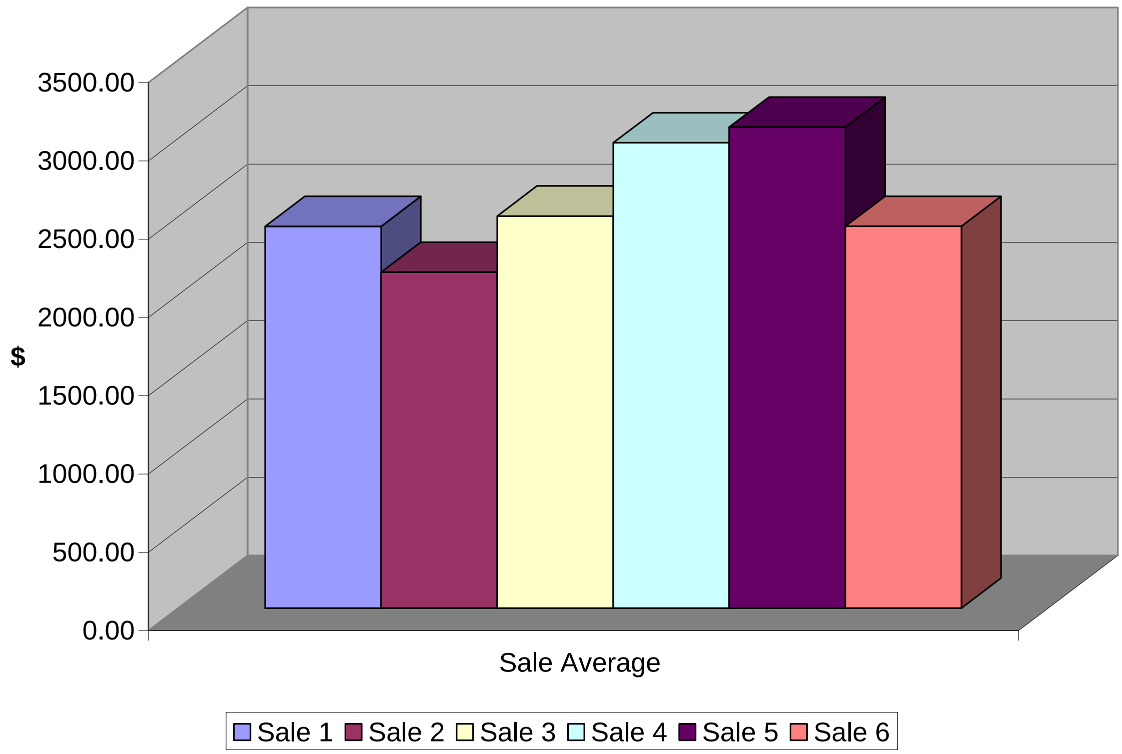
For each auction included in the study, bull information was observed and studied before auction. At each auction, actual bull prices were recorded. The average, maximum, minimum, and standard deviation (the standard deviation is a measure of how widely values are dispersed from the average value (mean)) for each study variable are compiled in Table 4.1 and will be discussed individually for each variable along with an explanation of how each trait and value is calculated in the following paragraphs. Gelbvieh and Balancer EPDs are calculated from a different base average for each breed. Thus, EPDs for Gelbvieh and Balancer's are not comparable to each other, only within a breed itself. The EPD variation and explanation will also follow.

Table 4.1 Overview of all Variables used in Study

Variables	Average	Max. Value	Min. Value	STD. DEV.
Bull Price ($)	2796.82	5250	1350	740.36
REA DNA (1-10)	5.01	8	1	1.06
MB DNA (1-10)	6.83	10	3	1.29
Tenderness DNA (1-10)	4.87	10	1	1.77
Balancer Calving Ease EPD	104.34	115	97	3.13
Balancer Birth Weight EPD	-.17	3.7	-4.1	1.35
Balancer Weaning Weight EPD	38.67	58	24	6.26
Balancer Yearling Weight EPD	79.64	113	54	10.02
Balancer REA EPD	.13	.34	-.20	.09
Balancer MB EPD	.04	.22	-.18	.06
Scrotal Circumference (cm)	36.84	44.5	31	2.18
Purebred Calving Ease EPD	104.54	112	99	3.22
Purebred Birth Weight EPD	.82	3.4	-3.7	1.27
Purebred Weaning Weight EPD	42.93	56	26	5.11
Purebred Yearling Weight EPD	80.49	100	52	8.92
Purebred REA EPD	.11	.24	-.07	.08
Purebred MB EPD	-.01	.20	-.19	.08

Purchase price of Gelbvieh and Balancer bulls varied widely in auctions analyzed in this study. The least and most expensive bulls were both Balancers at $1,350 and $5,250 respectively. Overall the Gelbvieh influenced and purebred continental genetics bulls had an average sale price of $2,796.82.

Figure 4.1: Average Gelbvieh / Balancer Bull Price by Sale



Carcass information for the potential bull buyers was derived from either EPDs or DNA. The DNA value is an actual value that each individual animal carries, rather than a projection of what the sire's progeny could potentially have based on EPD figures. In this study, DNA data are from the Igenity Profile system to maintain a constant variable for data collection and evaluation. A unique feature of Igenity is the profile concept that evaluates and reports results from a single DNA sample derived from tail hair follicles; an ear tag tissue punch; or a semen or blood sample. Currently, this genetic analysis includes many carcass composition traits; however, this study will only analyze three of the traits, Ribeye Area, Marbling Score, and Tenderness.

To assist beef cattle breeders and commercial producers in understanding the value of DNA information, Igenity incorporated a scoring system for each trait using a scale of 1 to 10. Higher values are not necessarily better; it only indicates the animal has the potential for more of that trait. The values listed in table 4.2 reflect the relative differences expected in animals compared to contemporaries with an Igenity profile score of 1. IGENITY also provides p-values for each trait. P-values are the probabilities that the associations between the markers and the trait(s) are purely due to chance alone. Therefore, smaller numbers indicate stronger evidence supporting the fact that the markers indeed affect the trait. P-values for IGENITY results range from $P < .01^{-3}$ to $P < .07^{-11}$, which are extremely significant. P-values, in combination with the population size and diversity, are one of the best ways to determine how "real" marker results are (Igenity). An explanation of the traits evaluated in this study will follow table 4.2.

Table 4.2 IGENITY Profile scoring system

Score from IGENITY	Ribeye Area in Square Inches	USDA Marbling Score	Tenderness in lbs. of WBSF
10	2.12	96.0	-2.27
9	1.86	84.7	-1.95
8	1.63	74.0	-1.85
7	1.40	63.6	-1.54
6	1.17	53.2	-1.22
5	0.94	42.9	-1.13
4	0.71	32.5	-0.79
3	0.49	22.0	-0.42
2	0.26	11.3	-0.21
1	0	0	0

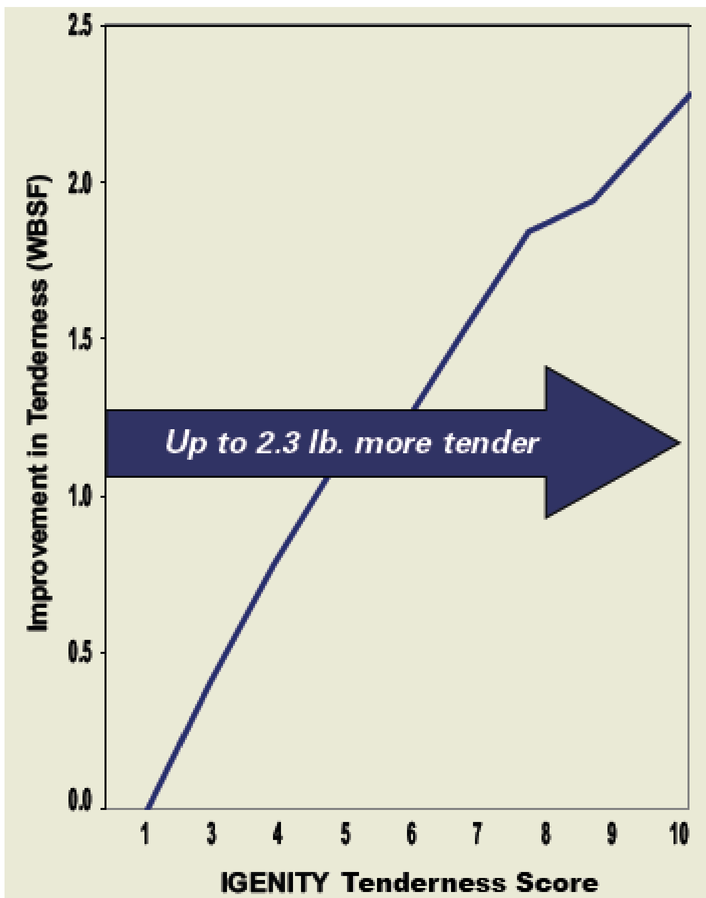
Source: Igenity

Ribeye area is measured in square inches for a group of animals with an Igenity Profile score of "10" for Ribeye Area, the average ribeye area is expected to be 2.12 square inches greater than in a group of animals that score "1". Higher scores reflect larger ribeye areas while lower Igenity Profile scores reflect smaller ribeye areas (Igenity). In this study, bulls averaged 5.01 on the Igenity Profile system where the Min and Max ranged from 1 to 8 with the Standard Deviation at 1.06.

Higher Igenity Scores for marbling equal greater genetic potential for marbling. In a group of animals with an Igenity Profile score of "10" for marbling, the average marbling can be expected to be 96 points greater than animals with a score of "1". Beef Quality for marbling uses a 1 to 999 point scale in the USDA Beef Grading System. Marbling points reflect how much intramuscular fat is present in the carcass and thus the potential to grade USDA Choice. The minimum marbling requirement for USDA Choice carcasses is 400 units of marbling. Each marbling score has 100 units. Therefore the 96 unit range from Igenity Profile scores 1 to 10 equals' almost one full marbling score (Igenity). The bulls evaluated in this study averaged 6.83 on the Igenity Profile with the Min and Max from 3 to 10 respectively. The Standard Deviation of the scores was 1.29.

The Igenity Profile score for Tenderness represents an animal's genetic potential for tenderness as measured by Warner-Bratzler Shear Force (WBSF), with "10" the most tender and "1" the least tender. Lower shear force means more tender beef. In a group of animals with an Igenity Profile Tenderness score of "10", 2.27 lbs. less shear force is required than an animal with an Igenity Profile of "1". This means higher Igenity Profile scores represent animals that are likely to produce more tender beef than those with lower scores (Igenity). This study found the bulls evaluated averaged 4.87 on the Igenity Profile. Minimum and Maximum ranged from 1 to 10 with the Standard Deviation at 1.77.

Figure 4.2: Relationship between IGENITY Tenderness Score and Beef Tenderness



Source: National Beef Cattle Evaluation Consortium / NCBA. 2006

Expected Progeny Differences (EPDs), may be used to estimate how future progeny of the subject animal will compare to progeny of other animals within the breed. The key words are estimate, future, compare, and within breed. EPDs are not designed to predict the performance of one or two progeny of a sire, but rather should be used to compare bulls based on estimated progeny performance. EPDs predict differences, not absolutes. An EPD may be derived from any combination of individual performance, pedigree, and progeny and grand progeny performance information (American Gelbvieh Association).

For Gelbvieh and Balancer's, EPDs are calculated from a different base and thus can not be compared to each other. Breed averages will be slightly different for both Gelbvieh and Balancer's, thus EPD data in the study should only be compared within its own breed. The definition of how each EPD is calculated and used is the same for each breed. Table 4.3 will include the breed averages for the EPDs that were observed in this study. These are the averages within the active breed, not the averages of the bulls evaluated for the study. The studies bulls may be compared to their representative active breed averages for comparison.

Table 4.3 Gelbvieh and Balancer Breed Averages for Selected EPDs

EPD	CE	BW	WW	YW	REA	MB
Gelbvieh	104	1.4	41	74	.06	-.04
Balancer	104	-.1	35	73	.07	.02

Calving Ease Direct (CE) is an EPD that is expressed as a ratio, with a higher ratio representing better (easier) calving ease. This value represents the direct influence a sire has on calving ease. Only first-calf heifer data is included in the calculations for this EPD. Balancer bulls of the study averaged 104.3 for CE while ranging from 97 to 115 with a Standard Deviation of 3.13. Gelbvieh bulls studied averaged 104.5, while having 99, 112 and 3.22 respectively for Minimum, Maximum and Standard Deviation.

Birth Weight (BW) predicts the difference, in pounds, for birth weight. Balancer bulls in the study averaged -.17 for BW while range from -4.1 to 3.7. Standard Deviation was 1.35 for the Balancer BW. The Gelbvieh bulls averaged 0.82 and ranged from -3.7 to 3.4. Standard Deviation was 1.27 for the Gelbvieh.

Weaning Weight (WW) predicts the difference, in pounds, for weaning weight (adjusted to age of dam and a standard 205 days of age). This is an indicator of growth from birth to weaning. The Balancer bulls observed averaged 38.67 lbs. while they ranged from 24 to 58 with a Standard Deviation of 6.26. The purebred bulls observed averaged 42.93 ranging from 26 to 56 and a Standard Deviation of 5.11.

Yearling Weight (YW) predicts the expected difference, in pounds, for yearling weight (adjusted to standard 365 days of age). This is an indicator of growth from birth to yearling. Balancers observed averaged 79.64 lbs. ranging from 54 to 113 in the data. Standard Deviation reported 10.02. Purebred bulls observed averaged 80.49 lbs. ranging from 52 to 100. The Standard Deviation observed was 8.92 for the Gelbvieh.

Rib Eye Area (RE) is expressed in square inches of rib eye muscle area adjusted to a constant fat endpoint. The REA EPD averaged 0.13 for the Balancer bulls while ranging from -0.20 to 0.34 with a Standard Deviation of 0.09. Gelbvieh bulls averaged 0.11 with a Minimum of -0.07 and a Maximum of 0.24. Standard Deviation reported 0.08.

Marbling (MB) is expressed in degrees of marbling score, a determinant of USDA Quality Grade. Value is adjusted to a constant fat endpoint. The Balancers averaged 0.04 for marbling while the range was from -0.18 to 0.22 with a Standard Deviation of 0.06. The Purebred bulls of the study averaged -0.01 ranging from -0.19 to 0.20. The Standard Deviation was 0.08 for the Gelbvieh bulls.

Scrotal Circumferences in the study are observations of actual values from the bulls when measured before being placed on auction. Scrotal Circumferences are measured in centimeters (cm). This measure is useful because there is a correlation between the scrotal circumference and the volume of semen-producing tissue that the bull possesses. The larger Scrotal Circumference should indicate a more fertile and valuable sire. These data are actual values thus both Balancers and Purebreds are calculated together. The average Scrotal Circumference was 36.84 cm while ranging from 31 cm to 44.5 cm.

Table 4.4 and 4.5 reports the results of a correlation analysis conducted on all of the proposed determinant variables. Correlation analyses were conducted separately for Balancer and Purebred bull variables. The majority of determinants had very low correlation with each other. However, Calving Ease Direct was highly correlated with other performance EPDs of Weaning Weight and Yearling Weight. Additionally, Weaning Weight and Yearling Weight were also highly correlated. This evaluation was the same for both Balancer and Purebred bulls. The correlation observation and issues will be addressed later.

Table 4.4 Correlation Results for Balancer Carcass DNA and Performance EPDs

Model Determinants	REA DNA	MB DNA	TN DNA	BCE EPD	BBW EPD	BWW EPD	BYW EPD	BREA EPD	BMB EPD	SC
REA DNA	1.000									
MB DNA	-0.311	1.000								
TN DNA	-0.309	0.050	1.000							
BCE EPD	0.039	-0.101	0.190	1.000						
BBW EPD	-0.008	-0.084	-0.051	-0.096	1.000					
BWW EPD	0.092	-0.119	0.206	0.940	0.083	1.000				
BYW EPD	0.065	-0.102	0.217	0.961	0.012	0.983	1.000			
BREA EPD	0.221	-0.095	0.073	0.540	-0.053	0.537	0.530	1.000		
BMB EPD	0.036	0.115	0.118	0.342	-0.167	0.303	0.341	0.173	1.000	
SC	0.122	0.060	0.034	0.109	0.014	0.105	0.126	0.192	0.089	1.000

Table 4.5 Correlation Results for Gelbvieh Carcass DNA and Performance EPDs

Model Determinants	REA DNA	MB DNA	TN DNA	PCE EPD	PBW EPD	PWW EPD	PYW EPD	PREA EPD	PMB EPD	SC
REA DNA	1.000									
MB DNA	-0.311	1.000								
TN DNA	-0.309	0.050	1.000							
PCE EPD	-0.037	0.106	-0.201	1.000						
PBW EPD	0.099	-0.025	-0.089	0.477	1.000					
PWW EPD	-0.027	0.091	-0.223	0.990	0.529	1.000				
PYW EPD	-0.034	0.097	-0.209	0.992	0.506	0.997	1.000			
PREA EPD	0.020	0.065	-0.146	0.773	0.525	0.780	0.783	1.000		
PMB EPD	0.043	0.062	0.106	-0.054	-0.076	-0.047	-0.007	0.138	1.000	
SC	0.122	0.060	0.034	-0.111	-0.035	-0.098	-0.104	-0.074	-0.034	1.000

4.3 Model Closure

The study is attempting to evaluate to what extent each observed input variable effects Gelbvieh / Balancer bull price at auction when the given input information is given to potential buyers before sale. It will be of value for producers to determine what value the technology of carcass DNA (Ribeye Area, Marbling, and Tenderness) has on bull value along with actual Scrotal Circumference and given performance EPDs (Calving Ease Direct, Birth Weight, Weaning Weight, Yearling Weight, Ribeye Area, and Marbling).

It is hypothesized that there is a relationship between bull price, Ribeye DNA, Marbling DNA, Tenderness DNA, Scrotal Circumference, Calving Ease Direct EPD, Birth Weight EPD, Weaning Weight EPD, Yearling Weight EPD, Ribeye Area EPD, and Marbling EPD. As costs continue to rise for producers, it becomes more important to identify just what genetic and production traits are driving the producers income and to what degree.

4.4 Regression Model

To analyze the impact of Carcass DNA, Scrotal measurements and Performance EPDs; the following function was developed:

Empirical Model (Equation 1 – Balancer and Purebred Model)

$$BULLPRICE = \beta_0 + \beta_1 READNA + \beta_2 MBDNA + \beta_3 TNDNA + \beta_4 BCE - \beta_5 BBW + \beta_6 BWW + \beta_7 BYW + \beta_8 BREA + \beta_9 BMB + \beta_{10} SC + \beta_{11} PCE - \beta_{12} PBW + \beta_{13} PWW + \beta_{14} PYW + \beta_{15} PREA + \beta_{16} PMB + \beta_{17} B/P + \beta_{18} S1 + \beta_{19} S2 + \beta_{20} S3 + \beta_{21} S4 + \beta_{22} S5 + \varepsilon_t$$

Where:

BULLPRICE = Price of Gelbvieh / Balancer Bull at Auction ($/bull)

β_0 = Intercept

READNA = Ribeye DNA Igenity Profile Value

MBDNA = Marbling DNA Igenity Profile Value

TNDNA = Tenderness DNA Igenity Profile Value

BCE = Balancer Calving Ease Direct EPD

BBW = Balancer Birth Weight EPD

BWW = Balancer Weaning Weight EPD

BYW = Balancer Yearling Weight EPD

BREA = Balancer Ribeye Area EPD

BMB = Balancer Marbling EPD

SC = Scrotal Circumference (actual measurement (cm))

PCE = Purebred Calving Ease Direct EPD

PBW = Purebred Birth Weight EPD

PWW = Purebred Weaning Weight EPD

PYW = Purebred Yearling Weight EPD

PREA = Purebred Ribeye Area EPD

PMB = Purebred Marbling EPD

B/P = 1 if Balancer and 0 if Purebred

S1 = 1 if Sale 1 and = 0 otherwise

S2 = 1 if Sale 2 and = 0 otherwise

S3 = 1 if Sale 3 and = 0 otherwise

S4 = 1 if Sale 4 and = 0 otherwise

S5 = 1 if Sale 5 and = 0 otherwise

S6 = 1 if Sale 6 and = 0 otherwise, Sale 6 is the default sale that is dropped from the model when estimated.

The impacts of EPD measures on bull price are allowed to differ across Balancer and Purebred breeds by including each of these measures in the model as interaction terms between breed dummy variables and the specific EPD variable. For example, for a Balancer EPD measure, the EPD variable in the model is the recorded value for Balancer bulls and is equal to zero for Purebred bulls. Likewise, EPD variables in the model for Purebred bulls are the recorded value if Purebred and equal to zero for Balancer bulls.

Doing this allows the model to estimate different impacts of EPD effects for Balancers relative to Purebreds.

BULLPRICE = Price of Gelbvieh / Balancer Bull at Auction is determined by:

READNA = It is hypothesized that the coefficient will be positive. A higher Ribeye Area score on the Igenity Profile reflects an increase in square inches of Ribeye size. Larger Ribeye's include more muscle and red meat produced. Ultimately, this will lead to more pounds of product and revenue.

MBDNA = It is hypothesized that the coefficient will be positive. An increase in Marbling or Intramuscular Fat in the beef carcass will increase profit and revenue per carcass and valued cut. The more Marbling in the beef carcass will make it more apt to reach USDA grade Choice which collects a fluctuating premium over lesser marbled carcass such as USDA grade Select. The increase in Marbling in a beef carcass should have a positive impact on the price and demand of a sire.

TNDNA = It is hypothesized that the coefficient will be positive. The Igenity Profile score for Tenderness represents an animal's genetic potential for tenderness as measured by Warner-Bratzler Shear Force (WBSF), with "10" the most tender and "1" the least tender. This means higher Igenity Profile scores represent animals that are more tender than those with lower scores (Igenity). Beef carcasses that are more tender should have a higher value in the retail sector and for the consumer. An increase in this variable means an increase in beef quality and thus should mean a more profitable carcass leading back to value of the bull sold.

BCE and PCE = It is hypothesized that the coefficients will be positive. Calving Ease Direct (CE) is an EPD that is expressed as a ratio, with a higher ratio representing better (easier) calving ease. This value represents the direct influence a sire has on calving ease. Fewer dystocia problems in the herd will require less labor and costs thus having a positive impact on the value of the sire of the calves.

BBW and PBW = It is hypothesized that the coefficients will be negative. Birth Weight (BW) predicts the difference, in pounds, for birth weight. An increase in birth weight may cause an increase in dystocia, labor, and costs. A decrease in birth weight EPD should be more economical for producers as long as the EPD is within limits thus lower BBW should increase the bull value.

BWW and PWW = It is hypothesized that the coefficients will be positive. Weaning Weight (WW) predicts the difference, in pounds, for weaning weight and is an indicator of growth from birth to weaning. An increase in growth and pounds should mean more profit at $/lb/head. Increased growth to calves means an increased value for the sire.

BYW and PYW = It is hypothesized that the coefficients will be positive. Yearling Weight (YW) predicts the expected difference, in pounds, for yearling weight and is an indicator of growth from birth to yearling. An increase in growth and pounds should mean an increase in revenue especially when observing $/lb/head or carcass. Yearling growth is more subjective to producers who are producing calves for retained ownership or slaughter. Yearling growth needs to stay within limits for producers who are producing replacements for their herd due to a risk in increased cow size, etc.

BREA and PREA = It is hypothesized that the coefficients will be positive. Rib Eye Area (RE) is expressed in square inches of rib eye muscle area. An increase in lbs. of muscle will increase the potential for more red meat production and revenue. This should increase the value of the bull being purchased.

BMB and PMB = It is hypothesized that the coefficients will be positive. Marbling (MB) is expressed in degrees of marbling score, a determinant of USDA Quality Grade. An increase in quality grade will increase the potential for profit from the carcass aspect. This should increase the value of the sire at auction.

B/P = It is hypothesized that the coefficient for the Balancer dummy variable will be positive. The purchase of either Balancer or Purebred shall have a positive effect on the bulls own purchase. This coefficient will be the premium or the discount for a Balancer relative to the other after adjusting for all other attributes included in the model.

S1 – S6 = The sale effect is unknown as no particular sale is expected to have higher prices necessarily than others. The mixture of buyers present and seller reputation likely determine whether there is a sale effect or not.

To analyze Balancer bulls and Gelbvieh bulls separately to observe any differences in bull data on the effect of Price the following functions were developed for each breed separately. The definition and sign for each variable will remain the same for the following functions as was shown in the previous function.

Empirical Model (Equation 2 – Balancer Model)

$$BULLPRICE = \beta_0 + \beta_1 READNA + \beta_2 MBDNA + \beta_3 TNDNA + \beta_4 BCE - \beta_5 BBW + \beta_6 BWW + \beta_7 BYW + \beta_8 BREA + \beta_9 BMB + \beta_{10} SC + \beta_{11} S1 + \beta_{12} S2 + \beta_{13} S3 + \beta_{14} S4 + \beta_{15} S5 + \varepsilon_t$$

Empirical Model (Equation 3 – Purebred Model)

$$BULLPRICE = \beta_0 + \beta_1 READNA + \beta_2 MBDNA + \beta_3 TNDNA + \beta_4 PCE - \beta_5 PBW + \beta_6 PWW + \beta_7 PYW + \beta_8 PREA + \beta_9 PMB + \beta_{10} SC + \beta_{11} S1 + \beta_{12} S2 + \beta_{13} S3 + \beta_{14} S4 + \beta_{15} S5 + \varepsilon_t$$

To analyze the impact Performance EPDs would have on the Balancer / Purebred bull price, Carcass DNA was left out of the function and then the following was developed:

Empirical Model (Equation 4 – EPD Model)

$$BULLPRICE = \beta_0 + \beta_1 BCE - \beta_2 BBW + \beta_3 BWW + \beta_4 BYW + \beta_5 BREA + \beta_6 BMB + \beta_7 SC + \beta_8 PCE - \beta_9 PBW + \beta_{10} PWW + \beta_{11} PYW + \beta_{12} PREA + \beta_{13} PMB + \beta_{14} B/P + \beta_{15} S1 + \beta_{16} S2 + \beta_{17} S3 + \beta_{18} S4 + \beta_{19} S5 + \varepsilon_t$$

4.5 Regression Analysis

The regression will show if there is a statistical relationship between the values of Gelbvieh / Balancer bulls and Carcass DNA and Performance Expected Progeny Difference information viewed by buyers before auction. We have made the assumption that genetic information and projections through DNA and EPDs will affect the value of a bull through auction. This study investigates the statistical relationships between Gelbvieh / Balancer bull prices and DNA variables of Ribeye Area, Marbling, and Tenderness; and Performance EPDs of Calving Ease Direct, Birth Weight, Weaning Weight, Yearling Weight, Ribeye Area, and Marbling.

The results of the regression for the determinants of the equation will be discussed in chapter 5. This will help to identify the more important impact determinants of the value of Gelbvieh / Balancer bulls at auction through genetic information.

CHAPTER V: RESULTS

This chapter will evaluate and discuss the regression analyses used to evaluate the variables in the model to determine their impact and importance on the value of Gelbvieh or Balancer bulls at auction. Each coefficient will be discussed in perspective to the dependent variable; bull price. Also, the t-stat and P-value will be observed for each independent variable to evaluate the significance from zero and the significance in determining bull price.

5.1 Regression Results

Results for the estimated regression to explain Gelbvieh / Balancer bull price or value at auction (equation 1) are shown in table 5.1.

Table 5.1 Coefficient Estimates of Gelbvieh / Balancer Bull Price Determinants for Carcass DNA and Performance EPDs

Variables	Coefficient	t-stat	P-Value
Igenity Profile DNA			
REA DNA (1-10)	-43.91	-1.12	0.262
MB DNA (1-10)	-57.83*	-1.93	0.055
Tenderness DNA (1-10)	18.25	0.83	0.409
Balancer Performance EPDs			
Balancer Calving Ease EPD	37.93**	2.50	0.013
Balancer Birth Weight EPD	38.11	0.96	0.337
Balancer Weaning Weight EPD	15.41	1.16	0.245
Balancer Yearling Weight EPD	8.74	1.20	0.231
Balancer REA EPD	782.2*	1.79	0.074
Balancer MB EPD	2924.2***	4.32	0.000
Actual Scrotal Circumference (cm)			
Scrotal Circumference	100.12***	5.75	0.000

Table 5.1 (cont). Coefficient Estimates of Gelbvieh / Balancer Bull Price Determinants for Carcass DNA and Performance EPDs

Variables	Coefficient	t-stat	P-Value
Purebred Performance EPDs			
Purebred Calving Ease EPD	67.78**	2.26	0.025
Purebred Birth Weight EPD	63.73	0.75	0.453
Purebred Weaning Weight EPD	-4.17	-0.13	0.897
Purebred Yearling Weight EPD	26.35	1.40	0.161
Purebred REA EPD	-304.9	-0.31	0.760
Purebred MB EPD	523	0.42	0.673
Balancer / Purebred Dummy	3502	0.97	0.331
Sales			
Sale 1	223	0.96	0.339
Sale 2	-232	-1.04	0.297
Sale 3	77	0.40	0.690
Sale 4	471***	2.61	0.010
Sale 5	490**	2.57	0.011
Constant	-9675***	-2.92	0.004
R Square	0.398		
Adjusted R Square	0.355		
Observations	74 Purebreds 256 Balancers 330 Total		

Note: One, two, and three asterisks indicate coefficient significantly different from zero at the 0.10, 0.05 and 0.01 levels, respectively.

The coefficient for Ribeye Area DNA is -43.9, suggesting that for every increment on the Igenity scale (1-10) Ribeye increases, the price of a Gelbvieh / Balancer bull would decrease \$43.90 per head. However, the P-value is ≥ 0.10 indicating this coefficient is not a statistically significant determinant of Gelbvieh / Balancer bull auction price. The large P-value indicates that we have not been able to estimate the impact of Ribeye Area DNA on bull price with a high level of precision and we do not have a high degree of confidence as to what impact this variable has on bull price. It was unexpected to see the coefficient negative for Ribeye DNA. It was hypothesized that a higher number on the Igenity scale would have a positive impact on bull price as this DNA value would mean an increase in Ribeye size for the bull's progeny. A reason that there might not be significance between the Ribeye DNA values and price would be that there was not much variation in Ribeye DNA between bulls. All bulls were in the acceptable range for buyers when making their selection purchases. Or perhaps buyers are not utilizing this information since it is relatively novel and not yet fully understood.

The coefficient for Marbling DNA is -57.83, which tells us that for every increment on the Igenity scale Marbling increases, the price of a Gelbvieh / Balancer bull will decrease \$57.83 per head. The fact that the P-value is ≤ 0.10 indicates that this coefficient is significantly different from zero and we can be 90 percent certain this variable is a determinant of the Gelbvieh / Balancer bull price. It was unexpected to see the coefficient negative for Marbling DNA. It was hypothesized that a higher number on the Igenity scale would have a positive impact on the bull price as the sire's progeny should be more apt to reach USDA Choice thus having an increased value. The unexpected sign is difficult to explain and the relationship may be spurious. There might not be sufficient variation in Marbling DNA between bulls in the data set and bulls may be in the acceptable range for buyers when making their selection purchases thus not effecting buyers in their selection process.

The coefficient for Tenderness DNA is 18.25, suggesting that for every increment Tenderness increases on the Igenity scale, the price of Gelbvieh / Balancer bulls would increase \$18.25 per head. However, the fact that the P-value is ≥ 0.10 indicates that this coefficient is not a statistically significant determinant of Gelbvieh / Balancer bull auction price. The large P-value indicates we are uncertain that this coefficient estimate is different from zero. The regression suggests that we do not have confidence in the independent variable that it affects the dependent variable. The positive coefficient sign for Tenderness was expected as it was hypothesized that with an increase of Tenderness on the Igenity scale, price will increase for each bull sold. Increased Tenderness DNA for each bull should impact value as the sire's progeny should be more apt to have higher quality carcasses that are more tender. Even with the positive coefficient sign, we can not be sure that the variable has an impact on the price as it is not significant from zero. A reason that there might not be significance between the Tenderness DNA values and price would be that there was not much variation in Tenderness DNA between bulls. All bulls were in the acceptable range for buyers when making their selection purchases thus not effecting buyers in their selection process.

The coefficient for Balancer Calving Ease Direct EPD is 37.93, which tells us that for every percentage increase in the Calving Ease Direct ratio, the bull price per head would increase $37.93. The fact that the P-value is $\leq$ 0 .05 indicates that this coefficient is significantly different than zero and we can be 95 percent certain this variable is a determinant of the Gelbvieh / Balancer bull price. A higher ratio or EPD represents better (easier) calving ease. This value represents the direct influence a sire has on calving ease, thus it was expected that the coefficient would be positive in respect to the dependent variable, bull price. A bull that would provide more calving ease in his genetic line would have more value to the producer purchasing the bull.

The coefficient for Balancer Birth Weight EPD is 38.11, suggesting that for every pound difference increase in the BW EPD, the Gelbvieh / Balancer bull price would increase $38.11 per head. However, the fact that the P-value is $\geq$ 0.10 indicates that this coefficient is not a statistically significant determinant of Gelbvieh / Balancer bull auction price. The large P-value indicates that we have not been able to estimate the impact of Balancer Birth Weight EPD on bull price with a high level of precision and we do not have a high degree of confidence as to what impact this variable has on bull price. In addition to not being statistically significant, the sign on Birth Weight was unexpected in the equation. Lower birth weight would typically mean that there would be less calving problems and issues, meaning lower costs and labor. However, depending on the herd and age of cows, birth weight may not always be important to producers if they can handle larger calves. Larger calves can mean a healthier, vigorous calf at birth. Whichever a producer would want into their herd genetics, the Birth Weight in this study was still not significant to the price of the bull.

The coefficient for Balancer Weaning Weight EPD is 15.41, suggesting that for every pound difference increase in the WW EPD, the Gelbvieh / Balancer bull price would increase $15.41 per head. However, the fact that the P-value is ≥ 0.10 indicates that this coefficient is not a statistically significant determinant of Gelbvieh / Balancer bull auction price. The large P-value indicates that we have not been able to estimate the impact of Balancer Weaning Weight EPD on bull price with a high level of precision and we do not have a high degree of confidence as to what impact this variable has on bull price. The positive sign on the Weaning Weight coefficient was to be expected. The positive effect of the coefficient may be small but should be positive towards the bull value as an increase on weight in the sire's calves means more value for the bull and producer. The increased Weaning Weight should indicate value for producers whether they market their calves at weaning, yearling, or are used for breeding stock, etc. However, this performance value was not significant to the price of bulls in this study for the buyers.

The coefficient for Balancer Yearling Weight EPD is 8.74, suggesting that for every pound difference increase in the YW EPD, the Gelbvieh / Balancer bull price would increase $8.74 per head. However, the fact that the P-value is ≥ 0.10 indicates that this coefficient is not a statistically significant determinant of Gelbvieh / Balancer bull auction price. The large P-value indicates that we have not been able to estimate the impact of Balancer Yearling Weight EPD on bull price with a high level of precision and we do not have a high degree of confidence as to what impact this variable has on bull price. The positive sign on the Yearling Weight coefficient was to be expected. The positive effect of the coefficient may be small but should be positive towards the bull value as an increase on weight in the sire's calves at a year of age means more value for the bull and producer. The performance value of growth from birth to yearling was not significant to the price of the bulls in this study.

The coefficient for Balancer Ribeye Area EPD is 782.2, which tells us that for every square inch increase in the REA EPD, the Gelbvieh / Balancer bull price will increase $782.20 per head. The incremental value increase can be deceptive for this coefficient as the REA EPD is recorded in hundredths. An increase in .01 for REA EPD would indicate an increase in $7.82 per head. The fact that the P-value is ≤ 0.10 indicates that this coefficient is significantly different than zero and we can be 90 percent certain this variable is a determinant of the Gelbvieh / Balancer bull price. The coefficient for REA EPD does not indicate a large effect on the bull value; however, the positive sign was to be expected for the coefficient as an increase in Ribeye Area and muscle mass should mean more value with more potential red meat on the sire calves carcasses.

The coefficient for Balancer Marbling EPD is 2924.2, which tells us that for every degree increase of marbling score in the MB EPD, the Gelbvieh / Balancer bull price will increase $2924.20 per head. The incremental value increase can be deceptive for this coefficient as the MB EPD is recorded in hundredths. An increase in .01 for MB EPD would indicate an increase in $29.24 per head. The fact that the P-value is ≤ 0.01 tells us that we can be over 99 percent certain that this coefficient is significantly different than zero and thus is a significant determinant of the price of the Gelbvieh / Balancer bull at auction. The positive coefficient was expected as an increase in marbling in the sire's calves would mean that they would be more apt to reach USDA Choice thus receiving a premium and increased revenue.

The coefficient for Scrotal Circumference is 100.12, which tells us that for every centimeter increase in circumference for actual scrotal measurements, the Gelbvieh / Balancer bull price will increase $100.12 per head. The fact that the P-value is ≤ 0.01 indicates that we can be over 99 percent certain that this coefficient is significantly different than zero and thus is a significant determinant of the price of the Gelbvieh / Balancer bull at auction. The positive coefficient was to be expected as increased Scrotal Circumference should indicate increase fertility in the sire being purchased. A bull's value should increase with the potential to be more fertile. It was evident in this study that the actual measurement was significant in the buyers mind as they made their purchase selections.

The coefficient for Purebred Calving Ease Direct EPD is 67.78, which tells us that for every percentage increase in the Calving Ease Direct ratio, the bull price per head would increase \$67.78. The fact that the P-value is ≤ 0.05 indicates that this coefficient is significantly different that zero and we can be 95 percent certain this variable is a determinant of the Gelbvieh / Balancer bull price. A higher ratio or EPD represents better (easier) calving ease. This value represents the direct influence a sire has on calving ease, thus it was expected that the coefficient would be positive in respect to the dependent variable, bull price. A bull that would provide more calving ease in his genetic line would have more value to the producer purchasing the bull.

The coefficient for Purebred Birth Weight EPD is 63.73, suggesting that for every pound difference increase in the BW EPD, the Gelbvieh / Balancer bull price would increase \$63.73 per head. However, the fact that the P-value is ≥ 0.10 indicates that this coefficient is not a statistically significant determinant of Gelbvieh / Balancer bull auction price. The large P-value indicates that we have not been able to estimate the impact of Purebred Birth Weight EPD on bull price with a high level of precision and we do not have a high degree of confidence as to what impact this variable has on bull price. In addition to not being statistically significant, the sign on Birth Weight was unexpected in the equation. Lower birth weight would typically mean that there would be less calving problems and issues, meaning lower costs and labor. However, depending on the herd and age of cows, birth weight may not always be important to producers if they can handle larger calves. Larger calves can mean a healthier, vigorous calf at birth. Whichever a producer would want into their herd genetics, the Birth Weight in this study was still not significant to the price of the bull.

The coefficient for Purebred Weaning Weight EPD is -4.17, suggesting that for every pound difference increase in the WW EPD, the Gelbvieh / Balancer bull price would decrease \$4.17 per head. However, the fact that the P-value is ≥ 0.10 indicates that this coefficient is not a statistically significant determinant of Gelbvieh / Balancer bull auction price. The large P-value indicates that we have not been able to estimate the impact of Purebred Weaning Weight EPD on bull price with a high level of precision and we do not have a high degree of confidence as to what impact this variable has on bull price. The negative coefficient on the Purebred Weaning Weight was unexpected. An increase in Weaning Weight should indicate value for producers; however, this performance value was not significant to the price of bulls in this study for the buyers.

The coefficient for Purebred Yearling Weight EPD is 26.35, suggesting that for every pound difference increase in the YW EPD, the Gelbvieh / Balancer bull price would increase $26.35 per head. However, the fact that the P-value is ≥ 0.10 indicates that this coefficient is not a statistically significant determinant of Gelbvieh / Balancer bull auction price. The large P-value indicates that we have not been able to estimate the impact of Purebred Yearling Weight EPD on bull price with a high level of precision and we do not have a high degree of confidence as to what impact this variable has on bull price. The positive sign on the Yearling Weight coefficient was to be expected. The effect of the coefficient should be positive towards the bull value as an increase on weight in the sire's calves at a year of age means more value for the bull and producer. The performance value of growth from birth to yearling was not significant to the price of the bulls in this study.

The coefficient for Purebred Ribeye Area EPD is -304.9, suggesting that for every square inch increase in the REA EPD, the Gelbvieh / Balancer bull price would decrease $304.90 per head. The incremental value increase can be deceptive for this coefficient as the REA EPD is recorded in hundredths. A change in .01 for REA EPD would indicate a decrease in $3.04 per head. However, the fact that the P-value is ≥ 0.10 indicates that this coefficient is not a statistically significant determinant of Gelbvieh / Balancer bull auction price. The large P-value indicates that we have not been able to estimate the impact of Purebred Ribeye Area EPD on bull price with a high level of precision and we do not have a high degree of confidence as to what impact this variable has on bull price. The coefficient for REA EPD does not indicate a large effect on the bull value; however, the negative sign was unexpected for the coefficient as an increase in Ribeye Area and muscle mass should mean more value with more potential red meat on the sire calves carcasses.

The coefficient for Purebred Marbling EPD is 523, suggesting that for every degree increase of marbling score in the MB EPD the Gelbvieh / Balancer bull price would increase $523 per head. The incremental value increase can be deceptive for this coefficient as the MB EPD is recorded in hundredths. An increase in 0.01 for MB EPD would indicate an increase in $5.23 per head. However, the fact that the P-value is $\geq$ 0.10 indicates that this coefficient is not a statistically significant determinant of Gelbvieh / Balancer bull auction price. The large P-value indicates that we have not been able to estimate the impact of Purebred Marbling EPD on bull price with a high level of precision and we do not have a high degree of confidence as to what impact this variable has on bull price. The positive coefficient was expected as an increase in marbling in the sire's calves would mean that they would be more apt to reach USDA Choice thus receiving a premium and increased revenue.

The R-squared and Adjusted R-squared values indicate how well the data fits the regression equation. The Adjusted R-squared 0.355 indicates that only 35.5 percent of the variability in the Gelbvieh / Balancer bull price at auction is explained by the independent variables. The Adjusted R-squared measured the percentage of the variation of Bull Price around its mean that is explained by the regression equation, adjusted for degrees of freedom.

Results for the estimated regression for Balancer bull data and variables to explain Bull Price (equation 2) are shown in Table 5.2.

Table 5.2 Coefficient Estimates of Balancer Bull Price Determinants for Carcass DNA and Performance EPDs

Variables	Coefficient	t-stat	P-Value
Igenity Profile DNA			
REA DNA (1-10)	-41.7	-1.05	0.294
MB DNA (1-10)	-60.5**	-1.99	0.047
Tenderness DNA (1-10)	-4.7	-0.22	0.828
Balancer Performance EPDs			
Balancer Calving Ease EPD	-11.5***	-3.41	0.001
Balancer Birth Weight EPD	-22.2	-0.61	0.543
Balancer Weaning Weight EPD	20.6	1.53	0.128
Balancer Yearling Weight EPD	2.07	0.29	0.773
Balancer REA EPD	525*	1.18	0.240
Balancer MB EPD	2939***	4.21	0.000
Actual Scrotal Circumference (cm)			
Scrotal Circumference	108***	6.07	0.000
Sales			
Sale 1	151	0.64	0.520
Sale 2	-144	-0.66	0.508
Sale 3	167	0.85	0.397
Sale 4	581***	3.15	0.002
Sale 5	564***	2.90	0.004
Constant	-896	-1.21	0.228
R Square	0.341		
Adjusted R Square	0.31		
Observations	256 Balancers		

Note: One, two, and three asterisks indicate coefficient significantly different from zero at the 0.10, 0.05 and 0.01 levels, respectively.

There were many large changes in observations when comparing regression equations 1 and 2. Signs changed on coefficients for Tenderness, Balancer Calving Ease Direct, and Balancer Birth Weight. Additionally, moderate coefficient changes occurred on the Balancer Calving Ease Direct and Balancer Birth Weight variables. The P-value for Marbling DNA was observed at the ≤ 0.05 significance level while Balancer Calving Ease Direct, Balancer Marbling EPD, Scrotal Circumference, and Sale 4 and 5 observed ≤ 0.01 significance. Generally, just running the model with only Balancer data changed the regression an insignificant amount.

The R-squared and Adjusted R-squared values were 0.341 and 0.31 respectively. This indicates that that the data did not have a good fit for the regression equation however, was not different than the base equation 1.

Results for the estimated regression for Purebred bull data and variables to explain Bull Price (equation 3) are shown in Table 5.3.

Table 5.3 Coefficient Estimates of Purebred Bull Price Determinants for Carcass DNA and Performance EPDs

Variables	Coefficient	t-stat	P-Value
Igenity Profile DNA			
REA DNA (1-10)	11.3	0.28	0.779
MB DNA (1-10)	-38.3	-1.22	0.222
Tenderness DNA (1-10)	21.4	0.95	0.342
Purebred Performance EPDs			
Purebred Calving Ease EPD	-13.7*	-1.85	0.065
Purebred Birth Weight EPD	-62.2	-0.85	0.395
Purebred Weaning Weight EPD	15.3	0.46	0.646
Purebred Yearling Weight EPD	10.9	0.58	0.565
Purebred REA EPD	132	0.12	0.901
Purebred MB EPD	1120	0.90	0.369

Table 5.3 (cont). Coefficient Estimates of Purebred Bull Price Determinants for Carcass DNA and Performance EPDs

Variables	Coefficient	t-stat	P-Value
Actual Scrotal Circumference (cm)			
Scrotal Circumference	118***	6.51	0.000
Sales			
Sale 1	-5	-0.02	0.984
Sale 2	-58	-0.25	0.800
Sale 3	189	0.94	0.349
Sale 4	600***	3.20	0.002
Sale 5	509**	2.54	0.012
Constant	-1872**	-2.55	0.011
R Square	0.295		
Adjusted R Square	0.262		
Observations	74 Purebreds		

Note: One, two, and three asterisks indicate coefficient significantly different from zero at the 0.10, 0.05 and 0.01 levels, respectively.

Small changes between the base equation 1 and the Purebred equation 2 were observed when comparing regressions. Signs changed on coefficients for Ribeye Area DNA, Purebred Calving Ease Direct, Purebred Weaning Weight, and Sale 1 and 2. Moderate coefficient changes occurred on the Ribeye Area DNA, Purebred Calving Ease Direct and Purebred Weaning Weight variables. The P-value for the Constant, Purebred Calving Ease Direct, and Sale 5 were observed at the ≤ 0.05 significance level while Scrotal Circumference and Sale 4 observed ≤ 0.01 significance. Generally, just running the model with only Purebred data changed the regression an insignificant amount.

The R-squared and Adjusted R-squared values were 0.295 and 0.262 respectively. This indicates that that the data did not have a good fit for the regression equation however, was not different than the base equation 1.

Results for the estimated regression for Purebred / Balancer bull Performance EPDs to explain Bull Price (equation 4) are shown in Table 5.4.

Table 5.4 Coefficient Estimates of Gelbvieh / Balancer Bull Price Determinants for Performance EPDs

Variables	Coefficient	t-stat	P-Value
Balancer Performance EPDs			
Balancer Calving Ease EPD	36.0**	2.38	0.018
Balancer Birth Weight EPD	35.3	0.90	0.369
Balancer Weaning Weight EPD	15.9	1.22	0.225
Balancer Yearling Weight EPD	8.94	1.23	0.221
Balancer REA EPD	727*	1.69	0.091
Balancer MB EPD	2671***	4.02	0.000
Purebred Performance EPDs			
Purebred Calving Ease EPD	59.4**	2.04	0.042
Purebred Birth Weight EPD	52.2	0.62	0.534
Purebred Weaning Weight EPD	-10.1	-0.32	0.752
Purebred Yearling Weight EPD	30.3	1.62	0.107
Purebred REA EPD	-248	-0.25	0.805
Purebred MB EPD	278	0.23	0.820
Actual Scrotal Circumference (cm)			
Scrotal Circumference	97.1***	5.60	0.000
Balancer / Purebred Dummy	2890	0.82	0.411
Sales			
Sale 1	222	0.88	0.381
Sale 2	-260	-1.25	0.210
Sale 3	142	0.68	0.498
Sale 4	443**	2.46	0.014
Sale 5	481**	2.51	0.012

Constant	-9277***	-2.93	0.004
R Square	0.388		
Adjusted R Square	0.35		
Observations	74 Purebreds 256 Balancers 330 Total		

Note: One, two, and three asterisks indicate coefficient significantly different from zero at the 0.10, 0.05 and 0.01 levels, respectively.

Changes were insignificant between the base equation 1 and the Purebred / Balancer EPD equation 4 when comparing regressions. No signs changed on variables and very small changes occurred between coefficients. The P-Value for the Balancer Ribeye Area EPD was at the ≤ 0.10 significance level. Observed at the ≤ 0.05 significance level were the Balancer Calving Ease Direct and Sales 4 and 5 while the Constant, Balancer Marbling EPD, and Scrotal Circumference observed ≤ 0.01 significance. Generally, just running the model with only Performance EPD data changed the regression the most insignificant amount of all models.

The R-squared and Adjusted R-squared values were 0.388 and 0.350 respectively. This indicates that that the data did not have a good fit for the regression equation however, was not different than the base equation 1.

5.2 Summary

The hedonic models estimated in this study only explained a range of 26.2 to 35.5 percent of the variation in the Gelbvieh / Balancer bull price at auction in relationship to the independent variables of Carcass DNA, Scrotal Circumference, and Performance EPDs. Overall, the variables were not a good fit for the equations in relation to the Adjusted R-squared value. Only a few of the variable coefficients in the equations were actually statistically significant. The equation that may have been the best fitting model was equation 1 where all variables and data were used together for both Balancers and Purebreds. In this regression, coefficients significant at the 0.01 level were Balancer Marbling EPD and Scrotal Circumference. Significant at the 0.05 level were Balancer

Calving Ease and Purebred Calving Ease. Observing significance at the 0.10 level were Marbling DNA and Balancer Ribeye Area EPD.

The impact of Carcass DNA, Scrotal Circumference and Performance EPDs on Bull Price as determined from the regression results will be discussed in Chapter 6.

CHAPTER VI: CONCLUSION AND IMPLICATIONS

This study used hedonic modeling to assess the value of Carcass DNA and Performance Expected Progeny Differences for Gelbvieh / Balancer bull prices at auction. Using data from 330 bulls at 6 different Gelbvieh and Balancer sales throughout Nebraska in the spring of 2008, we ran a regression on Ribeye Area DNA, Marbling DNA, Tenderness DNA, Balancer Calving Ease Direct EPD, Balancer Birth Weight EPD, Balancer Weaning Weight EPD, Balancer Yearling Weight EPD, Balancer Ribeye Area EPD, Balancer Marbling EPD, Scrotal Circumference, Purebred Calving Ease Direct EPD, Purebred Birth Weight EPD, Purebred Weaning Weight EPD, Purebred Yearling Weight EPD, Purebred Ribeye Area EPD, and Purebred Marbling EPD to evaluate the price effect these independent variables had on Bull Price at Auction. To evaluate how the sire information will effect bull price, all DNA, actual measurements, and EPDs were given to potential buyers before auction.

At the time period of data collection for this study, the bull market was very aggressive with good demand, especially for Purebred Gelbvieh and Gelbvieh influenced genetics. Outstanding genetics are in demand for all sires. At the time of data collection, other relating markets were strong for most producers such as feeder cattle and corn, wheat and other feeds. All 330 bulls together, Purebred and Balancers, averaged $2,796.82 with a range of $1,350.00 to $5,250.00.

This thesis only observed bull data to determine the bull's value for the buyer and its final price. It was hypothesized that all Carcass DNA and Performance EPDs except Birth Weight, would have a positive effect on Bull Price. However, in this study not all signs were expected after running the regression. A few items may have affected some of the coefficient signs in the regression to turn out unexpected. First, there may not have been much variability between bulls on the given variable with the unexpected sign. Secondly, other measured variables may have been more dominating over the bull price. Next, all bulls may have been within the acceptable range for the given measured variable, thus the buyer would not have placed much consideration on the variable when selecting the bull. Finally, there may have been variables in the regression that were highly correlated or had an unexpected correlation.

In the regression, some variables were highly correlated, thus making it difficult to find individual impacts for all variables. To help find the separate impacts of the variables, more bulls may be needed for the data to help dilute out some correlation effects. For both Balancers and Purebreds, Calving Ease Direct was highly correlated with Weaning Weight and Yearling Weight. Additionally, Weaning Weight was highly correlated with Yearling Weight. Calving Ease and the two growth EPDs may be correlated due to the fact that larger, more "growthy" and mature cattle will potentially calve easier due to such factors as larger body size and frame, and larger pelvic size. More "growthy" cattle may be more apt to calve all sizes of calf and from most presentations; normal and abnormal. Weaning Weight and Yearling Weight are highly correlated due to the fact that both are essentially the same measurement, just measured and adjusted to a different time frame. If a calf is quicker to grow to weaning age, it should be more apt to weigh more at yearling age as well. The same types of measurements should tend to be more likely to be correlated with each other.

In the regression, the determinants that had the most effect on bull value were Balancer and Purebred Calving Ease Direct EPD, Balancer Marbling EPD, and Scrotal Circumference. The Calving Ease Direct EPD was in the .05 significance level for both Balancer's and Purebred's when determining the Bull Price. The Balancer Marbling EPD and actual Scrotal Circumference were in the .01 significance level when determining the Bull Price.

R-squared and Adjusted R-squared did not indicate that the variables were a very good fit for the regression equation. The Adjusted R-squared 0.355 indicates that only 35.5 percent of the variability in the Gelbvieh / Balancer bull price at auction is explained by the independent variables.

6.1 Implications

Currently, the beef industry is taking advantage of important technologies such as DNA information and Expected Progeny Differences and using them to make stream line genetic and breeding decisions. These decisions dramatically affect the industry through factors such as beef production, reproduction, and herd efficiency. The decisions made today from a genetic standpoint can affect the cattle herd for the next decade. Therefore, these decisions are vitally important to the producer and the industry on a whole.

As technologies and decisions become even more important in the industry, the technologies observed in this study will become more economically important and have an effect on value of the breeding herds. Although this study was not able to grasp the full or large effect of the value of the sale bull through some of the industry's technologies, they will still remain vital to select. The value of these technologies may show more effect on the value of the sire at auction when other variables such as actual measurement are observed in addition.

While the data in this study implicates that we could not be fully confident that DNA technology had an affect on bull value, this technology must still be observed as this is actual data that can be successfully used for selection, not just a projection. In evaluating potential herd sires before sale, all variables must be evaluated such as phenotype, genetics, pedigrees, etc. to make a good breeding decision. Such variables such as phenotype should not be overlooked as this may play a larger role on bull value. Phenotype evaluation should observe structure, body condition, frame and much more. If a producer does not understand the developing technologies of the industry, phenotype of the herd sire will still possibly be the most important factor during the breeding season. The implications of this study should not solely effect the sire selection.

Another realization from this study to keep in mind is the fact that many producers do not observe the immediate realization or effects of many of the variables. Most producers would observe immediate effects of variables such as Calving Ease, Birth Weight, Weaning Weight, and Yearling Weight through overhead savings and revenue earnings. Most producers do not observe an immediate effect or advantage of the carcass variables observed such as Ribeye Area EPD or DNA, Marbling EPD or DNA, and Tenderness DNA unless the producer is integrated throughout the supply chain to be able to observe the immediate advantages. Due to the fact that many producers do not always see an immediate effect from some of the variables in this study, this may have an effect on the value of the certain variable observed at auction. The variables that producers observe a more immediate effect economically may have had more value at the auction throughout this study.

6.2 Future Research

For future research in this field, I would suggest evaluating other variables and data that may be provided to potential buyers before auction. Other suggested Expected Progeny Differences that may be observed are Efficiency, Maternal and Reproductive EPDs. When evaluating other data that may be provided before sale, it is important to observe other variables that can be in a bull sale catalog. Other variables possibly included could be individual lot pictures, pedigrees, sale order, actual measurements, adjusted measurements, weight, and age. Another possible variable to observe would be whether the sale provides any benefits to the bull buyer such as free delivery, breeding guarantee, and free care.

REFERENCES

American Gelbvieh Association. www.gelbvieh.org. 10900 Dover St., Westminster, CO 80021.

Beef Improvement Federation (BIF). Guidelines for the Uniform Beef Improvement Programs. 8th ed: 2002.

Bovigen, LLC. www.bovigen.com. 250 Plauche ST, Harahan, LA 70123.

Chvosta, Jan, R. Rucker, and M. Watts. *Transaction Costs and Cattle Marketing: The Information Content of Seller-Provided Presale Data at Bull Auctions*. Amer. J. Agr. Econ. 83:2 (2001): 286-301.

Dhuyvetter, Kevin, T. Schroeder, D. Simms, R. Bolze Jr., and J. Geske. *Determinants of Purebred Beef Bull Price Differentials*. Journal of Agricultural and Resource Economics. 21:2(1996):396-410.

Food and Agricultural Organization of the United Nations (FAO). www.fao.org. Viale delle Terme di Caracalla, 00153 Rome, Italy

Igenity. www.igenity.com. 3239 Satellite Blvd., Duluth, GA 30096-4640

National Beef Quality Audit (NBQA), 2005.

National Cattlemen's Beef Association (NCBA), www.beefusa.org. NCBA Denver, 9110 East Nichols Ave. Suite 300, Centennial, Colorado 80112.

Parcell, Joe, K. Dhuyvetter, D. Patterson, and R. Randle. *The Value of Carcass Characteristic EPDs in Bred Heifer Price*. NCR-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management. St. Louis, Missouri. April 18-19, 2005.

Richards, Timothy and S. Jeffrey. *Hedonic Pricing of Dairy Bulls – An Alternative Index of Genetic Merit*. University of Alberta, Department of Rural Economy. September, 1995.

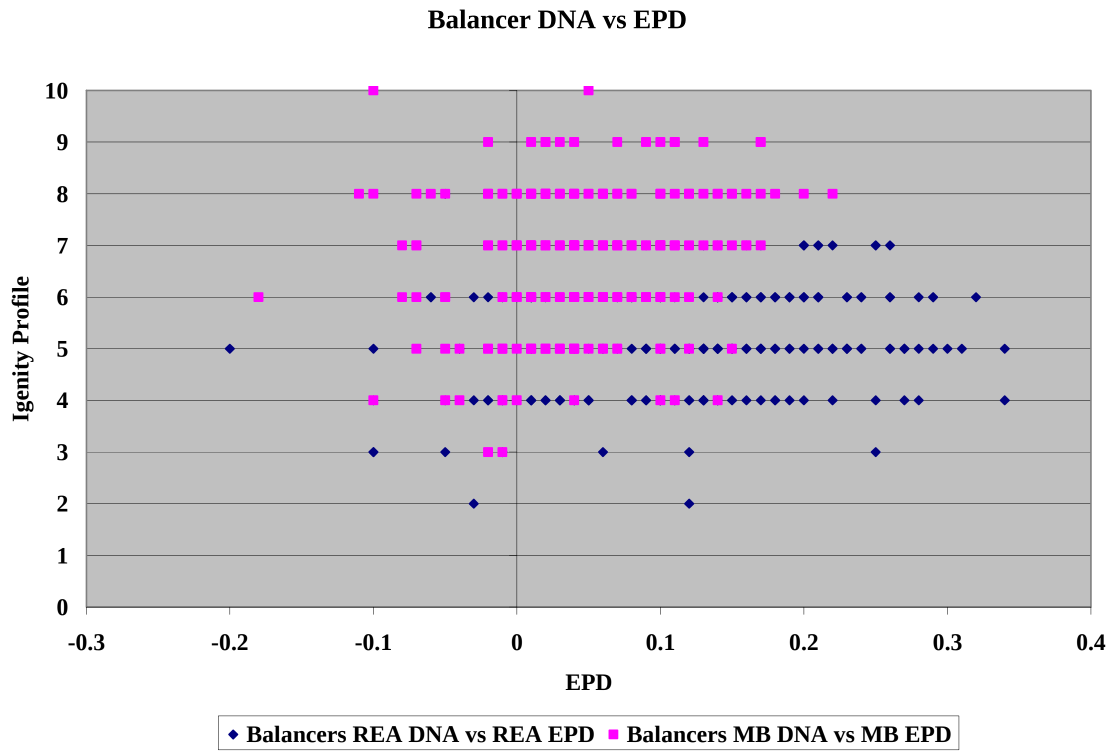
Schroeder, Ted, J. Espinosa, B. Goodwin. *The Value of Genetic Traits in Purebred Dairy Bull Services. Review of Agricultural Economics*, Vol. 14, No. 2. (July 1992), pp. 215-226.

Studemund, A. 2001. *Using econometrics: A practical guide*. 4th ed. Boston: Addison, Wesley and Longman.

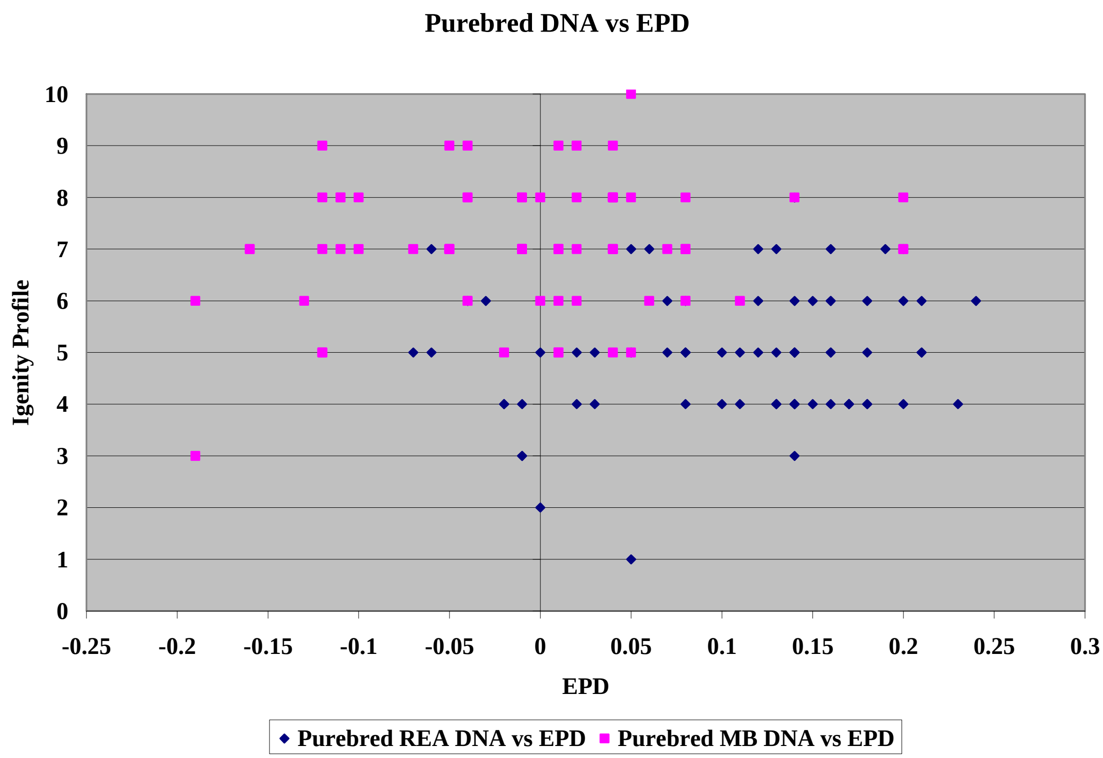
Turner, Tyler, K. Dhuyvetter, T. Marsh, and R. Jones. *Estimating the Ecomomic Values Associated With EPDs For Angus Bulls At Auction.* Western Agricultural Economics Association Annual Meeting. June 30 – July 2, 2004.

Walburger, Allan. *Estimating the Implicit Prices of Beef Cattle Attributes: A Case from Alberta*. Canadian Journal of Agricultural Economics. 50:2 (2002) 135-149.

APPENDIX A. BALANCER DNA VS. EPD



APPENDIX B. PUREBRED DNA VS. EPD



APPENDIX C. BULL PRICE VS. SCROTAL CIRCUMFERENCE