Journal of Agribusiness 29, 2 (Fall 2011)

Evaluating Beef Cow Productivity Based on Historical Offspring Performance

Roberta M. Slattery and Ted C. Schroeder

Industry standards for cow evaluations based on calf performance typically use Most Probable Producing Ability, which does not consider performance past weaning. In more recent years technologies such as grid marketing and individual animal identification have provided more data in later stages of fed cattle production and brought about opportunities to enhance cow evaluation. This study suggests two methods of cow evaluation using lifetime performance of calves; one on individual cows and one using cows grouped by age. Even with unaccounted variation of sires, some cows consistently produced an above- or below-average finished animal. Younger cows and very old cows typically produced calves with lower lifetime returns, but causes varied between efficiency, weight, and carcass quality. Both methods highlight calf performance relationships and show potential for enhancing management decision-making.

***Key words**:* beef cattle management, cattle evaluation, cow culling, grid marketing

Information technology has created potential to collect enormous amounts of data on individual animals to enhance cattle production management decisions. Grid marketing has generated several measures of quality on fed cattle previously not available in traditional marketing systems. Feedlots are utilizing ultrasound and electronic data tracking technologies to measure and manage cattle to optimize performance (Koontz et al. 2008). Cow-calf producers are increasingly adopting individual animal management for record-keeping and management decisions to improve returns (NAHMS 2008). These changes have produced a wealth of data about cattle growth and development at different stages of production, and brought about new opportunities for improvements in genetics and management designed to increase net returns. While data collection and tracking has mirrored the progress of technology, application of the information for decision support to increase returns has not been fully analyzed or understood.

Roberta M. Slattery is an extension agent, Agriculture and Natural Resources, and Ted C. Schroeder is university distinguished professor, Agricultural Economics, Kansas State University. We acknowledge an extensive data set generously provided by an anonymous ranch for this study and Cow Sense Herd Management Software by Midwest MicroSystems, LLC, for technical support. This project was supported by the USDA National Institute of Food and Agriculture Hatch project #KS460. We thank two journal reviewers for helpful comments on this article.

The purpose of this study is to identify and evaluate individual animal-traced product quality and production efficiency measures in cattle production to determine whether they can be used for enhancing cattle management decisions to increase net returns. Data on individual animals were collected at various stages of production: from cows and calves at the ranch; to calf backgrounding, growing, and finishing; and finally individual carcass traits on the grid system. Production performance and net return information for each calf was linked back to their dam. Specifically, this study evaluates productivity based on a cow's individual historical offspring return performance. Individual cow and cohort-grouped evaluations of production efficiency and returns were tested. The goal was to provide an assessment of individual animal performance information and net return on cow herd culling and management decisions.

The current industry standard for evaluating beef cow productivity is to use Most Probable Producing Ability (MPPA), which is calculated based on the adjusted 205-day weaning weight ratios of all calves a cow has produced (Beef Improvement Federation, 2002). MPPA is an index of how well a cow's calves collectively have performed, measured by weaning weight, relative to cohorts in the herd. For example, if a cow has an MPPA of 102, she has historically produced calves that have performed better than their cohorts. Using MPPA, cows are evaluated based on the growth of their calves up through weaning, but post-weaning performance is ignored. MPPA is a useful guide for cow-calf producers that sell their calves at weaning, but performance is only considered on a small part of an animal's life. Producers that retain ownership of their calves through finishing, especially those selling fed cattle on a grid marketing system, have to be concerned about more measures of animal performance than weaning weight. Furthermore, the critical question cow-calf producers are concerned with is the expected relative net return from each calf produced.

Grid marketing prices cattle individually based on hot carcass weight, yield grade, and quality grade, so several factors affect revenue. Also of concern for cow-calf producers who retain calf ownership is the cost of finishing cattle. Average daily gain, feed conversion, and days on feed, are all important profit determinants. Therefore, the most profitable cow is one that produces a calf that gains efficiently, produces a carcass that is heavy (but not so large as to incur heavy-weight grid discounts), has a superior quality grade, and has low yield grade. As such, evaluating cow productivity and economic performance includes evaluating her calves' lifetime performances. Even more important in the long run is the repeatability or predictability of net return performance of a cow's offspring.

Evaluating cows based on historical performance of their offspring is difficult because of the resources required to collect relevant information at all stages of production and to ensure calf performance is matched back to the appropriate dam. Even when accurate data for individual cows are maintained, in most commercial operations herd bulls are used and there is no cost-effective way of matching bulls with calves they sired. This creates a source of unaccounted variation in performance of offspring. However, this is a reality that the cow-calf industry faces when cattle are raised in commercial herds spread across vast acreage. This study evaluates cow and associated calf production in a large commercial cow-calf herd from the western United States.

Review of Literature

Grid marking historically came about to address losses in beef market shares to the pork and poultry industries, which was attributed to inconsistencies in beef quality (Fausti, Qaumi, and Diersen 2008). Traditionally, cattle were sold on a pen basis, with all animals receiving the same price per hundredweight (cwt.) (live or dressed) regardless of carcass quality attributes. Thus, the market signals to producers were to increase weight to receive more revenue. However, consumers demanded a higher quality and more consistent beef product, so the concept of value-based marketing was developed. Grid pricing is the most common form of value-based marketing which prices each animal individually based on carcass attributes. Carcasses are evaluated based on weight; quality grade, which is based mostly on inter-muscular fat or marbling; and yield grade, which is based mostly on external fat. The system encourages producers to raise higher quality and more consistent product, and produces a wealth of individualized data on cattle performance.

Marketing fed cattle on an individual basis through a grid system is a relatively new form of marketing. Therefore, research on utilizing information gained through grid pricing to enhance production and especially cow-herd management decisions has not been widely studied.

Forristall, May, and Lawrence (2002) found that fed cattle traits—such as carcass marbling score, average daily gain, and feed efficiency—were not highly correlated (0.17 or less) with cow traits such as cow age, cow weight, cow body condition score, and cow feed cost. However, cows that were ranked as "low cost" produced more "high return" steers, and cows ranked as "high cost" produced more "low return" steers, suggesting cows having lower feed costs tend to produce relatively more profitable calves.

Walburger and Crews (2004) used carcass data to predict future cattle performance by estimating several models to predict cattle quality on an individual level using physical measurements of the calf and characteristics of the cow. In addition, ultrasound measurements of a calf or measurements from related cattle that were previously slaughtered were also used. Regression analysis was used to predict hot carcass weight, rib-eye area, backfat, marbling, pre-slaughter weight and the most profitable marketing channel (between live, dressed, or grid pricing). Ultrasound measurements were better predictors of finished carcass characteristics than relations data. However, both sets of data used together could potentially increase returns by better predicting optimal marketing channels. A model that used ultrasound measurements could increase gross value of cattle by $9.04 to $16.75 per head by marketing them in appropriate channels, but using ultrasound and relations data could increase gross value by $11.27 to $27.93 per head. Clearly, there is value in knowing an animal's parentage and the performance of related calves, but prediction accuracy and how this is related to genetics are still uncertain.

Herring and Bertrand (2002) assessed how heritability of efficiency traits in the feedlot related to carcass traits. Feed intake and residual feed intake were moderately heritable along with fat thickness and marbling, suggesting that selection for these characteristics could improve cattle quality and efficiency. Additionally, many efficiency measures were highly correlated, implying selection for a single efficiency trait could decrease overall feed consumption and reduce feedlot costs. Feed efficiency is an important component to cattle feeding profitability (Belasco et al., 2009). However, it is one of the harder components of cattle genetics to monitor since technology to obtain individual animal feed intake is cost-prohibitive and scarce. Having complete records of parentage information is also implausible in commercial feedlot operations, thus genetic selection for feed efficiency is rarely feasible.

Genetic relationships also vary across management practices. The U.S. Meat Animal Research Center (Rios-Utrera et al., 2005) estimated heritability, genetic variance, and genetic correlations among 14 carcass traits when endpoints are determined by age, weight, or fat thickness. Modeling procedures revealed total maternal effects of the dam were small, therefore not explaining much offspring variation in carcass traits. Heritability values, in general, varied tremendously across the different endpoints. Empirically the strongest genetic traits were marbling score, retail product weight, bone weight, and actual percent retail product. Hot carcass weight, yield grade, and other measures were moderately heritable depending on the endpoint used. Conclusions were that enough variation in carcass traits exist that carcass quality could be improved through selection. However, since the magnitudes and even the signs of correlations between traits differed across endpoints, complications exist in selection when management decisions are not constant.

Many factors influence cattle quality and overall profitability, but relationships among cattle characteristics are complicated and difficult to study. To date, no industry standards exist for evaluating cow productivity based on finished offspring performance in commercial herds. This study captures two levels of cow performance evaluation. First, analysis is conducted on individual cows which have produced three or more calves where feedlot and carcass data were collected. The objective is to evaluate consistency of finished offspring performance to determine if culling and replacement decisions can be enhanced using this type of cow evaluation. Second, maternal influence is evaluated when cows are grouped by their age at the time the calf was conceived. Previous research has shown calves from cows 2-4 years of age and over 11 years of age are smaller in weaning weight than calves from 5- to 10-year-old cows (Beef Improvement Federation 2002). Knowing this, it is reasonable to expect that inferior calves at weaning also are disadvantaged throughout their lifetimes. Individual traits and overall returns are evaluated to test whether this trend continues.

Methods for Ranking Animal Performance

We employed two related analyses to evaluate cow rankings based upon repeatable calf net return performance. In particular, 1) we examined relative animal performance measures and net returns of calves retained through finishing, and 2) we evaluated how cow age relates to net returns and net return determinants.

Relative performance and net returns

Profitability is measured as a Net Return per head to the rancher for retaining ownership of a calf in the feedlot until harvest:

$$Net\ Return = (Grid\ Price \times HCW) - TCOG - Interest - Feeder\ Value \qquad (1)$$

where *Grid Price* is base selling price adjusted for quality grade and yield grade multiplied by hot carcass weight (*HCW*) to obtain gross revenue. *TCOG* is total cost of gain. *Interest* is interest cost during feeding. *Feeder Value* is the market value of the animal when placed on feed. To assess relative animal performance used to rank cows, we created a set of performance-related ratios for individual calves. Ratio calculations of *individual animal measures* for hot carcass weight (*HCW*), quality grade value (*QG*), yield grade value (*YG*), average daily gain (*ADG*), feedlot receiving weight (*InWt*), dressing percentage (*DrsPct*), and days on feed (*DOF*) were calculated for each cohort group of calves as:

$$Ratio = (Individual\ animal\ measure/Average\ for\ cohort\ group) \times 100 \qquad (2)$$

where discounts or premiums were taken from the base price to assign individual values for *QG* and *YG*.

Cohort groups were characterized by the lot number of the animal since all animals in a lot group were of the same sex, entered the feedlot on the same day, were born around a similar date, and were of similar breed. By using this contemporary grouping, calves with equal opportunities to perform are evaluated against each other to give a measure of relative performance.

Most traits in equation (2) are measured on a scale where larger values are preferred to smaller values for a given cohort set. Therefore, an animal is above average relative to its cohorts if the ratio for that performance measure is greater than 100 or below average if the ratio is less than 100. Days on feed are an exception to this rule because more days are not necessarily better or worse. The fewer days an animal is fed, the lower its feedlot costs, so an animal that gains quickly should be more profitable than an animal that gains weight slowly, all else equal. A counter argument is that the longer an animal is fed, the heavier its hot carcass weight, and therefore the higher the revenue. This is a complicated matter since cattle in this feedlot were sorted into optimal marketing times based on body traits. An animal that finishes quickly may gain backfat early, which may not be as profitable as an animal that was fed longer, achieved a higher weight, and did not gain backfat until later. These confounding factors make it difficult to analyze which are better: more or fewer days until finish. For indexing, a ratio above 100 means more days to finish than the cohort average and a ratio below 100 means fewer days to finish than average.

Feed conversion is measured as pounds of feed per pound of gain; therefore, a smaller value means less feed is needed for gain and the animal is more efficient. Because of this relationship, the feed conversion ratio (FeedConv) is calculated differently so the relationship is reversed to be consistent with other indexes where higher is preferable. The calculation for feed conversion is:

$$\textit{Ratio} = (100 - ((\textit{Individual animal measure}/\textit{Average for lot group}) \times 100)) + 100 \quad (3)$$

where a ratio above 100 is above-average (better feed conversion) and a ratio less than 100 is below-average (worse feed conversion).

Weaning weight is also included in the analysis, even though industry standards already exist for this measurement when evaluating cow performance. Weaning weight is adjusted to a 205-day reference point as follows:

$$205 - Day\ Weaning\ Wt. = \left[\left(\frac{(Weaning\ Wt. - Birth\ Wt.)}{\text{Weaning Age}}\right) \times 205\right] + Birth\ Wt. \qquad (4)$$

This 205-day weaning weight is converted to a ratio so calves are compared to their peers in the cohort group. This is accomplished in the same manner as equation 2 and is referred to as *205WeanWt.*

To compare net returns across animals in a cohort group, a difference calculation was used. Net Return is measured in dollars per head, so the difference is a dollar-per-head difference from the average of the cohorts in the lot. The calculation is:

$$\text{NR Difference} = (\text{Individual animal NR} - \text{Average NR of Cohort Group}). \quad (5)$$

The larger the NR difference, the higher the net return is for that animal relative to its cohorts.

For each cow that had sufficient calves for meaningful rankings (discussed in Data section below), a mean and standard deviation of all calves produced and retained through finishing was calculated for NR differences. Not all cows had the same number of calves, so standard errors by cow were calculated as:

$$SE\ of\ statistic\ for\ each\ cow = \frac{Standard\ Deviation\ of\ Calves\ Produced}{Square\ Root\ of\ Number\ of\ Calves} \quad (6)$$

From this, a 95% confidence interval for each cow was calculated to represent the interval expected to contain the profitability difference values of the cow's calves. This was calculated by:

$$\text{Confidence Interval} = \text{Calculated Mean of all Calves} \pm (1.96 \times SE). \quad (7)$$

The average difference value of zero was used to evaluate the performance of a cow based on her confidence interval. Zero is the overall mean of the profitability difference since a difference of zero would represent a calf that is exactly equal to the average for the cohort group. Therefore, cows that have confidence intervals above zero, contain zero, or below zero represent cows that are above average, average, or below average, respectively, for all of the calves they have produced. For example, if a cow's confidence interval had a minimum value above zero, this would be interpreted as: With 95% confidence this cow will produce calves that are above the average for the cohort group to which they belong. By taking a numerical count of all cows above average, average, and below average, the consistency of cow production can be assessed.

To evaluate the consistency of cow production, a simulation was run by randomly assigning all calves to cows and calculating confidence intervals on this simulated data set. The simulation was run one hundred times and corresponding confidence intervals and counts of above average, average, or below average cows were made. The average counts for all 100 trials were used to compare to the actual data. If actual cow production is more consistent than a random situation, there should be more cows that have above or below zero confidence intervals. Cows should be more consistently producing above or below average calves and fewer cows should be producing a mixture of each. This is a way to evaluate how meaningful or accurate cow assessments can be when lifetime performance of calves is used as the appraisal tool. A Chi-Square Goodness of Fit test is used to test for statistical significance of the observed proportions in the data varying from the random simulation.

To determine how useful having information on previous calf net return performance is for predicting individual cow offspring performance this year, regression analysis was used. In particular, the net return this year was regressed against the net return the previous year, the second time a cow had a steer calf. The third year that a cow had a steer calf, the net return that year was regressed against the average of the net returns for the previous two steer calves, and so forth for the fourth steer calf. In this way, we could assess predictability of past calf profitability for each cow on the current year's profitability. Since prices are held constant each year for calculation of net returns (as discussed below), the net returns directly reflect a combination of calf growing and finishing efficiency and grid value when harvested. High predictability of current net return for each cow relative to previous net return, would suggest considerable value in tracking returns for each cow's offspring for ranking cow value. Low predictability would indicate other facts are affecting returns for each cow's offspring that we do not have data to quantify such as the calf's sire or other external factors.

Cow age and return analysis

The second part of cow evaluation was to estimate how cow age relates to feedlot and carcass trait performance. A simple regression was performed to evaluate how cow age affects feedlot, carcass, and net return ratio measures (equations (2)-(3) and (5)). The independent variables were dummy variables for the age of the cow (with cow age of 6 years as the base) and the dependent variables were ratios of *205WeanWt, Inwt, Hotwt, DrsPct, QG, YG, FeedConv, ADG, DOF,* and *NR* differences. Each regression took the form:

$$Ratio\ or\ Difference\ Measure = \beta_0 + \beta_1(Age\ 2) + \ +\beta_2(Age\ 3) + \ \beta_3(Age\ 4) \ + \beta_4(Age\ 5) + \beta_5(Age\ 6) + \beta_6(Age\ 7) + \beta_7(Age\ 8) + \beta_8(Age\ 9) + \beta_9(Age\ 10) + \beta_{10}(Age\ 11) + \ e \qquad (8)$$

Age i (i=2, 3 …11) are dummy variables being 1 for a cow of age i and zero otherwise. There were 10 separate regressions representing the cow age relationship for each feedlot and carcass characteristic, and measure of overall return. The point of this analysis is to determine the pattern of each net return determinant across cow age.

Data

Lifetime performance measures on steers were gathered from a Mid-western ranch that retained ownership of calves through a custom feed yard every year. Data included measures of performance on 3,665 animals across 8 feedlot cohort groups, collected over a ten-year time span. Each November, one lot of steers was sent to the feedlot where they were fed out and marketed around the month of June the following summer.

For the analyses completed in this study, prices and cost were averaged across the years that data were collected to create a single price and cost scenario, and applied to all 10 years of cattle performance data. Cattle were priced using *National Weekly Direct Slaughter Cattle-Premiums and Discounts* reported by USDA Market News Service as an average of June values from 1999 to 2007. The base price was $125.35/cwt. which was based on fed cattle prices for the month of June, averaged from 1997 to 2007 for 1100-1300 pound select/choice steers, and adjusted to a dressed price at 63% (obtained from the Livestock Marketing Information Center). Feeder cattle values were $94.08/cwt., determined using Kansas average feeder prices for 600-700 weight steers in November, averaged between the years 1998 and 2006 (obtained from the Livestock Marketing Information Center).

Total cost of gain (*TCOG*) in the feedlot included feed, yardage, processing, and treatment cost. Feed costs were calculated by multiplying individual estimated feed conversion, average daily gain, and days on feed, by $0.037 dry matter dollars-per-pound feed price, which was determined based on November through June Dodge City, Kan., corn prices averaged from 1998 to 2006 obtained from the Livestock Marketing Information Center. Yardage was assumed to be $5 per head plus $0.42 per head per day on feed, which is a typical feedlot cost in the Midwestern region without feed mark-up. Processing of cattle upon arrival at the feedlot was held at $7 per head and actual animal medical treatment costs were adjusted to 2009 dollars using the Consumer Price Index. Interest, representing opportunity cost of retaining ownership until slaughter, was calculated at an 8% annual rate on the entire value of the feeder and on half the *TCOG*. With prices and costs standardized to one time period, there appeared to be no trend of increased or decreased performance throughout the years of the data.

Steers were managed individually in the feed yard using ultrasound, electronic scales, and video imaging cameras 2-3 times during their feeding period to determine an optimal time to market, thus attempting to attain every animal's fullest potential (Microbeef Technology, 2010). A marketing date was employed if an animal became too heavy, was depositing too much backfat, or marginal cost of gain exceeded marginal revenue. Animals were marketed on a grid system so an individual price was received based on carcass characteristics.

Comparisons to the cohort group using equations (2) through (5) were performed on the entire set of 3,665 steers, all of which were used in analysis of cow performance grouped by age. When individual cow evaluations were made, there had to be enough calves from each cow to evaluate consistency and make meaningful comparisons. Out of 3,665 calves, 1,337 were able to be matched with cows that had three or more calves with associated feedlot and carcass information, which equated to the evaluation of 391 cows. This is an important observation in itself. Calves on a typical ranch, even one that retains ownership through finishing, go to varying endpoints and cows need to have multiple calves going to a consistent endpoint to complete meaningful assessment of predictability.

Summary statistics for performance ratios and return differences are shown in Table 1, divided into the two sets used for individual and grouped cow analysis. Remarkable differences in performance and net returns are seen in calf cohorts. For example, the average daily gain (*ADG*) ratio had a standard deviation of 12% of the mean with a range from 34% to 150%. This means that the worst calf in a cohort had daily gain that was only 34% of the average for that group of calves, and the best had daily gain that was 50% greater than the average of the group. Similar variation is seen for *205 Wean Wt. ratio, Inwt ratio, HCW ratio*, and *DOF ratio*. This suggests that production measures reveal considerable variation is calves even from a single source.

Table 1. Summary Statistics

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
		Grouped Cow Analysis			
205WeanWt. ratio (%)	3665	100.40	12.92	49.26	178.08
ADG ratio (%)	3665	100.12	11.65	33.98	150.32
HCW ratio (%)	3665	100.41	9.51	67.53	129.28
QG ratio (%)	3665	100.07	5.20	78.41	113.75
YG ratio (%)	3665	100.00	2.62	85.43	105.00
Inwt ratio (%)	3665	100.56	10.26	48.57	144.18
FeedConv ratio (%)	3665	99.76	8.80	-4.12	135.15
DOF ratio (%)	3665	100.00	16.41	44.65	152.71
DrsPct ratio (%)	3665	100.07	3.47	80.77	117.77
NR difference ($/head)	3665	0.63	82.56	-346.41	263.30
		Subset for Individual Cow Analysis			
NR difference ($/head)	1337	5.18	81.11	-346.41	253.18

Net return differences among calves are also noteworthy. The average, by definition is right at zero for the grouped cow analysis. However, calves ranged from -$418 per head to $281 per head profit difference relative to the average calf in a cohort feeding group. For calves included in the individual cow analysis (only including calves for the 391cows that had 3 or more calves in the data set), net return is still highly variable across calves.

This indicates that calf profitability has considerable variation even for individual calves in a cohort group. Is this variation related consistently to individual cows? We seek to explore this further.

Results and Discussion

Ranking Individual Cows

In explaining the results, recognize that mean return differences of the 1,137 calf subset used for individual cow analysis is not zero; it is $5.18 per head for *NR* (Table 1), meaning this subsample of calves performed better on average than the entire group of calves retained by this ranch over the ten-year period. There could be number of reasons why this occurred, one being that calves from 2-year-old and 3-year-old cows are not included since only cows that had 3 or more calves were used here. Because of this higher mean in the subset, it would make sense that the results show more cows having above-average confidence intervals than those that have below-average confidence intervals.

This is seen in Table 2, which displays the observed confidence interval distributions of the actual data compared to the randomly simulated percentages. Chi-Square Goodness of Fit tests were performed to measure whether the observed proportions in the data varied significantly from a random situation. If they do not, then this information is of little value in making cow retention decisions. If the distributions are statistically and practically different, this suggests relative calf net return performance can be related back to the cow with predictable confidence.

Table 2. Individual Cow Net Return Distribution

Confidence Interval	Frequency	Percent	Test Percent	Difference in Percentages
Below Zero	31	7.9	7.8	0.1
Contain Zero	302	77.2	82.1	-4.9
Above Zero	58	14.8	10.1	4.8
Chi-Square Value	9.9421			
Probability	0.0069			
Degrees of Freedom	2			

Table 2 shows for *NR*, 31 of 391 cows had calves that performed statistically significantly (95% confidence) worse than average of their cohorts. Of the 391 cows, 78% had calves that did not consistently perform different from the average of their cohort groups and 14% had calves that consistently earned returns greater-than-average of their cohort groups.

NR distributions are statistically significantly different from the randomly simulated data at the 95% confidence level (Table 2). This suggests that cow performance is causing cows to be classified into each of the three categories based on their calves' lifetime performances. However, practically, the actual and randomly simulated distributions are modestly different. For example, 14% of calves actually performed statistically better than their cohort groups compared to a random number of 12%. Thus, the amount of improvement in *NR* by knowing individual cows and predicting the return consistency of their offspring in finishing does not appear to be offer large opportunities.

To assess whether knowing net returns to previous calves helps in predicting the current year's calf return (recall that prices are held constant over time, so variation in net returns in related to non-market events), we plotted each cow's current year calf net return against the previous year's return. This scatter plot for cows that had three or more steer calves in the data set is provided in Figure 1. If last year's net return was a strong predictor for this year's return we would expect to see an upward sloping trend line in the scatter plot. However, the trend line is slightly downward sloping (marginally significant slope coefficient with p-value = 0.11) and overall the scatter plot appears random. This indicates that there is little information that can be used from calf net return in one year relative to the expected return of that cow's calf the next year, even without changes in market prices. That is, individual cow's calf return performance through finishing and grid pricing appears unpredictable from one year to the next based just upon the most recent past return.

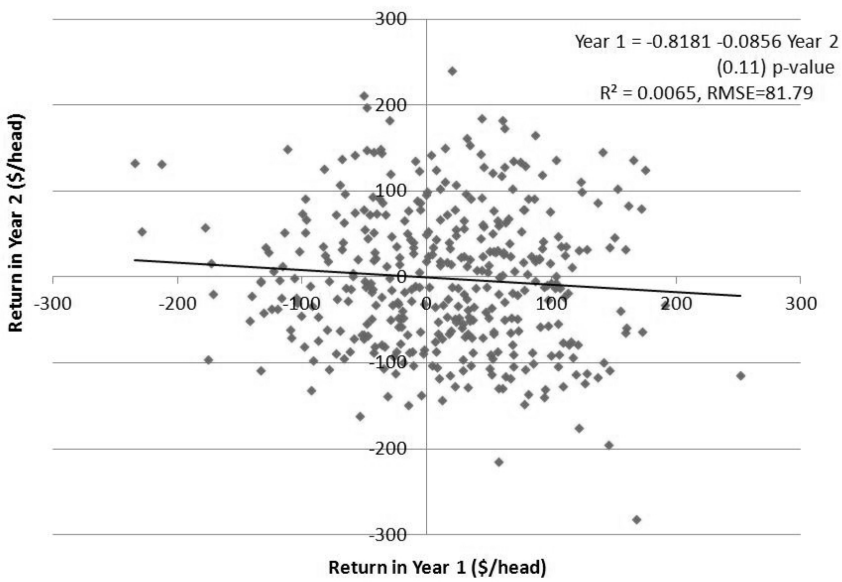

Figure 1. Scatter Plot of Return in Year 1 and Year 2 for Steer Calves (N=391)

To further evaluate, as the cow has additional calves, whether past calf performance helps predict current performance, we plotted the current calf net return against the average returns for steer calves from each cow over the previous two years of steer calves from each cow (Figure 2). If there is persistence in cow offspring performance, this may show up more strongly when multiple previous calf crops are compared to the current calf crop. The scatter plot in Figure 2 shows a positive relationship (p-value of slope = 0.03) with each dollar per head net return average from the past two calf crops increasing the current calf's return by $0.17 per head. However, the scatter plot remains mostly random implying we have not gained much in predictive power by using returns from the past two calves to predict the current calf return.

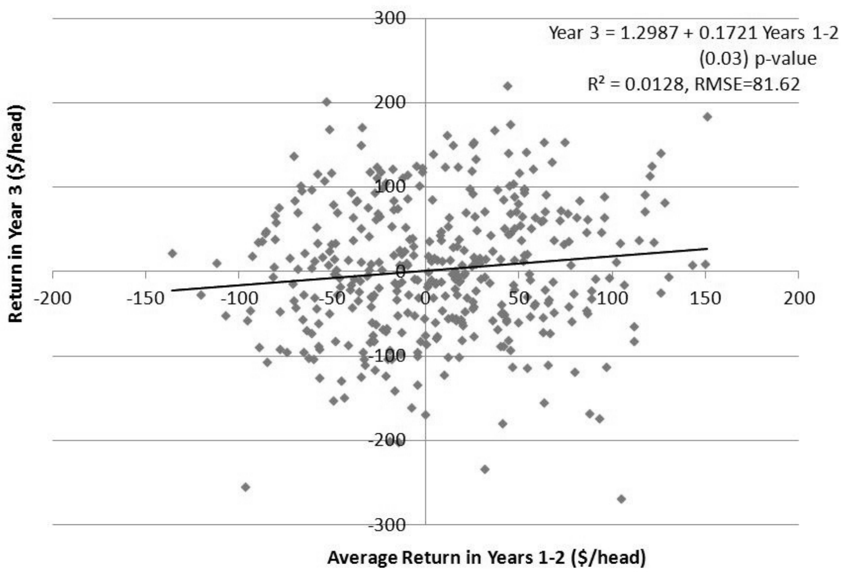

Figure 2. Scatter Plot of Return in Year 3 and Average of Returns in Years 1 and 2 for Steer Calves (N=391)

Finally, we plotted the current calf return against the average of the past three year's calves (Figure 3). Fewer calves are included in Figure 3 than in Figures 1 and 2 because fewer cows in the data set had four steer calves over the time frame. Nonetheless, the positive correlation becomes slightly stronger as one uses the average of the past three calves' net returns to predict the current year's calf return with a $1 per head increase in average return over the past three years increasing predicted current return by $0.38 per head (p-value=0.02). However, overall predictive accuracy is still low. Furthermore, by the time a cow has had three steer calves, much of her useful life is likely already behind her and the value associated with trying to rank her calf performance going forward is certainly of less marginal value than it would be for a younger cow.

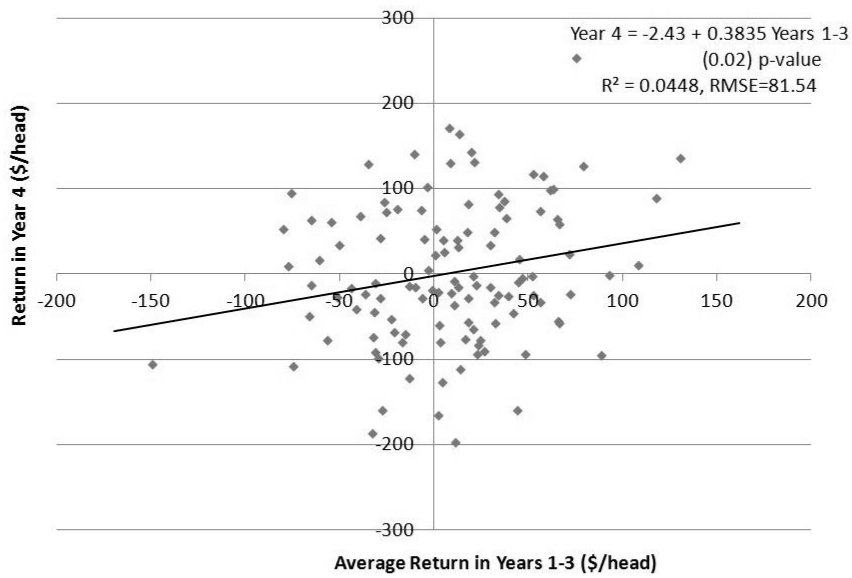

Figure 3. Scatter Plot of Return in Year 4 and Average of Returns in Years 1-3 for Steer Calves (N=116)

Implications of the distributions and scatter plots are that Net Return performance evaluations may offer fine-tuning opportunities to current culling practices but they do not appear to add major value. When deciding which cows to cull and heifers to retain, offspring performance evaluations may enhance decision-making for cows on the tails of the distribution. If deciding replacements from a group of heifers, retaining from cows in the above-average category can offer a simple way to make herd improvements. Many times managers pick the largest heifers to retain because there are no other characteristics to differentiate heifers; but, in the long-term, this creates a larger maturity-size cow with more feed requirements for maintenance. Producers should be focusing more on efficient cows that perform well reproductively, and produce efficient and quality calves. Therefore, instead of retaining heifers by size, managers can retain based on past performance of cows to differentiate. The more years of past calf performance that can be accumulated, the more predictive is that information, but likely the lower the marginal value of that information. Furthermore, there still remains a lot of random error if only past calf performance is assessed in predicting future calf performance.

When making culling decisions, below-average cows should be most highly considered. However, the actual magnitude in loss of revenue/profit in calves from below-average cows should be quantified before direct judgment can be made. Statistically, there will always be "below average" calves no matter how superior the quality of the entire herd. Because of this, there will always be cows that produce below-average calves relative to cohorts, but the losses in profit due to them need to be quantified before direct culling is performed. If heavy culling needs to be performed due to a drought or downsizing of the operation, these cows would be the best candidates after culling open, unsound, or old cows.

Grouped Cow Analysis

Table 3 displays regression results based on the entire 3,665 calves to determine the effect of cow age on feedlot and carcass performance of calves. All models exhibit low R^2 values; nevertheless, patterns in performance are seen suggesting cow age influences calf performance. The *205WeanWt* ratio model shows that calves from cows 2- to 4-years-old and 9- to 11-years-old have significantly lower weaning weight ratios than a cow that is 6 years old. This is expected since Beef Improvement Guidelines (2002) also suggest this relationship; however, this model shows weaning performance decreasing more dramatically at higher cow ages. The *Inwt* ratio model shows that cows 3- to 4-years-old and 9- to 11-years-old also have decreased performance, relative to a 6-year-old cow, at the time calves are received into the feedlot. This is also expected because calves in the same cohort group would have been back-grounded a similar amount of days, therefore calves should have the same relative performance at weaning as feedlot receiving. The exception to this is the 2-year-old cow. Since a 2-year-old cow is having its first calf, management practices are slightly different than other cows on this ranch. Two-year-old cows typically require more supervision, so they are calved an average 29 days sooner than older cows; therefore, their calves tend to be an average 34 pounds heavier at feedlot receiving. Because *205WeanWt* ratio adjusts for age of the calf, this relationship is not seen there; but with *Inwt*, ratio age is not considered so calves from 2-year-old cows appear equivalent to those from 6-year-old cows, but this is a management difference and not actual performance.

Table 3. Regression Results for Age of Cow Influence

Variable	205WeanWt ratio	Inwt ratio	Hotwt ratio	DrsPct ratio	QG ratio	YG ratio	FeedCn ratio	ADG ratio	DOF ratio	NR difference
					Parameter Estimates					
Intercept	109.21*	103.01*	100.64*	100.02*	99.71*	100.29*	99.82*	100.31*	97.86*	-9.04
Age 2	-18.28*	0.93	0.96	-0.20	1.94*	-0.41*	-3.55*	-2.34*	3.89*	7.69
Age 3	-10.16*	-7.27*	-0.90	0.19	-0.47	-0.20	2.54*	1.15	4.07*	22.56*
Age 4	-5.95*	-3.88*	0.16	0.26	-0.34	0.01	1.58*	1.19	2.47*	16.06*
Age 5	-1.72	-1.38	-0.75	0.07	-0.46	-0.14	0.61	0.75	-0.89	-2.14
Age 7	1.14	0.27	-0.59	0.39	0.29	-0.09	0.25	-0.28	-2.37	-0.07
Age 8	-1.14	-0.95	-1.19	-0.05	-0.06	-0.21	0.36	-0.26	-1.17	-7.06
Age 9	-2.51*	-3.20*	-3.53*	-0.08	0.38	0.03	-0.44	-1.61	-2.24	-1.13
Age 10	-6.18*	-5.85*	-1.72	0.17	0.33	-0.24	-0.54	0.73	1.79	14.59
Age 11	-10.15*	-8.64*	-4.73*	-1.71*	1.22	-0.29	-0.07	-0.38	3.95	8.10
R^2	0.28	0.10	0.01	0.00	0.04	0.00	0.07	0.02	0.02	0.01
RMSE	10.94	9.75	9.46	3.47	5.10	2.62	8.49	11.57	16.26	82.12

* indicates statistically different from zero at the .05 level
* N=3,665 in all regression models

The *Hotwt* ratio model shows that hot carcass weight is unaffected by cow age except in later years. Nine-year-old and 11-year-old cows show significantly decreased performance in their calves when measured by hot carcass weight, which will have a great effect on revenue received for these calves. Dressing percentage also drops significantly in the 11-year-old cow, shown in the *DrsPct* ratio model, which also will lead to decrease profitability in calves from these cows.

Measures of carcass quality appear less influenced by cow age when looking at *QG* ratio and *YG* ratio models. The only significant difference from the performance of 6-year-old cows is 2-year-old cows which tend to have slightly better quality grade and slightly worse yield grade. While performance is not largely different, it highlights another slight management difference and a possible performance relationship. Two-year-old cows on this ranch are bred with artificial insemination (AI) instead of herd bulls, which are used in older cows. The genetics of the AI bulls could be superior to herd bulls which could lead to better quality grade and yield grade performance. Another reason for this relationship could also be that calves from 2-year-old cows tend to gain slower and take longer days to finish, which could be a contributor to less external body fat deposition and more lean muscle tissue. Models of *FeedConv* ratio, *ADG* ratio, and *DOF* ratio show significantly decreased performance in the 2-year-old cow from the 6-year-old cow base. Two-year-old cows have inferior gain performance in their calves most likely because 2-year-old cows typically produce less milk and have less mothering ability. Calves from 2-year-old cows appear disadvantaged in the feedlot, yet the decreased performance is seen only in the first year. Three-year-old and 4-year-old cows show significantly different performance, with better feed conversion than 6-year-old cows, but longer days on feed. Because these calves came into the feedlot at a relatively lighter weight, even with superior gain performance they may take longer to finish.

All of these characteristics can be brought together when looking at the net return of the calves across cow age. The *NR* difference model shows significantly better performance in 3-year-old and 4-year-old cows. Three-year-old cows bring $22.56 per head better return than the average of the feedlot groups, while 4-year-old cows bring $16.06 per head better. These are economically important amounts in an industry where profit margins are small. No other cow age groups have significant net return differences from average feedlot performance.

Summary

Making judgments on cow performance based on offspring's traits are complicated and inaccurate due to environment, management, bull genetics, and other external factors. Even when accounting for all variation possible, without knowing the genetics of the bull it is hard to evaluate the productive ability of a cow. This study used two subsets of data collected from a ranch that individually identified cows and associated offspring, retained ownership through a commercial feed yard, and marketed all fed cattle on a grid system. Cow evaluations were performed on individuals with three or more steer calves having lifetime performance data, and also on groups of cows by cow age.

Individual cow offspring performance evaluations can be performed and used to enhance management decisions. However, offspring performance appears to not be highly predictable, in general, based on the information most commercial cow producers are likely to collect, even with individual cow and calf identification tracking. Thus, performance evaluations based on typical information collected by cow-calf producers are likely only useful together with other information used to make culling decisions such as physical characteristics, age, and/or health status of the cow.

Evaluations performed in a grouped setting also give insight into which calf characteristics are fluctuating over cow ages and why returns may decrease in calves from older cows. Weaning weight and feedlot receiving weight are less for young cows and very old cows which lead to decreased returns. Very old cows also show decreased calf performance in hot carcass weight and dressing percentage while younger cows show deceased performance in calf feed conversion and average daily gain, which leads to more days on feed.

This study reveals that more research is needed in the area of individual cow identification, offspring tracking, and ranking of cow value to the operation. Data in this area is becoming increasingly available, and more analysis needs to be completed to reinforce discovered relationships.

References

Beef Improvement Federation. (2002). *Guidelines for Uniform Beef Improvement Programs*. http://www.beefimprovement.org/library/06guidelines.pdf Accessed June 2009.

Belasco, E.J., M.R. Taylor, B.K. Goodwin, and T.C. Schroeder. (2009). "Probabilistic Models of Yield, Price, and Revenue Risks for Fed Cattle Production." *Journal of Agricultural and Applied Economics* 41, 1:91-105.

CME Group. *Daily Settlements for Corn Futures*. (2009, June). http://www.cmegroup.cm/trading/commodities/grain-and-oilseed/corn.html[Retrieved July 1, 2009].CME Group. Daily Settlements for Live Cattle Futures. (2009, June). http://www.cmegroup.com/trading/commodities/livestock/live-cattle.html [Retrieved July 1, 2009].

Forristall, C., G.J. May, and J.D. Lawrence. (2002). "Assessing the Cost of Beef Quality." Paper presented at NCR-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management. Held in St. Louis, Mo., April 23-24, 2002.

Herring, W.O., and J.K. Bertrand. (2002). "Multi-Trait Prediction of Feed Conversion in Feedlot Cattle." Beef Improvement Federation Annual Meeting. Held in Omaha, NE. July 10, 2002.

Koontz, S.R., D.L. Hoag, J.R. Brethour, J. Walker. (2008). "Production Inefficiency in Fed Cattle Marketing and the Value of Sorting Pens into Alternative Marketing Groups Using Ultrasound Technology." *Journal of Agricultural and Applied Economics* 40,3:895-912.

Livestock Marketing Information Center. (2010). Lakewood, Colo. Available at: http://www.lmic.info [Retrieved June 1, 2010].

Microbeef Technologies. (2010). Amarillo, Texas. Available at: http://www.microbeef.com/ [Retrieved June 1, 2010].National Animal Health Monitoring System *Beef 2007-08, Part III: Changes in the U.S. Beef Cow-calf Industry, 1993-2008*. (2008). Fort Collins, Colo.: Animal and Plant Health Inspection Service.

Rios-Utrera, A., L.V. Cundiff, K.E. Gregory, R.M. Koch, M.E. Dikeman, M. Koohmaraie, and L.D. Van Vleck. (2005). "Genetic Analysis of Carcass Traits of Steers adjusted to age, weight, or fat thickness slaughter endpoints." *Journal of Animal Science* 83:764-76.

U.S. Department of Agriculture Market News Service. (2009). *National Weekly Direct Slaughter Cattle-Premiums and Discounts*. www.ams.usda.gov/mnreports/lm_ct155.txt [Retrieved June 1, 2009].

U.S. Department of Agriculture Market News Service. (2009). *Oklahoma National Stockyards Weekly Narrative Cattle Summary of Week of June 01, 2009*. http://search.ams.usda.gov/mndms/2009/06/KO_LS15520090603.TXT [Retrieved June 1, 2009].

Walburger, A., and D.H. Crews. (2004). "Improving Market Selection for Fed Beef Cattle: The Value of Real-Time Ultrasound and Relations Data." *Canadian Journal of Agricultural Economics* 52:1-16.