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EVALUATION OF CALF OUTPUT AND PROGENY CARCASS DATA OF COMMERCIAL BEEF BULLS

A.L. Van Eenennaam†, D.J. Drake*†, and D.J.Garrick‡
†University of California, Davis, CA and ‡Iowa State University, Ames, IA

ABSTRACT: Multi-sire breeding pastures preclude visual paternity identification; limiting opportunities for evaluation of sire prolificacy or progeny performance. Furthermore, few producers retrospectively receive individual carcass data resulting from the harvesting of their calves. As a result, commercial cow-calf producers have little opportunity to evaluate the performance of their herd bulls. In this study, DNA-based testing was used to assign paternity to a cohort of 205 steers from a cowherd bred to 19 registered Angus bulls that had passed a breeding soundness exam. Carcass data was collected following a feedlot phase where all steers were fed as a contemporary group. Gross income was assigned to carcasses based on carcass weight and a $2.87/kg carcass value, adjusted by the American Angus Association grid. One hundred and eighty calves were assigned to single sires (87.8 %), and all sires were excluded from the remaining 25 (12.2%) animals. The number of steer calves per bull varied from 0 to 22. The two highest output bulls accounted for nearly a quarter of all the calves assigned. Carcass data showed significant differences between sires for carcass weight, yield grade, marbling score, fat thickness, grid value, and value per carcass. Breed association EPDs for these young bulls were low accuracy, about 0.05 for carcass traits and 0.3 for ultrasound carcass traits and some were poorly correlated with observed carcass measurements: reflecting the shortcomings of the low accuracy EPDs that are associated with young sires. The average carcass value of steers from different sires varied by as much as $160. The total value of steer calves produced showed large variation between sires, ranging from $0 to $21,098. Calf output was more important than average carcass value in determining the gross income per sire. The five most prolific bulls contributed half of the total income from the steer calf crop. This work demonstrates the need for accurate tools for early decisions regarding bull selection.

Key Words: parentage, bull, evaluation, EPD

Introduction

Many beef cattle are produced in multi-sire breeding pastures limiting opportunities for visual sire identification and genetic evaluation. Single bull breeding pastures can provide paternity but are not typically used due to extensive land use, inadequate fences, risk of bull failure, and the increased labor costs associated with pasture subdivisions. DNA-testing offers an approach to assign parentage without changing production practices (Dodds et al., 2005), and provided the tests are sufficiently powerful they can even be used to assign paternity in large multi-sire groups (Van Eenennaam et al., 2007). Multi-sire breeding pastures have shown large variation in calf output (number of calves) by individual sires (DeNise, 1999; Holroyd et al., 2002; Van Eenennaam et al., 2007). Age of bull, breed, fertility-associated antigen status, sperm motility, and morphology, and social dominance have been associated with variation in calf output in multi-sired herds (Whitworth et al., 2003). In the absence of progeny information, genetic evaluation of herd bulls has been limited to that derived from their pedigree. Although breed-based EPDs are the most effective selection tool currently available for yearling bulls, the low accuracy of young sire evaluations means that considerable genetic variation remains among bulls with similar EPD profiles. DNA-testing allows progeny testing to be undertaken on commercial bulls and offers an approach to develop on-ranch or "commercial ranch" genetic evaluations of herd bulls based on the performance of their offspring under field conditions. Such evaluations may help producers identify bulls whose progeny perform well in their ranch environment. Tracking the performance of individual offspring through processing and grading further presents an opportunity to improve the accuracy of carcass trait genetic evaluations for herd bulls. Genetic evaluations for beef carcass traits have not been reported from multi-sire breeding herds. The objective of this work was to use parentage assigned from DNA markers to determine calf output, progeny carcass trait performance, and gross carcass value derived from commercial sires in multi-sired breeding pastures. Additionally, commercial carcass trait genetic evaluations were developed and compared to the low accuracy pedigree-based genetic evaluations typically associated with yearling bulls.

Material and Methods

Animals and ranch operation. This study was conducted on a commercial farm using animals that were owned by the cooperator and standard animal husbandry practices were employed. Nineteen bulls registered with the American Angus Association (**AAA**) were randomly assigned to three multi-sire breeding pastures with mature cows. All bulls were in good body condition and had passed a breeding soundness examination (**BSE**) by a licensed veterinarian prior to the breeding season. Bulls were assigned to achieve approximately a 25:1 female:bull ratio. Injuries and fighting, as well as changes in body condition of bulls, contributed to management decisions to move bulls among breeding groups to maintain an approximate 25:1 ratio throughout the breeding season. A single Angus AI sire selected for calving ease was used to breed a group of first-calf heifers. Calves were born between 1/4/06-3/3/06 and steers were shipped and fed together on a commercial feedlot in California. Steers were on feed for 149 days and group performance was 1.29 kg/d. Individual carcass data was obtained by a USDA grader. Gross income was derived for individual carcasses based on weight and a $2.87/kg carcass value adjusted by the AAA grid. Partial assumptions of this grid are: Choice-Select spread $11.00, Prime premium $8.00, Standard discount $-15.00, YG 1 premium $3.00, YG 2 premium $1.50, YG 4 & 5 discount -$25.00.

DNA collection. Tail hair samples were obtained from the 19 natural service sires and their steer progeny to obtain DNA for parentage determination. A semen straw was used to obtain DNA from the one AI sire. No DNA was obtained from the dams. Microsatellite analysis and sire/calf matching was conducted at the UC Davis Veterinary Genetics Laboratory as described by Van Eenennaam et al. (2007).

Data analysis. Carcass traits and values were analyzed by ANOVA as a randomized design with sire as the class variable. Carcass weight was used as a covariate. Contrasts were used to separate groups of bulls for mean comparisons. All statistical procedures were conducted in the General Linear Model module of Systat 11. Genetic evaluation of carcass traits from the steer progeny of 17 herd bulls and the AI sire was carried out using a sire model equation y = m+Zu+e where y represented the dependent variable, m was the mean, u was a vector of direct sire progeny differences, Z was an incidence matrix relating calves to their sires, and e was a vector of residuals. The resulting mixed model equations were solved directly, and BIF accuracies were computed from diagonal elements of the inverse coefficient matrix assuming a heritability (h^2) of 0.25. Spearman's rank correlation was used to compare commercial ranch and AAA EPD rank.

Results and Discussion

Calves were either assigned to a single sire (n=180) or were excluded from all sire candidates (n=25). Large differences in steer calf output (Figure 1), ranging from 0 to 22 steer calves per bull, were observed. Age was associated (P <0.01) with prolificacy, and no progeny were assigned to the two yearling bulls involved in this study.

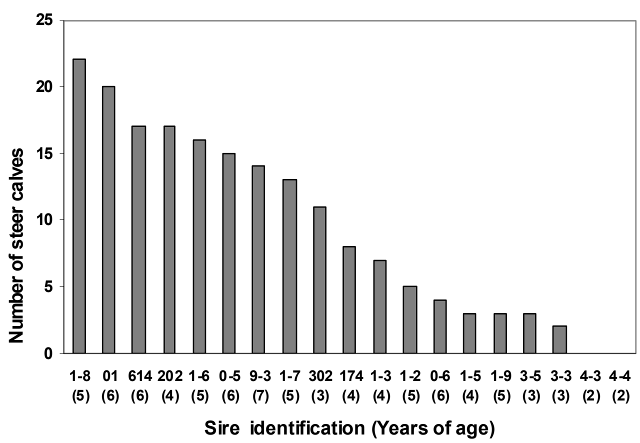

Figure 1. Number of steer calves assigned to each herd sire present in multi-sire breeding pastures as determined by microsatellite analysis of DNA from progeny and sires.

Sire differences (Table 1) were found for mean carcass weight, yield grade, fat thickness, marbling score, grid value, and mean value per carcass, but not for ribeye area (P=0.22). Carcass weight was a significant covariate for all carcass traits except grid value. When adjusted for carcass weight, sire remained significant for value per carcass, fat thickness, marbling score, yield grade and grid value. There was a sire effect (P<0.05) on mean carcass value which ranged from $798 to $958, a difference of $160 per head (Figure 2). None of the 16 progeny of the sire with the highest mean carcass value ('1-6') had a marbling grade of Slight or less, whereas 85% (17/20) of the progeny of sire '01' graded Slight or less. This information is not typically relayed to commercial cow-calf producers, and although it impacts the profitability of the feedlot sector, it is only of direct economic relevance to producers who retain ownership of their cattle or receive some premium for product quality.

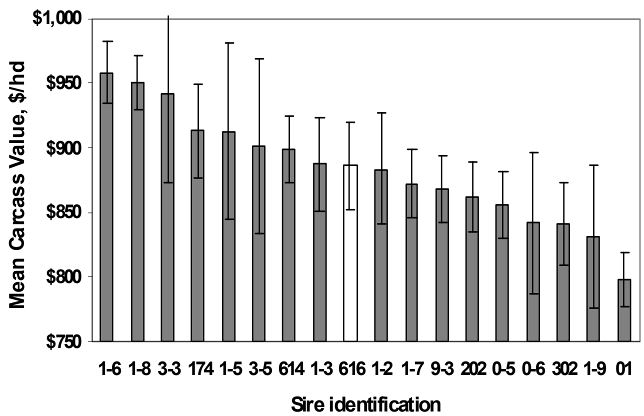

Figure 2. Mean value of carcasses (SEM) derived from steer calves assigned to herd sires in multi-sire breeding pastures. The white bar indicates the AI bull.

The total gross value of steer carcasses produced showed large variation between sires, ranging from $0 to $21,098 (Figure 3). In aggregate, the top five bulls produced nearly 50 percent of the gross income derived from the steer calf crop. The bull with the lowest mean carcass value ('01') was ranked second in terms of gross carcass value due to his high calf output.

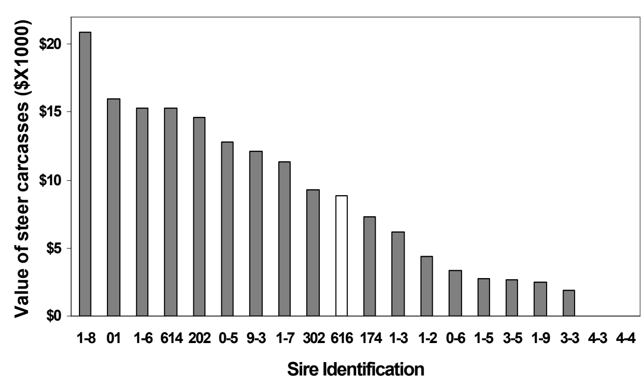

Figure 3. Total gross value of carcasses from steer calves assigned to herd sires in multi-sire breeding pastures. The white bar indicates the AI bull.

Commercial ranch EPDs were calculated for carcass weight (CARCASS), marbling score (MARBLING), ribeye area (REA), rib fat thickness measurement (FAT), and AAA grid value (AAAGRID) for the 17 herd bulls that had carcass data (Table 2). The BIF accuracy for the commercial ranch EPDs ranged from 0.06 for bulls with only 2 phenotyped progeny, to 0.35 for the bull with 21 phenotyped progeny.

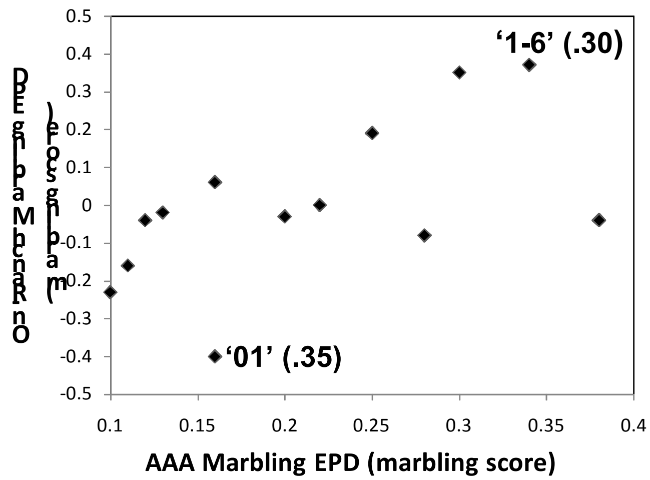

Figure 4. Commercial ranch marbling EPD versus American Angus Association (AAA) EPD for commercial Angus sires. The bulls with the highest and lowest commercial ranch EPDs had 16 and 20 phenotyped steer progeny, respectively. The BIF accuracy of the commercial ranch EPD for these two bulls is shown in brackets (assuming heritability=0.25).

The rank order of the bulls using the commercial ranch EPDs was compared to those based on AAA EPDs. Rank order correlations of carcass traits ranged between 0.37 and 0.47 except for carcass weight which was lower (0.10), and fat thickness which had a negative correlation (Table 3).

Table 3. Spearman rank order correlations between AAA and commercial ranch EPDs

Commercial ranch EPD: AAA EPD	n	Spearman Rank Order Correlation
CARCASS: CARCASS	14	0.10
MARBLING:MARBLING	14	0.43
MARBLING:IMF	17	0.37
REA:REA	14	0.47
REA:ultrasoundREA	17	0.38
FAT:FAT	14	- 0.20
FAT:ultrasoundFAT	17	0.47
AAAGRID:AAAGRID	14	0.37

Most natural service bull-buying decisions are made using relatively low accuracy EPDs. The use of DNA-tests to assign parentage gives commercial cow-calf producers the opportunity to develop commercial ranch EPDs for any trait that is routinely measured on their calves. Culling decisions can then be informed by both realized calf output and EPDs developed under individual commercial ranch conditions.

Large variation in bull output was observed in this study and greatly affected the gross income derived from each bull. Other studies have shown bull output to be moderately repeatable across years providing the composition of bull mating groups remain relatively similar (DeNise, 1999; Holroyd et al., 2002). Van Eenennaam et al. (2007) reported that young bulls often sired no progeny when run in a multi-sire group with mature bulls. Given the obvious importance of calf output on bull profitability, and the fact that years of service has a significant effect on the return to investment of developing commercial ranch EPDs (Weaber, 2004), using fewer total bulls while managing young bulls as a separate breeding group would seem to be a common-sense practice with high potential for economic return.

If cow-calf producers retain ownership of their cattle or receive product quality premiums, then carcass attributes become economically relevant and should factor into selection decisions. The commercial EPDs developed in this project ranked some bulls quite differently to the rank derived from low accuracy carcass trait EPDs based on pedigree indices. Further economic analysis is needed to determine if the benefit derived from making improved selection decisions based on commercial ranch EPDs, outweighs the additional expenses involved with genotyping and collection of progeny performance data.

Acknowledgements

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Table 1. Mean value and standard deviations of carcass traits of progeny groups for herd sires

Sire	n	Carcass weight (kg)	SD	YG	SD	Marbling score [a]	SD	Rib eye area (cm^2)	SD	Fat Depth (mm)	SD	Grid Value ($)	SD	Value per carcass ($)	SD
1-6	16	339	7	2.9	0.2	5.7	0.2	83.9	1.9	13.4	1.1	-1.86	1.84	958	24
1-8	21	344	6	3.0	0.1	5.5	0.2	82.7	1.6	13.1	1.0	-4.86	1.60	951	21
3-3	2	324	21	2.3	0.4	5.5	0.6	84.2	5.3	9.1	3.2	1.78	5.20	941	68
174	7	320	11	3.0	0.2	6.1	0.3	75.4	2.9	11.8	1.7	-0.76	2.78	913	36
1-5	2	360	21	3.5	0.4	4.6	0.6	85.5	5.3	18.3	3.2	-15.20	5.20	913	68
3-5	2	326	21	2.0	0.4	4.7	0.6	84.2	5.3	6.1	3.2	-5.15	5.20	901	68
614	14	329	8	2.4	0.2	5.0	0.2	79.5	2.0	7.6	1.2	-6.16	1.96	899	26
1-3	7	342	11	2.8	0.2	4.9	0.3	80.6	2.9	11.5	1.7	-11.57	2.78	887	36
616[b]	8	326	10	3.1	0.2	5.5	0.3	79.9	2.7	14.5	1.6	-7.16	2.60	886	34
1-2	5	323	13	3.0	0.3	4.9	0.4	78.1	3.4	12.4	2.0	-6.11	3.29	884	43
1-7	13	321	8	2.7	0.2	5.0	0.2	78.8	2.1	11.1	1.2	-6.76	2.04	872	27
9-3	14	340	8	3.2	0.2	4.7	0.2	78.0	2.0	12.9	1.2	-14.38	1.96	868	26
202	12	326	8	2.9	0.2	4.7	0.2	78.6	2.2	11.9	1.3	-10.04	2.12	862	28
0-5	14	329	8	3.1	0.2	4.5	0.2	77.2	2.0	12.9	1.2	-12.00	1.96	856	26
0-6	3	340	17	3.2	0.3	4.7	0.5	78.5	4.4	13.2	2.6	-17.98	4.24	842	55
302	9	306	10	2.8	0.2	4.9	0.3	74.1	2.5	11.1	1.5	-5.42	2.45	841	32
1-9	3	308	17	2.2	0.3	4.5	0.5	76.8	4.4	6.8	2.6	-7.67	4.24	831	55
01	20	304	7	2.1	0.1	4.3	0.2	78.6	1.7	6.8	1.0	-10.70	1.64	798	21
P [c]		0.006		<.0001		<.0001		0.22		<.0001		<.0001		0.0013	

[a] Marbling score: 4.0=Slight- (Select-), 5.0=Small- (Choice-), 6.0=Modest- (Choice).
[b] A.I. sire.
[c] Test of sire effect within column.

Table 2. Commercial ranch and EPDs and BIF accuracies (ACC) for 17 registered Angus herd bulls derived from carcass records on a single contemporary group containing 2 to 21 steer progeny per sire, and American Angus Association carcass EPDs and ACC.

	Commercial ranch				American Angus Association						
	EPD		ACC		EPD			ACC			
	min	max	min	max	min	max	mean	min	max	mean	Percentile[a]
CARCASS	- 30	13	0.06	0.35	-2	13	4.29	0.05	0.05	0.05	50
MARBLING	-0.4	0.37	0.06	0.35	0.06	0.38	0.21	0.05	0.05	0.05	40
REA	-0.2	0.35	0.06	0.35	0.02	0.36	0.16	0.05	0.05	0.05	47
FAT	-0.1	0.5	0.06	0.35	-0.02	0.03	0	0.05	0.05	0.05	56
AAA GRID	-3.16	3.08	0.06	0.35	12.3	25.2	17.8	--	--	--	31
ultrasoundREA	--	--			-0.1	0.52	0.18	0.19	0.37	0.32	60
IMF	--	--			0.01	0.31	0.18	0.17	0.38	0.30	30
ultrasoundFAT	--	--			-0.02	0.02	0	0.20	0.39	0.33	48

[a] Average EPD percentile compared to current Angus bulls (http://www.angussiresearch.com/brekdown.html?epd_parent_ct=1).