

Growth Performance, Carcass Characteristics, and Profitability of Steers Sired by Terminal vs. Maternal Bulls

B. A. Schneider, J. D. Tatum, S. L. Gruber, D. N. Schutz, D. W. Couch, T. E. Engle, R. M. Enns, and T. G. Field

SUMMARY

Steer progeny ($n = 80$) produced by mating British crossbred females to one of three terminal (Charolais) sires or one of five maternal (Angus or Red Angus-Composite) sires were evaluated from birth to harvest to compare the effects of sire type (terminal vs. maternal) on growth performance, carcass characteristics, and net return per head. Steers sired by terminal bulls were heavier ($P < 0.05$) at most stages of production from birth to harvest, and grew faster ($P < 0.05$) from birth to weaning compared with steers sired by maternal bulls. Feed intake was greater ($P < 0.05$) for terminal-cross steers, but feed conversion and cost of gain during finishing were not affected by sire type. Carcasses of steers sired by terminal bulls were heavier ($P < 0.05$) than carcasses from steers sired by maternal sires, however, carcass grade traits did not differ between the two groups. Profitability of the two groups was compared using two different marketing scenarios. In the first scenario, which simulated selling calves at weaning, progeny of terminal sires would have generated more ($P < 0.05$) gross revenue and \$39.52 more net return per head than did calves sired by maternal bulls. In the second scenario, which involved retained ownership through harvest, terminal-cross calves generated more ($P < 0.05$) gross revenue per head than did maternal-cross calves and returned an average of \$83.66 more net revenue per head than did maternal-cross calves.

Key Words: (cattle, beef, carcass, growth, crossbreeding, profit).

INTRODUCTION

The cowherd at the Colorado State University Eastern Colorado Research Center (ECRC), near Akron, CO, is comprised of approximately 250 crossbred beef females. For the past several years, sire selection has emphasized maternal traits and involved the use of Red Angus, Angus, Polled Hereford, and Red Angus-Composite (Red Angus \times Hereford \times Simmental \times Gelbvieh) sires. The operation traditionally has produced its own crossbred replacement females and retained ownership of steer calves and heifers not selected as replacements, through finishing, marketing finished cattle directly to nearby commercial beef packing firms.

In 2002, the managers at ECRC began a transition to a terminal-cross breeding program. The program involves the purchase and subsequent development of replacement females. Mature cows are mated to terminal sires, selected for growth and carcass performance, and resulting progeny, both steers and heifers, are finished for direct marketing.

A long-term research objective at ECRC is to evaluate the effects of various terminal-sire genetic inputs on growth performance, carcass value, and herd profitability. The 2003 ECRC calf-crop was the last to include calves representing both breeding programs (i.e., terminal and maternal). Correspondingly, this trial was conducted to provide benchmark performance information for the purpose of measuring initial and ongoing impacts of terminal-sire genetic inputs into the breeding system at ECRC.

MATERIALS and METHODS

Steer progeny ($n = 80$) of eight different bulls were used to compare the effects of sire type (terminal vs.

maternal) on growth performance, carcass characteristics, and net return per head. Terminal sires included three Charolais bulls, while maternal sires used for the study included two Red Angus-Composite bulls and three Angus bulls. Terminal and maternal sires were mated to British-type crossbred females (with a predominance of Red Angus, Angus, and Hereford influence) to produce forty steer calves of each type. Heifer calves sired by maternal bulls were developed as replacement females, which prevented comparison of terminal and maternal type heifers. The cowherd was divided into two separate breeding groups — first-calf heifers and mature cows. Females were synchronized and mass mated via a single cycle of artificial insemination (AI). Following AI, “clean-up” bulls were used in single-breed breeding pastures (one or two bulls per pasture) for approximately 90-d. First-calf heifers were mated to maternal bulls (both AI and clean-up) to minimize dystocia. Mature cows (ages three years or older) were mated, via AI, to a terminal sire; however, clean-up bulls of both types were used for mature cows. The breeding scheme used to produce calves for this study resulted in partial confounding of sire type with age of dam. Calves produced by two-year-old dams ($n = 15$) were all sired by maternal bulls. Of the calves produced by dams three-years old or older, ($n = 65$), forty calves were sired by terminal bulls and twenty-five calves were sired by maternal bulls.

Calves were born between 23-February and 26-May, 2003 and, all except two calves were born during the first 70 days of the calving period. Individual birth weights were recorded and male calves were castrated within 24 hours of birth. Weaning occurred in early October at an average age of 186 days. Individual weaning weights were recorded, and the calves were subsequently transported to the CSU research feedlot, located at the Agricultural Research, Education and Development Center (ARDEC) northeast of Fort Collins, CO.

Following a 70-day growing period, the steers were weighed, implanted with implants containing 200 mg progesterone and 20 mg estradiol benzoate, and allocated, by weight and sire type, to 10-head replicated pens (four pen replicates per type) for finishing. At 58 days after receiving the first implant, steers were weighed individually and re-implanted with implants containing 120 mg trenbolone acetate and 24 mg 17- β estradiol. Steers were fed a steam flaked corn-based final finishing diet (1.02 Mcal/lb NE_m, 0.69 Mcal/lb NE_g, and 13.47% CP dry matter basis). These steers were involved in another research trial in which four pens of cattle (two pens per sire type) were supplemented with a feed additive for a brief period during finishing. The remaining four pens served as paired, negative controls.

Daily feed consumption for each pen of cattle was monitored throughout the feedlot phase of the study; however, all other traits were recorded for individual animals. To permit calculation of feeding costs on an individual-animal basis, individual feed consumption was estimated using the following prediction equation developed by the National Research Council (NRC, 2000): NE_m intake (Mcal/day) = SBW (shrunk body weight)^{0.75} * (0.2435 * NE_m - 0.0466 * NE_m² - 0.0869). Daily dry matter intake (DDMI) was then calculated by dividing total NE_m intake (Mcal/day) by the dietary NE_m concentration (Mcal/kg). Aggregated values for predicted individual animal intake within a pen and actual dry matter intake consumption figures for pens were very similar.

Individual final live weights were obtained before feeding on the day before harvest. Harvest dates were chosen to coincide with an estimated U.S. Choice quality grade endpoint. Steers (two pens of each type; terminal vs. maternal) were harvested on 24-May and 15-June, 2003 at a commercial processing facility using conventional, humane procedures. After a 36-hour chill, a USDA grading supervisor assigned scores for

marbling and lean maturity to each carcass and ribeye area measurements were obtained using the Computer Vision System™ (Research Management Systems, Inc.). A two-member panel of trained evaluators recorded measurements or estimates of adjusted fat thickness, hot carcass weight, percentage kidney, pelvic and heart (KPH) fat, and skeletal maturity. Official quality and yield grades for each carcass, were assigned by USDA grading supervisors. Carcasses were priced individually using the Gelbvieh Alliance "Muscle" grid (base carcass price = \$136.43/cwt; Choice grade base = 53.5%; and Choice/Select spread = \$19.22/cwt) and actual prices received for the cattle were used to calculate gross return per head.

Costs of production from birth to weaning were estimated using the 5-year average Standard Performance Analysis (SPA) data for Northwest Kansas, representing cow-calf operators who sold calves at weaning (KSU, 2003). The cost estimate used for our analysis was \$414.41 per cow.

Costs accrued during the feedlot phase of production were calculated using predicted individual feed costs (\$0.08/lb, dry matter basis) plus actual costs for yardage (daily charge of \$0.40 per head), processing/chute fees (\$6.00 per head), and average veterinary expenses per animal (\$3.50 per head). Veterinary expenses were similar for steers sired by terminal vs. maternal sires.

Each calf was valued at weaning using U.S. average October 3, 2003 feeder calf price quotes reported by Cattle-Fax and the animal's actual weaning weight. An estimate of net return, as if the calf had been sold at weaning, was calculated by subtracting estimated costs of production from birth to weaning from each animal's calculated market value at weaning.

Estimates of net return, representing a retained-ownership program, also were computed by subtracting estimated total costs of production from birth to harvest from the gross return per head (calculated

using actual carcass prices and carcass weights).

Data were analyzed using least squares mixed model procedures of SAS (Cary, NC). Statistical models for birth and weaning traits included the fixed effects of sire type and dam age class (BIF, 2004), along with the random effect of sire nested within sire type. Models for weaning traits also included age of calf as a covariate. Statistical models for post-weaning traits (growth performance during finishing and carcass traits) included fixed effects of sire type and dam age class and the random effect of sire nested within sire type. When appropriate, statistical models also included fixed effects of treatment (feed additive) and treatment \times sire type. Dam age class, treatment, and treatment \times sire type had no effect ($P > .05$) on post-weaning traits. Correspondingly, all post-weaning traits were analyzed using reduced models that included the fixed effect of sire type and the random effect of sire nested within sire type. Comparisons of frequencies for specific carcass quality and yield grade categories were tested for significance using Chi-Square tests of independence. All comparisons were tested using a comparisonwise significance level of 0.05.

RESULTS and DISCUSSION

Least squares means comparing birth weight and growth performance of steers sired by terminal vs. maternal bulls are presented in Table 1. Despite a mean difference ($P = 0.1554$) in birth weight of 8.7 pounds (Table 1), no difference in calving ease (data not presented) was observed for terminal vs. maternal sires. Steers sired by terminal bulls were heavier at weaning and gained more rapidly from birth to weaning compared with steers sired by maternal bulls (Table 1). Steers sired by terminal bulls also were heavier at the beginning of the finishing period and had heavier finished live weights compared with steers produced by maternal sires

(Table 1). Steers produced by terminal sires consumed more feed during finishing; however, feed conversion (F:G) and cost of gain (\$/lb), during finishing, did not differ between the two groups (Table 1).

Least squares means for carcass traits are presented in Table 2. Cattle representing the two sire types were compared at nearly identical quality grade endpoints in this study. Mean marbling scores and the percentage of carcasses grading Choice or higher were similar for both groups (Table 2). Carcasses of steers sired by terminal bulls were heavier than carcasses of maternal-cross steers, however, the two groups had similar mean values for fat thickness, ribeye area, and percentage of KPH fat (Table 2). Calculated mean yield grades for the two groups did not differ, but there was a tendency ($P = 0.0704$) for steers sired by terminal bulls to produce more YG-1 and YG-2 carcasses. Maternal-type steers, produced two YG-4 carcasses (5%) vs. zero YG-4 carcasses for terminal-type steers (Table 2); however, this difference was not statistically significant. None of the carcasses, produced by steers in either group, received discounts for carcass weights that were too heavy or too light, or for quality grades of Standard or lower (i.e., “no roll” discount).

Profitability of steers produced by terminal vs. maternal sires was compared using two marketing scenarios (Table 3). In the first scenario, which simulated selling calves at weaning on October 3, 2003; steers sired by terminal sires would have generated more gross revenue and net return per head (Table 3). In the second scenario, which involved retained ownership through harvest, terminal-cross calves generated more gross revenue per head than did maternal-cross calves (Table 3) and returned an average of \$83.66 more net revenue per head to the cowherd than did maternal-cross calves (Table 3). The higher profitability of the terminal-cross steers stemmed primarily from their superior growth and heavier carcass weights; carcass

grade performance had a negligible impact on differences in profitability between the two groups. Net returns reported in Table 3 are uncommonly high and reflect the fact that these cattle were sold during a time period characterized by unusually high prices for live cattle and beef carcasses.

IMPLICATIONS

Results of this study suggest that, for commercial cow-calf operators that routinely retain ownership of their calves through finishing and who have access to a reliable source of affordable replacement females, the use of a terminal-cross breeding system may be a viable strategy for improving profitability of the cowherd. However, our analysis did not account for possible cost differences associated with purchase vs. within-herd production of replacement females and did not include an assessment of the profitability of terminal-cross heifers in a retained-ownership program. Future studies are planned to address these information voids.

LITERATURE CITED

- Beef Improvement Federation. 2004. Guidelines for Animal Evaluation. (Available: <http://www.beefimprovement.org/guidelines/Chap3.PDF>)
- KSU. 2003. Information regarding livestock and meat marketing, budgets, and policy issues to assist producers in making marketing decisions. Kansas State University (Available: <http://www.agmanager.info/livestock/>).
- NRC. 2000. Nutrient Requirements of Domestic Animals. Nutrient Requirements of Beef Cattle. 7th revised Ed. Natl. Acad. Press, Washington D.C.

Table 1. Least squares means for growth performance traits.

Trait	Sire type		<i>P</i> > <i>F</i>
	Terminal	Maternal	
	$\mu \pm \text{SEM}$		
Birth weight, lb	92.8 ± 4.04	84.1 ± 3.38	0.1554
Weaning Weight, lb	584 ± 11.15	498 ± 9.10	< 0.0001
Pre-weaning ADG, lb/d	2.60 ± 0.06	2.24 ± 0.05	0.0130
Weight at start of finishing period, lb ^a	733 ± 12.15	648 ± 9.91	< 0.0001
Final weight, lb	1442 ± 20.95	1315 ± 20.93	0.0104
Finishing ADG, lb/d	4.23 ± 0.12	3.96 ± 0.10	0.1591
Feed consumed during finishing, lb ^b	3631 ± 25.00	3348 ± 25.00	< 0.0001
Feed conversion during finishing (F:G), lb ^b	5.16 ± 0.11	5.02 ± 0.10	0.4070
Cost of gain during finishing, \$/lb gain ^{bc}	0.50 ± 0.01	0.49 ± 0.01	0.7723

^a December 16, 2003.^b Calculated from December 16, 2004 until harvest (avg. 170 d); on a dry matter basis.^c Cost includes feed costs plus yardage, processing, and veterinary expenses.

Table 2. Least squares means for carcass traits and frequencies of specific USDA quality grades (QG) and yield grades (YG).

Trait	Sire type		<i>P</i> > <i>F</i>
	Terminal	Maternal	
	$\mu \pm \text{SEM}$		
Adjusted fat thickness, in	0.53 ± 0.04	0.60 ± 0.03	0.1787
Dressing Percentage	63.9 ± 0.18	63.6 ± 0.18	0.3468
Hot carcass wt, lbs	893 ± 15.23	813 ± 12.86	0.0092
Ribeye Area, in ²	13.3 ± 0.29	12.9 ± 0.26	0.3965
Percentage Kidney, Pelvic and Heart fat	2.20 ± 0.04	2.24 ± 0.04	0.4766
Marbling score ^a	518 ± 7.93	513 ± 7.93	0.6568
Yield grade ^b	3.32 ± 0.09	3.34 ± 0.09	0.8445
	Frequency, %		<i>P</i> > χ^2
QG of Choice or higher	60.0	62.5	0.8185
YG-1 and YG-2	52.5	32.5	0.0704
YG-4	0	5.0	0.1521
Weight and (or) "no-roll" discounts	0	0	--

^a Marbling Score: 400 = Slight⁰⁰; 500 = Small⁰⁰; 600 = Modest⁰⁰.^b Calculated using the following equation: YG = 2.5 + (2.5 * AFT) + (.2 * KPH) - (0.32 * REA) + (0.0038 * HCW).

Table 3. Least squares means for gross revenue and net return showing two different marketing scenarios.

Trait	Sire type		<i>P</i> > <i>F</i>
	Terminal, $\mu \pm \text{SEM}$	Maternal, $\mu \pm \text{SEM}$	
	Returns if calves were sold at weaning		
Gross revenue from sales of weaned calves, \$/hd ^a	617.06 ± 12.31	577.54 ± 10.04	0.0413
Net return, \$/hd	202.65 ± 12.31	163.13 ± 10.04	0.0413
	Returns for retained-ownership through finishing		
Gross revenue from sales of carcasses, \$/hd ^b	1227.34 ± 20.53	1114.03 ± 17.73	0.0137
Net return, \$/hd	349.11 ± 19.64	265.45 ± 16.89	0.0274

^a Reported U.S weekly average market prices for October 3, 2003; 450lb steer \$116.15/cwt, 550lb steer \$105.65/cwt.^b Base carcass price = \$136.43/cwt; Choice grade base = 53.5%; and Choice/Select spread = \$19.22/cwt.