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WHAT ARE HERD BULLS ACCOMPLISHING IN MULTIPLE SIRE BREEDING PASTURES?[1]

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Abstract

In the absence of paternity testing there is no way to track which progeny belong to individual sires in multiple sire breeding pastures. DNA testing was used to determine the paternity of calves born to approximately 2,400 commercial cows/year bred in multi-sire, natural service breeding pastures on 3 large collaborating ranches in Northern California. A total of eight calf crops born spring 2009 through fall 2010 from the 3 ranches were evaluated. There were large differences in the number of calves sired per bull ranging from 0 to 54. For sires that were present for an entire breeding season the mean number of calves sired was 17.8 (± 4.8). In half of these 8 breeding seasons, at least one bull was removed due to injury or poor condition. There were 12 instances where a bull was present during a breeding season but sired no calves. In other words, any time a bull was put out in a multiple sire breeding pasture in any given season, there was a 7.3% chance that he would produce no calves. Sire prolificacy and combined weaning weight produced per sire in each calf crop were moderately repeatable (0.5) in consecutive calf crops. This means that bulls siring a large number of calves in one calf crop tended to remain prolific in subsequent calf crops regardless of new bull groupings. Sire output measured as total adjusted weaning weight and number of calves per season was not correlated with American Angus Association (AAA) growth EPDs but these traits had moderate correlations with scrotal circumference EPDs (r=0.42, and 0.38), respectively. Prolificacy ultimately governs the long-term contribution of any given sire to the genetic composition of the herd.

Introduction

In the commercial cow-calf sector, the principal determinants of income are the number of sale animals and the value per sale animal (Garrick and Golden, 2009). In that regard, a herd bull has two qualities of value to commercial producers. One is his ability to impregnate as many cows as possible, and the other is the ability to pass genes for superior performance on to his offspring. In the absence of the former, the importance of the latter is moot. Bulls with superior EPDs do not contribute to genetic improvement if they sire no calves. Natural service breeding is the predominant practice for beef cattle operations in the U.S. but few studies have examined the variation in number of calves sired and the consistency of an individual bull's performance in multiple sire breeding pastures.

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In previous work we found that five of 27 (19%) herd sires in a large multisire breeding group produced over 50% of the calves, whereas 10 sires produced no progeny and of these nine were yearling bulls (Van Eenennaam et al., 2007). Likewise an Australian study looking at full or partial *Bos indicus* bulls in multiple sire breeding groups found 14% of the bulls produced over 30% of the calves, 58% sired 10% or fewer calves, and 6% of bulls sired no calves (Holroyd et al., 2002). In that study the number of progeny sired was found to be a moderately repeatable trait (r=0.43-0.69) from year to year. These data suggest that certain bulls in a multisire team are disproportionately impacting both herd genetics and ranch income.

"Reproductive" tools such as breeding soundness examinations (BSE) evaluate a bull's phenotypic characteristics and semen quality, but few genetic tools exist for selecting bulls with superior breeding performance. Holroyd (2002) found that there were breed differences in a variety of traits related to calf output (e.g. scrotal circumference, testicular tone, dominance, libido score, and semen quality), but that those traits explained only 35-57% of the phenotypic variation in the number of progeny sired.

As part of a 4-year USDA study we are tracking the paternity and performance of calves born to approximately 2,400 commercial cows per year. All cows are bred in multisire, natural service breeding pastures on 3 large collaborating ranches in Northern California. Here we report preliminary data on various aspects of bull prolificacy and performance from the first two years of that study.

Characteristics of Cooperating Ranches

The three ranches, located in Siskiyou County in Northern California close to the Oregon border, are operated as commercial cow calf enterprises. Income is derived from the weight of calves going into the feedlot plus premiums for superior carcass quality and the use of Angus bulls, as part of a partnership with the feedlot and packer. Climatic conditions are characterized as Intermountain high desert. Principle forages are perennial grasses such as wheatgrass, with fescue the dominant irrigated forage. Wintertime hay feeding is the common practice. All ranches raise their own replacement heifers at about a 20 percent replacement rate. Angus sires have been used extensively in the past 10 years making the cow herds primarily Angus.

Ranch 1 has a spring calving herd of 550 cows, with the start of calving around January 1. These cattle spend their summers on high mountain meadows. A fall calving herd of 350 cows, with the start of calving about September 1 remain on the valley floor during the summer. Breeding seasons are 60 days in length and include several breeding pastures typically involving 2 to 5 bulls, and a cow to bull ratio of approximately 25:1. Breeding occurs in private fenced pastures generally less than 100 acres in size. Bulls used include predominately Angus (AN), South Devon (SD), and South Devon x Angus (SDX) cross bulls bred on the ranch.

Ranch 2 has a 200 cow spring calving herd, and a calving start date of February 1. These cattle spend the summers on the valley floor. A 300 cow fall calving herd, with the start of calving about October 1 spend their summers on high mountain meadows before returning to the valley to calve. Breeding seasons are 90 days in length with several breeding pastures generally of 2 to 5 bulls, and a cow to bull ratio of approximately 25:1. Breeding pastures are less than 100 acres in size. Bulls used include predominately Angus, and some Horned Hereford.

Ranch 3 has a 700 cow fall calving herd, with calving commencing around August 15. The breeding season is about 120 days. Cattle remain on the valley floor all year. Breeding pastures tend to be somewhat larger and consist of 5 to 9 bulls. Bulls used included predominately Angus, three Red Angus, and one Horned Hereford bull.

Prior to the breeding season a BSE was conducted on all bulls and only bulls passing the exam were used. DNA was taken on all bulls and run on the Illumina Bovine SNP50 BeadChip assay (San Diego, CA). Breeding groups consisted of replacement heifers and mature (all other) cows. The cows were not generally assigned to the same breeding group each year, but rather randomly assigned each breeding season. Cows in the various fall or spring herds generally stayed with those breeding herds. Bulls were observed on a daily or several times per week basis and removed from the breeding pasture for injury or poor body condition. When bulls were removed, replacement bulls were most frequently obtained from other breeding groups as idle substitute bulls were not typically available. The replacement bull selection decision was based on a variety of factors including reassigning bulls from breeding pastures that had a slightly lower cow to bull ratio, selecting bulls that were observed to be very actively breeding cows, or selections were made to avoid bull dominance issues such as placing experienced bulls in with young bulls, or a history of observed aggressive behavior. Replacement heifers were bred to younger, lighter bulls which had typically been purchased for calving ease. These bulls were shifted from replacement heifers to mature cows as they become older and heavier over time.

Birth dates and dam identification were obtained at calving and calves were individually identified. Birth weights were taken only at Ranch 2. Electronic ear tags (EIDs) were placed in calves at marking time and hair samples for DNA testing were obtained at that time. Bovine SeekSire genotyping (GeneSeek Inc., Lincoln, NE) using a ~100 SNP panel was used to determine parentage. Individual calf weights were obtained at approximately 205 days of age. These weights were adjusted for cow age and calf age according to BIF recommendations except that age ranges were wider than this guide due to practical constraints associated with calves going to summer pastures where they were not accessible for weighing. Weights for each calving group were obtained on consecutive days when it was not possible to weigh them all in one day.

Results

A total of eight calf crops born from Spring 2009 through Fall 2010 on the three ranches were evaluated. There were large differences in the number of calves sired per bull in any given breeding season ranging from 0 to 54. Table 1 summarizes the average number of calves produced by each sire on each ranch broken down by year and calf crop. This analysis includes progeny derived from 74 potential sires that sired at least one calf in either or both years. A cumulative total of 152 bull seasons (i.e. a bull season = one bull present on a ranch for one breeding season) on the three different ranches are represented in Table 1.

For sires that were present for the entire breeding season the mean number of calves sired was 17.8 ± 4.8, with a comparatively small range in average number (16.1-21.3) between ranches. These “full season” bulls had individual calf numbers of 1 to 54 calves per sire. There were also 12 instances where a bull was present during a breeding season but sired no calves. This means that for each time a bull had an opportunity to breed cows in any given season, there was a 7.3% chance that he would produce no calf. This value is similar to the 6.0% reported by Holroyd et al. (2002).

Table 1. Average bull age at the beginning of the breeding season, and number of calves produced per bull on 3 commercial ranches in Northern California in 2009 and 2010.

Ranch	Year	Calf crop	# of sires	Min. bull age	Max bull age	Mean bull age	Total # of calves	Min. # calves	Max. # calves	Mean # calves
									per bull	
1	2009	Spring	13	1.5	3.1	2.5 ± 0.6	246	6	40	**18.9** ± 12.5
		-partial[2]	10	3.0	6.1	4.2 ± 10	196	3	47	**19.6** ± 13.0
1	2009	Fall	19	1.6	3.8	2.9 ± 0.9	345	1	47	**18.2** ± 13.9
		- partial[2]	2	2.8	3.8	3.3 ± 0.8	12	5	7	**6.0** ± 1.4
1	2010	Spring	19	2.1	5.2	3.4 ± 0.9	366	5	36	**19.3** ± 10.7
		-partial[2]	2	3.1	4.1	3.6 ± 0.8	46	4	42	**23.0** ± 26.9
2	2009	Spring	8	0.7	9.2	3.5 ± 2.7	139	1	44	**17.4** ± 16.6
2	2009	Fall	9	1.4	8.8	4.4 ± 2.2	196	10	48	**21.8** ± 11.4
		-partial[2]	5	1.3	7.9	3.7 ± 2.8	58	1	21	**11.6** ± 8.6
2	2010	Spring	8	1.7	5.3	2.9 ± 1.2	129	3	28	**16.1** ± 9.1
3	2009	Fall	30	1.6	5.6	3.3 ± 10	639	2	54	**21.3** ± 13.8
3	2010	Fall	27	1.6	5.2	3.7 ± 1.3	568	1	52	**21.0** ± 13.1

There was at least one breeding pasture where bulls were removed or added during the breeding season in half of the 8 calf crops examined. These are shown as "partial" sires (Table 1). "Partial" bulls were only present for a portion of the breeding season. Partial bulls included 43.5, 9.5, 9.5 and 35.7 percent of the total bulls present during a given breeding season on a ranch, and sired 44.3, 3.4, 11.2 and 22.8 percent of the calves, respectively. Partial season bulls had a similar number of calves 17.0 (± 3.2) per breeding season as "full season" bulls. They were on average slightly older 4.2 (± 0.3) years than full season bulls 3.3 (± 0.1) years ($P<0.05$).

Sire Age

Mean sire age at the start of the breeding season was 3.4 ± 0.5 years, with a range from 0.7 to 9.2 years. The number of calves sired in a breeding season (Figure 1) increased with age ($P< 0.05$) but age explained little of the variation in calf output as can be seen by the scatterplot in Figure 1 (R^2=0.037). It should be noted that these results were likely influenced by the fact that the producers tried to place yearling bulls together in a single breeding pasture when making sire assignments. This was based on previous work showing that yearling bulls were rarely able to successfully compete against more mature bulls and produced few progeny when partnered with older bulls in multiple-sire breeding pastures (Van Eenennaam et al., 2007).

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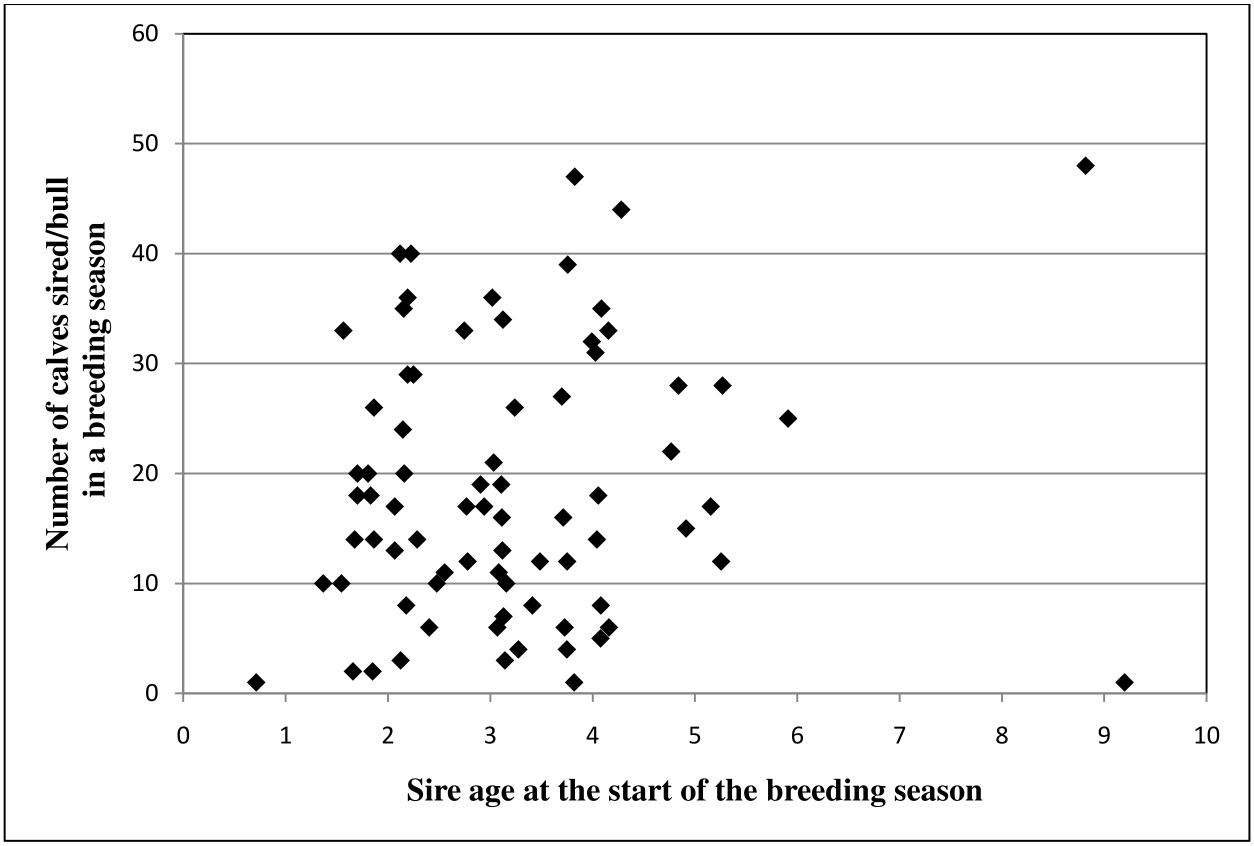
[2] Partial breeding season sires were only present for a portion of the breeding season.

Figure 1. Bull age at the start of the breeding season explained very little of the variation in sire output.



Evaluation of Full Breeding Season Bulls

Due to the frequency and potential conflicts associated with evaluating bulls when competing bulls were added or removed from the breeding pasture mid-season, we evaluated only the group of bulls that were present in a single pasture for the entire duration of the breeding season, and where there were no additions or removals of bulls from that pasture. Additionally, these bulls were required to be present for 2 or 3 breeding seasons. Twenty bulls on ranches 1 or 2 met these criteria. Least square means for total adjusted weaning weight output for a breeding season varied ($P<0.01$) from 601- 20,665 lbs per sire (mean 9,044 ± 5,502). This output was almost entirely correlated ($r=0.99$) to the number of calves per sire, which varied ($P<.01$) from 4.5 to 38.4 (mean 18.7 ± 10.4), and showed little correlation ($r=0.015$) with mean adjusted weaning weight, which ranged ($P<.001$) from 516 to 608 lbs (Table 2).

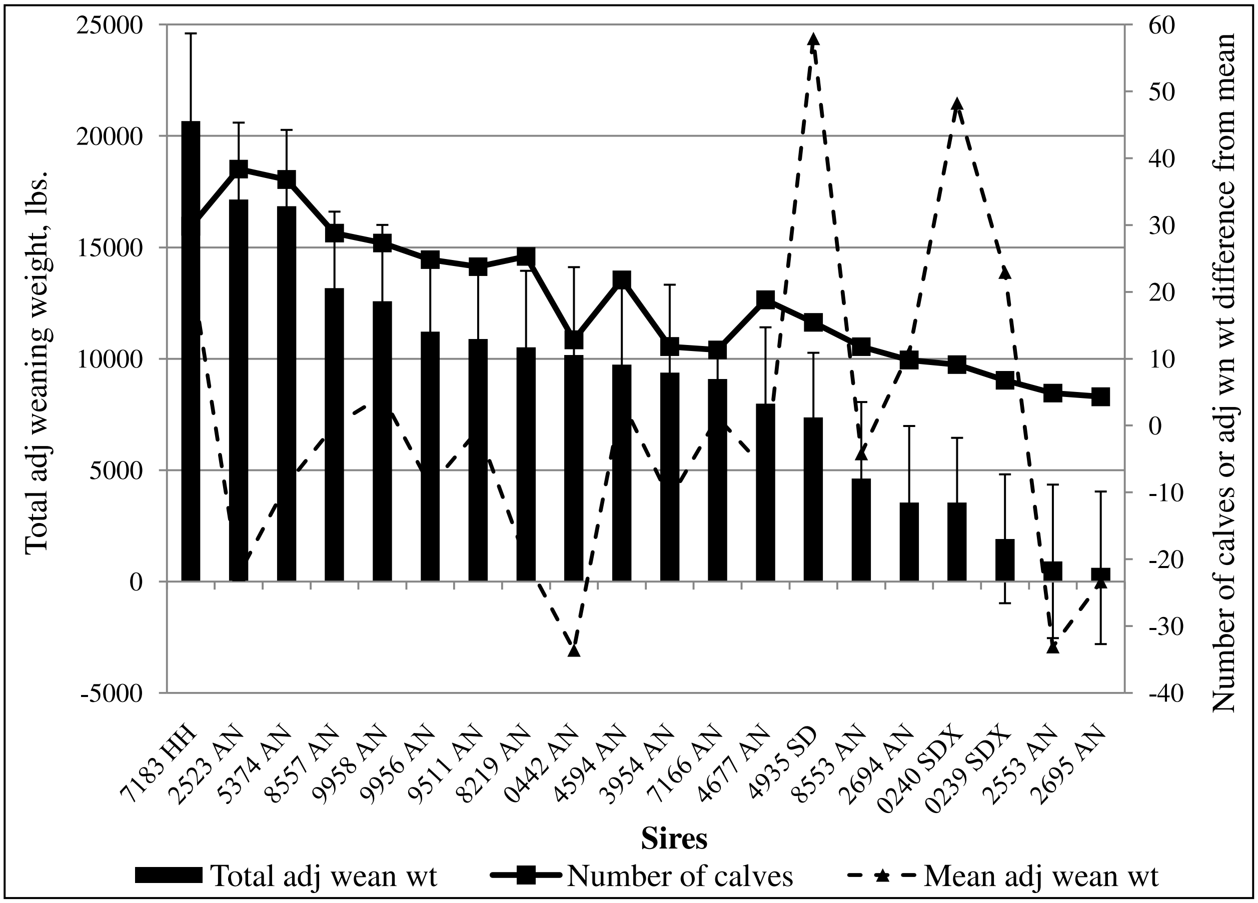
Not unexpectedly, the bull producing crossbred offspring with the highest total adjusted weaning weight was a Horned Hereford bull (Figure 2). Although he was not the most prolific bull, the combination of a high adjusted weaning weight due to crossbreeding, and a relatively high number of calves resulted in the highest total adjusted weaning weight. The value of heterosis is sometimes overlooked on commercial ranches, and yet the hybrid vigor associated with crossbreeding has been consistently shown to positively impact growth, health and reproductive traits. This is visually evident as the adjusted weaning weight "peaks" in both Figures 2 and 3.

Table 2. Least square means adjusted for ranch, year and season for the 20 sires from ranch 1 and 2 that were used for an entire breeding season in one pasture without other bulls being added or removed and which were used for 2 or 3 breeding season (sorted by total adjusted weaning weight). AN = Angus, SD = South Devon, SDX = South Devon x Angus, and HH = Horned Hereford.

Last 4 of sire reg. number + breed	Mean total adj. weaning weight (lbs)	Mean number of calves	Mean adj. weaning wt (lbs)	Mean calving day	Mean days to calving
7183 HH	20665 ± 3933	30 ± 6.7	573 ± 37	35.9 ± 18.1	310 ± 6
2523 AN	17147 ± 3445	38 ± 6.4	528 ± 27	31.3 ± 13.5	304 ± 6
5374 AN	16841 ± 3424	37 ± 6.2	541 ± 27	26.3 ± 13.2	297 ± 6
8557 AN	13173 ± 3424	29 ± 6.2	550 ± 12	30.5 ± 13.2	298 ± 6
9958 AN	12577 ± 3424	27 ± 6.2	554 ± 27	29.0 ± 13.2	300 ± 6
9956 AN	11209 ± 3424	25 ± 6.2	541 ± 27	34.7 ± 13.2	306 ± 6
9511 AN	10885 ± 2892	24 ± 5.3	549 ± 26	27.1 ± 5.9	296 ± 6
8219 AN	10516 ± 3424	25 ± 6.2	530 ± 27	29.3 ± 13.2	299 ± 6
0442 AN	10172 ± 3933	13 ± 6.7	516 ± 37	18.8 ± 18.1	324 ± 6
4594 AN	9730 ± 3424	22 ± 6.2	554 ± 27	23.8 ± 13.2	293 ± 6
3954 AN	9383 ± 3933	12 ± 6.7	539 ± 37	3.9 ± 18.1	301 ± 2
7166 AN	9094 ± 1047	11 ± 6.7	551 ± 37	25.8 ± 18.1	300 ± 6
4677 AN	7981 ± 3424	19 ± 6.2	543 ± 27	35.6 ± 13.2	305 ± 6
4935 SD	7368 ± 2892	16 ± 5.3	608 ± 26	31.5 ± 12.8	305 ± 5
8553 AN	4626 ± 3424	12 ± 6.2	546 ± 27	24.2 ± 13.2	292 ± 6
2694 AN	3551 ± 3424	10 ± 6.2	561 ± 27	24.5 ± 13.2	295 ± 6
0240 SDX	3550 ± 2892	9 ± 5.3	598 ± 26	31.3 ± 12.8	305 ± 5
0239 SDX	1912 ± 2892	7 ± 5.3	573 ± 26	26.0 ± 12.8	300 ± 5
2553 AN	899 ± 3445	5 ± 6.4	517 ± 27	23.7 ± 13.5	297 ± 6
2695 AN	610 ± 3424	4 ± 6.2	526 ± 27	29.3 ± 13.2	300 ± 6

It is often assumed that bulls contribute equally to the next generation, or perhaps more optimistically that the most expensive bulls with "good numbers" will sire more than their share! As can be seen from the data collected in this study, the presence of a bull in a breeding group is not a guarantee of offspring, let alone the production of sufficient offspring to result in the selection of his daughters as replacement heifers. A large number of bulls were removed from breeding pastures for a variety of reasons (injury, poor condition, weight loss, death, fighting). As a result a sizeable number of the bulls on this project produced less than the expected number of progeny (i.e. ~ 20-25/breeding season). Additionally, sires failed completely (i.e. no calves sired) at a rate of 7.3% in any given breeding season. These low output bulls incurred the same purchase investment and annual maintenance costs as their more prolific herd mates. The costs associated with sire failure, including the need to carry a larger bull battery to have some spares in the case of bull breakdown should be factored into decisions comparing the relative costs of breeding using artificial insemination (AI) versus the use of nature service herd sires.

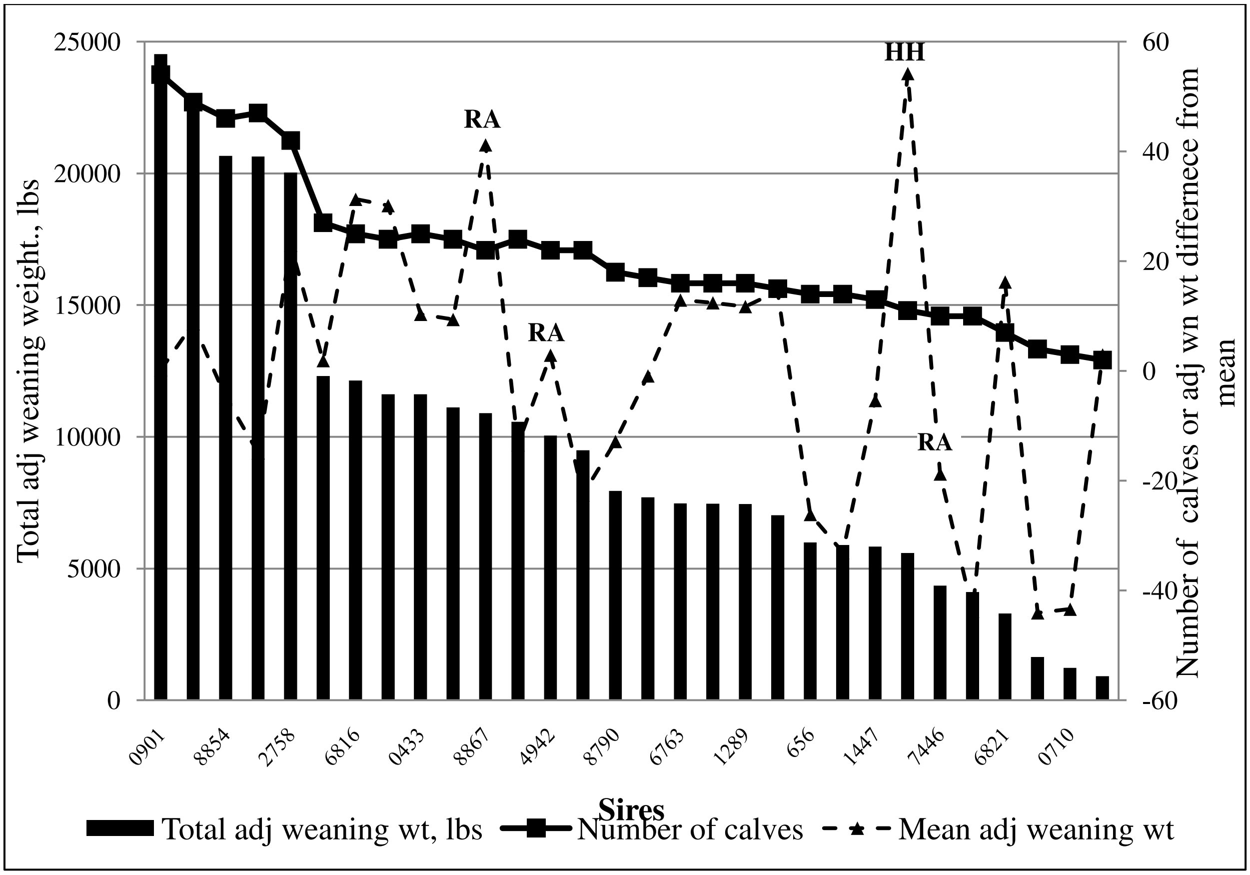
Figure 2. Sire output for ranches 1 and 2 as least square mean total adjusted weaning weight per sire, number of calves and mean individual animal adjusted weaning weight. The number of calves was closely correlated (r=0.99) to total adjusted weaning weight. Mean adjusted weaning weight per calf was not closely correlated (r=0.015) to total output. Figure includes only bulls that were present for the full length of the breeding season (i.e. no additions or removal of bulls in their breeding pasture), and that were in use for greater than one breeding season in this trial. AN = Angus, SD = South Devon, SDX = South Devon x Angus, and HH = Horned Hereford.



Least square means for the "partial" bulls (i.e. bulls that were only present for a portion of the breeding season) were lower for adjusted weaning weight (P<0.05) and were more variable than "full season" bulls (492 ± 9.5 vs. 513 ± 4.1) but similar for number of calves per sire per breeding season (17 ± 3.2 vs. 19 ± 1.2) and total adjusted weaning weight (8346 ± 1761 vs. 9847 ± 761), respectively. This is not entirely surprising since substitute bulls that were used for partial or limited periods of time were generally recruited from the bull battery *per se* and were not inferior or restricted-use bulls.

We evaluated sire prolificacy and total output at ranch 3 separately from the other two ranches (Figure 3). Data were analyzed at the whole ranch level, instead of by individual breeding pastures because there was significant movement of sires between breeding pastures during the longer 120 day breeding season on the ranch. Overall, a similar pattern was observed whereby total weight output closely matched the number of calves sired, while bulls with the highest individual calf weights (again crossbred calves), were not among the highest bulls in total output.

Figure 3. Sire output for ranch 3 as total adjusted weaning weight per sire, number of calves and mean individual animal adjusted weaning weight. All bulls were Angus except for those marked RA = Red Angus, and HH = Horned Hereford.



Repeatability of Bull Performance

The previous information supports a very wide range in bull performance as measured by their number of calves and total weaning weight produced as an average over 2 or 3 breeding seasons. We were interested in answering the following question, "Do bulls that are prolific in one breeding season perform as well in subsequent seasons or is the mean merely a compilation of good and poor performances?" Using the 20 "full season" bulls that were in use for 2 or 3 breeding seasons (Table 2), we calculated the repeatability of 5 traits between their first breeding season and the subsequent season. These were mixed-aged bulls. This test might be of interest to producers deciding whether or not to conduct paternity testing to determine the number of calves sired by bulls in their bull battery. Repeatability varied for the different traits: total adjusted weaning weight r=0.50, number of calves r=0.50, mean adjusted weaning weight=0.675, days to calving r=0.19 and calving day r=0.09. We also analyzed calf output repeatability between the same bulls from the single Fall calving group on ranch 3 in year 1 and 2. Under the more variable conditions associated with this ranch the repeatability of number of progeny sired between year 1 and 2 was 0.33. These repeatability estimates for number of calves sired are similar to those reported by Holroyd (2002) of 0.43-0.69 for predominantly *Bos indicus* bulls in northern Australia under more extensive conditions. Collectively these studies provide strong evidence for the moderate repeatability of calf output for sires.

Association of Prolificacy with Reproductive Measures and EPDs

Days to calving and calving day (day calved during the calving season) were not different between sires (P>0.18) and had little correlation with total output as adjusted weaning weight or number of calves, days to calving (r= -0.03, r= -0.06), calving day (r=0.12, 0.07), respectively. All traits were slightly better correlated as rank order (data not shown). Sire output as total adjusted weaning weight and number of calves were not well correlated to Angus Association weaning weight EPDs (r= -0.14 and -0.05; n=15) or yearling weight EPDs (r= -0.04 and 0.02; n=15) but had moderate correlation to scrotal circumference EPDs (r=0.42, and 0.38; n=5), respectively. The low correlation between growth trait EPDs and output was not unexpected since the actual mean adjusted weaning weight was not closely related to total output. Reproductive measures of the bulls such as their calving day and days to calving values might have been expected to be related to calf output and thus total weaning weight but were not. Apparently these measures are more closely tied to age and growth of individual calves rather than the number of calves. The number of calves was moderately related to scrotal circumference (SC) EPDs although the number of sires with this EPD was limited (n=5).

Scrotal circumference has consistently been reported to be a useful method for assessing reproductive function in bulls (Burns et al., 2011). Scrotal circumference EPDs have been positively associated with sperm motility and total BSE score (Moser et al., 1996). Burns et al. (2011) published an excellent review of the correlation between scrotal circumference and reproductive traits. Table 3 is excerpted from that review paper. The relationship between scrotal circumference EPDs and male reproduction as measured by the total number of calves sired during a natural service breeding season does not appear to be among the published studies and might be an interesting topic for further investigation.

These data do not strongly support or recommend specific bull management practices to enhance prolificacy. Previous work suggested a separate multiple-sire breeding pasture for yearling bulls would be advantageous as yearling bulls in mixed-aged sire groups sired few if any progeny (Van Eenennaam et al. 2007). A risk-avoidance policy might be to spread the high prolificacy bulls so that each breeding pasture has at least one. The lower prolificacy bulls would then be divided randomly. The data suggest that the high prolificacy bulls will remain so, and some of the lower prolificacy bulls will improve. This would tend to avoid pastures without a strong performer.

One observation we made during the course of this study is that producers often purchase "heifer" bulls with high calving ease EPDs to avoid dystocia. As these "heifer" bulls mature and get too heavy to breed the heifers, they are often moved across to breed the cows, despite the fact that cows have little calving difficulty and selection for bulls to breed cows would ideally put emphasis on a different suite of traits. A preferable approach may be to use semen from high calving ease AI bulls on heifers, and focus herd bull selection on traits of importance to breeding cows. This would accelerate genetic progress (using semen from high accuracy calving ease bulls on heifers would focus genetic improvement on young animals and accelerate the rate of genetic progress due to a decrease in the generation interval), while reducing the selection emphasis on calving ease which is of less importance when considering herd bulls to breed cows.

Table 3. Summary of literature on the correlation between scrotal circumference and a) male and b) female progeny reproductive traits in cattle (Adapted from Tables 1, 2 in Burns et al. (2011)).

Reference	Breed	Age	Male Traits	r_g	Comments
Brinks et al. (1978)	H, A	12 mo	Motility % % primary abnormality % secondary abnormality % normal	0.25 −0.51 −0.42 0.58	Scrotal circumference favorably correlated with all semen traits evaluated. n = 287
Mackinnon et al. (1990)	Dr	 9 mo 12 mo 18 mo	Difference in SC between high- and low-fertility lines (EBV for PR) High–Low 5.8 mm High–Low 9.6 mm High–Low 16.0 mm		n = 111
			Female Progeny Traits		
Brinks et al. (1978)	H, A	12 mo	Age of puberty	−0.71	
King et al. (1983)	H	12 mo	Age of puberty	−1.07	A review of data to 1988 linking 12 month SC to various parameters of growth and reproduction
Perry et al. (1990)	GA, AX, BX, GB, HSh, AXBX, BXAX	16 mo	Age of puberty		6 genotypes n = 26 sires n = 285 females and 51 males
Vargas et al. (1998)	B	18 mo	Age of puberty	−0.32	n = 28 males n = 261 females
Martinez-Velazquez et al. (2003)	H, A, R, L, S, C, P, G, Bvh, MARC I, II & III	12 mo	Age of puberty	−0.15	n > 7000
Morris et al. (1992)	H, A, HA, HA (R), SDxA, JA, MaJA, FA, SiFA, FH	9 mo 11 mo 13 mo	Standard age 1st estrus Standard age 1st estrus Standard age 1st estrus	0.15 ± 0.20 −0.28 ± 0.21 −0.46 ± 0.23	Cross-breeding experiment follows on in later years. Based on H and A with other British breeds. n = 234 sire groups of about 6 males and 6 females
Morris et al. (1993)	A	9–13 mo 13 mo	Standard age 1st estrus Standard age 1st estrus	−0.40 ± 0.29 −0.50 ± 0.29	Continued from previous study but run on separate property. n = 550 cows mated
Morris et al. (1999)	H, A, HA, HA (R), SDxA, JA, MaJA, FA, SiFA, FH	9–13 mo	Standard age 1st estrus – site 1 Standard age 1st estrus – site 2	−0.19 −0.21	Continuation of previous studies at 2 sites. By now have long history of selection – effects
Smith et al. (1989)	H, A	12 mo	Age 1st calf		Allowances made for inbreeding of herd
Martinez-Velazquez et al. (2003)	H, A, H, A, R, L, S, C, P, G, Bvh, MARC I, II & III	12 mo	Age 1st calf	0.15	n > 7000

Reference	Breed	Age	Female Progeny Traits	r_g	Comments
Meyer et al. (1991)	H A ZX	12–24 mo	Days to calving	−0.25	Data from various sources. Variable age around about puberty. Some older
			Days to calving	−0.28	
			Days to calving	−0.41	
Morris et al. (1999)	H, A, HA, HA (R), SDxA, JA, MaJA, FA, SiFA, FH	9–13 mo	Calving date – site 1	−0.06	Continuation of previous at 2 sites. By now have long history of selection – effects
			Calving date – site 2	−0.25	
Meyer and Johnston (2001)	B	10–26 mo	Days to calving	−0.3	Modeled data only, none of original data given
Morris and Cullen (1994)	Cattle; H, A, HA, HA (R), SDxA, JA, MaJA, FA, SiFA, FH	9 mo	Yearling pregnancy rate	0.53 ± 0.61	Continuation of previous studies. New site. Multiple breeds and crosses
		11 mo		0.34 ± 0.59	
		13 mo		0.57 ± 0.77	
Evans et al. (1999)	H	12 mo	Heifer pregnancy rate	0.002 ± 0.45	n = 1220 bulls. Pregnancy as yes or no
Eler et al. (2004)	N	15 mo	Yearling pregnancy rate	0.20 ± 0.13	n = 25,466
Toelle and Robison (1985)	H	6.5 mo	Lifetime pregnancy rate	0.99 0.93	
		12 mo	Lifetime pregnancy rate		
Morris and Cullen (1994)	H, A, HA, HA (R), SDxA, JA, MaJA, FA, SiFA, FH	9 mo	Lifetime pregnancy rate	0.30 ± 0.37	Continuation of previous studies. New site. Multiple breeds and crosses
		11 mo	Lifetime pregnancy rate	0.48 ± 0.46	
		13 mo	Lifetime pregnancy rate	0.35 ± 0.45	
Morris et al. (1999)	H, A, H, A, HA, HA (R), SDxA, JA, MaJA, FA, SiFA, FH	9–13 mo	Lifetime pregnancy rate – site 1	0.34	Continuation of previous at 2 sites. By now have long history of selection – effects
			Lifetime pregnancy rate – site 2	0.14	
Mwansa et al. (2000)	F_1HA, F_1CH, F_1CA, F_1CSh, F_1SiH, F_1Si A, F_1SiSh, F_1LH, F_1LA, F_1LSh	12 mo	Lifetime pregnancy rate	−0.25	Multiple breeds and crosses
Morris and Cullen (1994)	H, A, H, A, HA, HA (R), SDxA, JA, MaJA, FA, SiFA, FH	9 mo	Lifetime calf production	−0.09 ± 0.45	Continuation of previous studies. New site. Multiple breeds and crosses
		11 mo	Lifetime calf production	0.03 ± 0.51	
		13 mo	Lifetime calf production	0.08 ± 0.55	
Bamualim et al. (1984)	Dr	2–7 year	EBV fertility		Post-pubertal

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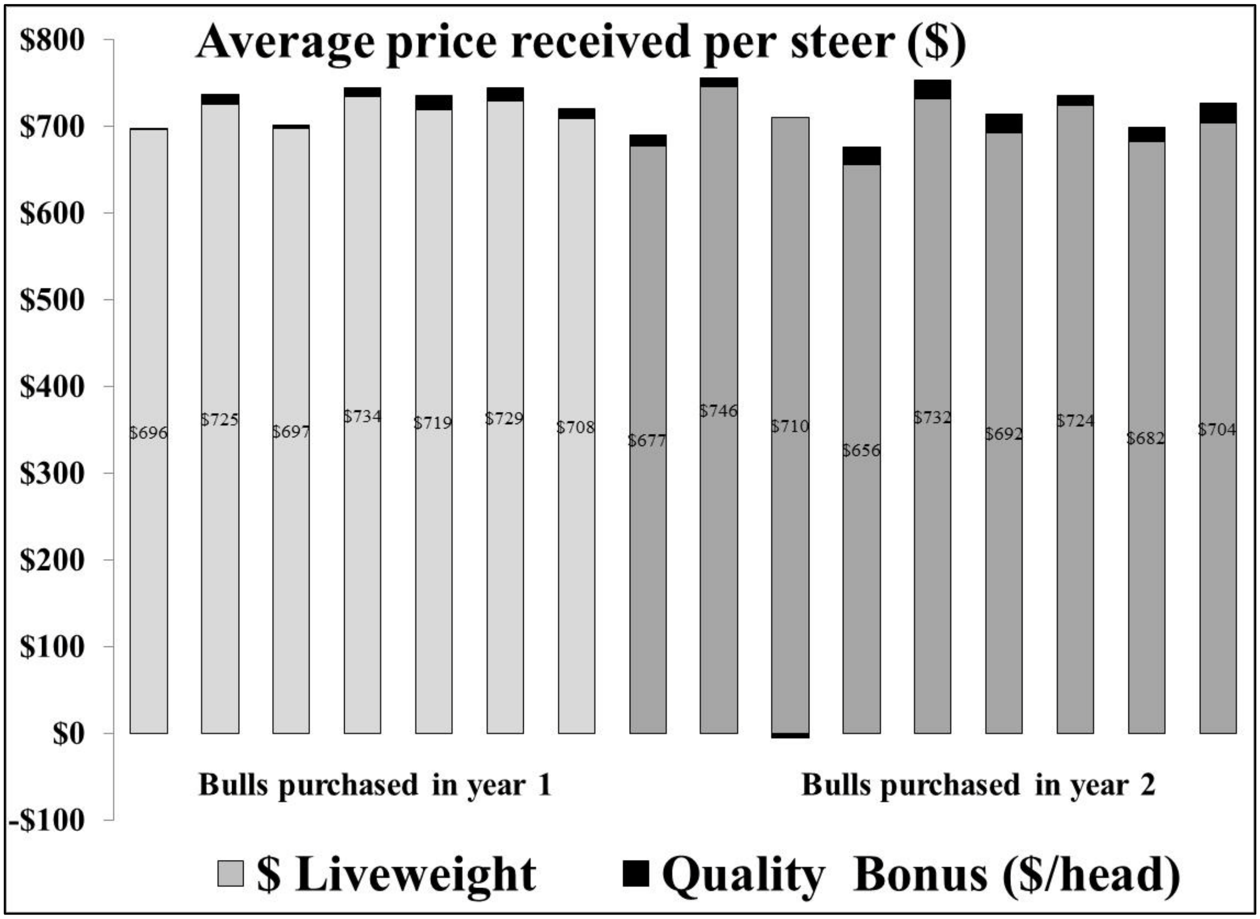
A, Angus; Age, age of sampling in months (mo); AX, Africander cross (1/2 Africander, ¼ Shorthorn, ¼ H); AXBX, and BXAX, reciprocal cross between BX and AX; B, Brahman; Bvh, Braunvieh; BX, Brahman cross, (1/2 Brahman, ¼ Shorthorn, ¼ H); C, Charolais; Dr, Droughtmaster; EBV, estimated breeding value; F_1CA, first cross Charolais × Angus; F_1CH, first cross Charolais × Hereford; F_1CSh, first cross Charolais × Shorthorn; F_1HA, first cross Hereford × Angus; F_1LA, first cross Limousin × Angus; F_1LH, first cross Limousin × Hereford; F_1LSh, first cross Limousin × Shorthorn; F_1ShSh, first cross Shorthorn × Shorthorn; F_1SiA, first cross Simmental × Angus; F_1SiH, first cross Simmental × Hereford; FA, Fresian × Angus; FH, Fresian × Hereford; G, Gelbvieh; GA, high grade Africander; GB, high grade Brahman; H, Hereford; HA (R), Hereford × Angus (Rotation-cross herd – 75% H and 25% A); HA, Hereford × Angus; HSh, ½ Hereford ½ Shorthorn; Hx, Hereford cross; JA, Jersey × Angus; L, Limousin; l, live animal measurement; MaJA, Maine Anjou (25%) × Jersey (25%) × Angus (50%) (three-breed composition); MARC I = ¼ Bvh ¼ C ¼ L 1/8 H 1/8A; MARC II = ¼ G ¼ S1/4 H ¼ A; MARC III = ¼ R ¼ P ¼ H ¼ A; N, Nelore; n, sample number; ns, not significant ($p > 0.05$); P, Pinzgauer; R, Red Poll; r_g, genetic correlation; S, sample type; SC, scrotal circumference (or diameter); SDxA, South Devon × Angus; SiFA, Simmental (25%) × Fresian (25%) × Angus (50%); Z, Zebu; ZX, zebu cross.

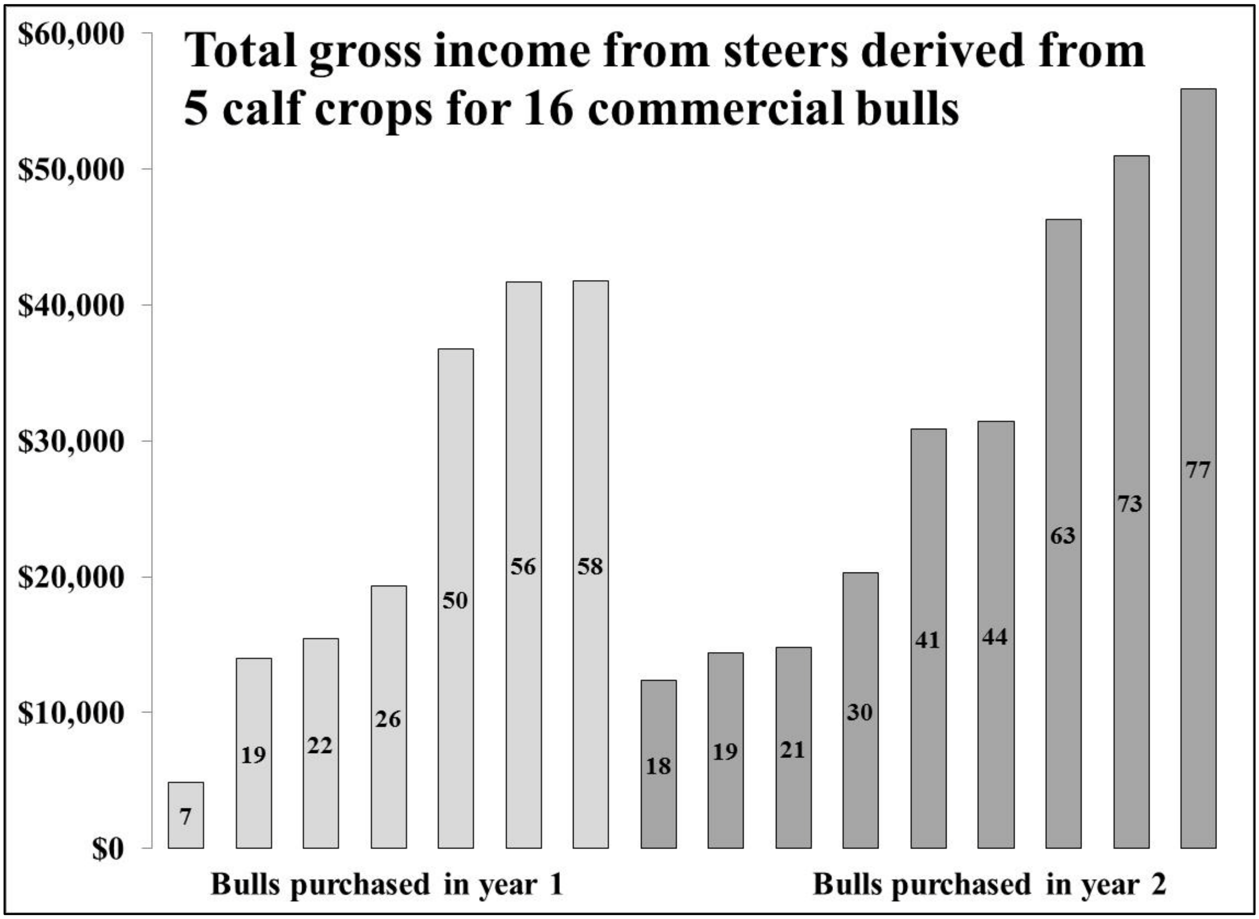
In a related economic study we compiled data on all of the **steer** progeny derived from two cohorts of 16 bulls purchased in successive years that all served as herd sires for 5 breeding seasons in multisire breeding groups on ranch 1. Offspring were marketed at an average of 314 days of age to the feedlot, and although the producer did not retain ownership they participated in a program that required selection for specific carcass attributes and rewarded carcass quality with a premium paid back to the producer. The average gross return including the quality premium derived from the steer progeny of each sire was $721 (Figure 4), but the total gross revenue derived from all male offspring of each bull ranged from $4,881 to $55,889 (Figure 5) due mainly to differences in sire prolificacy (Van Eenennaam and Drake, 2011).

Figure 4. Average gross return/steer progeny produced by two cohorts (■ born 2004; ■ born 2005) of Angus yearling bulls. Offspring were marketed at an average of 314 days of age to the feedlot, and an additional carcass-based quality premium (black shading) was paid to the commercial producer.



In this case, the producer-derived value associated with improving carcass quality was small compared to the total carcass liveweight value. However, it should be noted that the producer reported additional benefits of participating in the partnership program. These included a genuine interest in producing a quality product for the consumer, a preferred supplier status, and a predictable sale price. This final circumstance is not the case for many smaller US producers who are subject to the vagaries of the auction yard on sale day.

Figure 5. Total gross revenue (No. of progeny sired) derived from all of the steer progeny produced by two cohorts (□ born 2004; ■ born 2005) of Angus yearling bulls purchased in successive years. All bulls served as herd sires for 5 breeding seasons in multisire breeding groups on a US commercial ranch. Order of 16 bulls is the same in both Figures 4 and 5.



Summary and Conclusions

This study used DNA testing of calves sired in multiple sire breeding pastures to determine that natural service bulls typically sired between 15 to 20 calves per breeding season, however considerable variation was observed between bulls. High prolificacy bulls sired in excess of 50 calves per breeding season. Conversely, bulls sired no progeny in 7.3% of bull seasons (i.e. a bull put out with the cows for a single breeding season). In half of the 8 breeding seasons analyzed, at least one bull was removed due to injury or poor condition. Sire prolificacy and total weaning weight produced per sire were moderately repeatable for subsequent calf crops. Growth EPDs were not found to be associated with sire prolificacy, however data on a small number of bulls with scrotal circumference EPD suggest this trait was moderately correlated with total number of progeny and cumulative weaning weight attributable to a sire from a breeding season. These data suggest that a small number of highly prolific sires are producing a disproportionate number of offspring and likely replacement heifer candidates on these commercial ranches. Consequently, these sires are likely to have a considerable impact on the genetic trend of these commercial herds into the future.

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