Using Proven Genetics in an AI Program*

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Introduction

The development of methods to synchronize estrus in beef cattle has been refined to a point that is feasible as well as reasonable to obtain pregnancy rates in mixed populations of cycling and anestrous cows that exceed 50% to a single fixed-time artificial insemination, provided a progestin based estrus synchronization protocol is used (Lamb et al., 2001; Kojima et al., 2002; Perry et al., 2002; Kojima et al., 2003a, 2003b; Bremer et al., 2004; Stegner et al., 2004; Bader et al., 2005; Schafer et al., 2005; and Larson et al., 2006). However, despite this level of success, recent surveys indicate that fewer than 10% of beef cows in the U.S. are bred artificially. Perhaps part of the reason for the low adoption rate of these technologies is due to the fact that there is little if any documented evidence of the economic value that is added as a result of this change in breeding management. Furthermore, to the knowledge of the authors there has been no published data regarding the differences in value that may be attained over time from both terminal groups of animals and replacement females, sired by bulls: 1) in a natural service setting; 2) the result of AI to older sires with predictable expected progeny differences; or 3) younger AI sires with limited data available to support their expected progeny differences. Therefore, the objective of this experiment was to determine the economic impact of using proven genetics in an AI program.

Terminology & Abbreviations

AI – Artificial Insemination
EPD – Expected Progeny Difference
High Accuracy Sires (HAS) – AI Sires with accuracies ≥ 0.85 for BW, WW, and YW EPDs at the time of synchronization and AI
Low Accuracy Sires (LAS) – AI Sires with accuracies < 0.85 for BW, WW, and YW EPDs at the time of synchronization and AI
Calving Ease Sires (CES) – AI Sires with high accuracies that were bred exclusively to virgin heifers
NS – Natural Service used after one round of fixed-time AI

Experimental Design

The calves used in this project were the result of matings from a trial comparing pregnancy rates resulting from fixed-time AI to one of two estrus synchronization protocols at four locations. A profile of the sires represented in this trial is summarized in Table 1. A common, high-accuracy AI sire was used at Locations 1, 2, and 4. Calves at all locations were weaned according to MFA Health Track requirements (www.mfahealthtrack.com) with the first round of vaccinations given prior to weaning. Calves were weaned on the same day within each location, all locations weaned within a two week period, and all calves were shipped to the same feedlot on the same day. Calves from the 4 locations were commingled and assigned to pens within breed type, by sire group (HAS, n = 96; LAS, n = 101; CES, n = 38, and NS, n = 93), and weight, and fed a common ration throughout the duration of the trial. The cattle were harvested over a 63 day period and determined to be finished according to ultrasound measurement of back fat thickness between the 12^{th} and 13^{th} rib, live weight, and visual observation of fat deposition patterns. All animals included in the analysis were harvested at the same commercial processing facility and individual carcass measurements were collected. To eliminate market variation that may have existed the year during which the trial took place, feeder calf value was determined using the Kansas State University price slide equation (Dhuyvetter et al., 2001) based on the three-year average of fed cattle and corn futures. Carcass value was determined using a dressed weight value base of $137.32/cwt based on 50% of the gross hot carcass weight for a pen of cattle grading Choice or better, with premiums and discounts added to the base price for actual performance of cattle in their respective sire groups. The value of premiums and discounts was based on three-year average historical USDA Agriculture Marketing Service reported values (Table 2; USDA, 2006) and did not fluctuate based on market seasonality.

Table 1. Profile of breed makeup and number of sires used at each location.

Location	Cow Breed	Breed of Sires	HAS[a]	LAS[b]	CES[c]	NS Sires[d]
1	Angus	Angus	1[e]	2	2	7
2	Red Angus / Gelbvieh	Red Angus	0	1	0	8
3	Angus	Angus	1[e]	0	2	4
4	Angus	Angus	1[e]	0	1	0

[a]Number of different high accuracy (HAS) AI sires, which had BW, WW, and YW EPD accuracies ≥ 0.85 at the time of breeding at each location.
[b]Number of different low accuracy (LAS) AI sires, which had BW, WW, and YW EPD accuracies < 0.85 at the time of breeding at each location.
[c]Number of different calving ease (CES) AI sires with high accuracies but bred exclusively to virgin heifers at each location.
[d]Number of different natural service (NS) sires used at each location.
[e]The same high accuracy AI sire was used at Location 1, 2, and 4.

Results

Economic Value. The most important factor contributing to the sustainability of production agriculture is the net economic return created and captured by implementation of production practices based on decisions and goals established by the manager(s). Due to variable management practices on each farm prior to weaning that can not be accounted for in the model, and which may affect production levels and value of calves at weaning, differences in value of calves at weaning among the different sire groups was not analyzed. Table 3 illustrates

Table 2. Historical value of premiums and discounts ($/cwt) reported by the USDA Agricultural Marketing Service for a 50% Choice/50% Select pen of cattle.

YG/QG	Prime	Certified	Choice	Select	Standard
1	$25.91	$19.69	$9.84	($3.88)	($16.39)
2	$24.42	$18.20	$8.35	($5.37)	($17.88)
3	$22.93	$16.71	$6.86	($6.86)	($19.37)
4	$14.63	$8.49	($1.44)	($15.16)	($27.67)

for each sire group the average weight, calf value ($/hd) at the start of the trial (entry into the feedlot), feedlot expenses, revenue, net return, and the difference in net return relative to the HAS group after conclusion of the trial. Although the calves in the HAS group entered the feedlot at statistically the same value as the calves in the LAS and CES groups, following the conclusion of the trial, the HAS calves had an average net return of $50.69 and $53.83 greater than the LAS and CES calves respectively. Additionally the HAS group had a $41.76 greater initial value than calves in the NS group, subsequently the HAS calves finished with $89.66 more in net return which corresponds to $47.90 increase in value added during the trial.

Each location involved in the study made pedigree records available on the cows in their respective herds, making it possible to analyze the differences in value that existed between calves from the various sire groups that were out of an AI sired or natural service sired dam to estimate the lifetime value difference that exists between different groups of replacement heifers. Table 4 shows the expected differences in lifetime value that exist between heifers from the HAS group compared to heifers from the NS group assuming: 1) one round of artificial insemination to a high accuracy sire was performed on the HAS sired daughters each subsequent breeding season; 2) artificial insemination was not performed on NS sired daughters (traditional management in most operations); and 3) the same quality of high accuracy and natural service sires represented in these data were mated to those females over their productive lifetime.

Table 3. Average pre-conditioned calf weight, value, total fed cattle revenue, total feedlot costs, and net return for calves in the high accuracy (HAS), low accuracy (LAS), calving ease (CES), and natural service (NS) sire groups and net return advantage of the HAS group relative to the other groups.

	HAS	LAS	CES	NS
Ave pre-conditioned calf weight	668^{w}	685^{x}	646^{y}	597^{z}
Ave pre-conditioned calf value ($/hd)[a]	$714.59^{wx}	$724.27^{w}	$701.64^{x}	$672.83^{y}
Total fed cattle revenue ($/hd)[b]	$1030.01^{w}	$1001.29^{x}	$975.02^{x}	$928.94^{y}
Total feedlot costs ($/hd)[c]	$244.93^{w}	$257.22^{x}	$256.72^{x}	$275.28^{y}
Net return	$70.50^{x}	$19.81^{y}	$16.66^{yz}	($19.17)^{z}
Net return relative to HAS	–	$50.69	$53.83	$89.66

[a]Average feeder calf value ($/hd) based on Kansas State University price slide equation using the three-year average of fed cattle and corn futures.
[b]Determined using a dressed weight value base of $137.32/cwt based on a 50% Choice/50% Select pen of cattle, with historical values for premiums and discounts as reported by USDA Agricultural Marketing Service added to the base price for actual performance of cattle in their respective sire groups.
[c]Includes yardage, feed costs, antibiotic costs, interest on the feeder calf value, and interest on half of all other costs.
[w,x,y,z]Values with a row containing a common superscript are not different ($P > 0.05$).

Table 4. Estimated lifetime value advantage of high accuracy (HAS) sired replacement females compared to natural service (NS) sired replacement females.

Expected average lifespan (yr)	Lifetime value difference ($/replacement female)[a]
4	$248.43
5	$306.08
6	$362.08
7	$416.40

[a]Net present value computed assuming a 3% discount rate.

Morbidity. Approximately 60 to 70 days into the start of the trial there was a respiratory outbreak, which was diagnosed by veterinarians to be Bovine Respiratory Syncytial Virus (BRSV). Since there were no NS sired cattle from Location 4 they were excluded from the analysis of morbidity rate. A significantly larger percentage of NS sired calves were treated for respiratory problems than HAS calves, LAS calves, and CES calves, but treatment rates among different AI sire groups were similar (Table 5). Furthermore, calves from the same sire group but originating from different locations, had similar treatment rates, which suggests that genetics may play a greater role in disease resistance than what has been previously reported (pre-weaning, $h^2 = 0.10$; post-weaning, $h^2 = 0.06$; Muggli-Cockett et al., 1992).

Table 5. Number of calves and comparison of respiratory treatment rate among high accuracy calves (HAS), low accuracy calves (LAS), calving ease calves (CES), and natural service calves (NS) from locations 1, 2, and 3.

	HAS	LAS	CES	NS
n	48	101	25	93
Treated	6.3%[a]	11.9%[a]	16.0%[a]	39.8%[b]

[a,b]Columns containing a common superscript are not different ($P > 0.05$).

Carcass Characteristics. Despite the fact each sire group were harvested at the same average yield grade (Table 6), which suggests that all cattle were harvested at the same point relative to being finished, there were significant differences among sire groups for average quality grade (Table 6, Figure 1), ribeye area (REA) determined by instrumental measurement, hot carcass weight (HCW), and age at the time of harvest (Table 6).

Table 6. Number of cattle, percentage grading Prime, Certified Angus Beef (CAB) or better, and Choice or better, mean quality grade (QG), yield grade (YG), ribeye area (REA), hot carcass weight (HCW), and age at harvest for calves in the high accuracy (HAS), low accuracy (LAS), calving ease (CES), and natural service (NS) sire groups.

Sire Group	n	Prime (%)	CAB or better (%)	Choice or better (%)	QG	YG	REA	HCW	Age (d)
HAS	96	15.6[a]	66.7[a]	100[a]	Choice +[a]	2.5	12.0[a]	669[a]	408[a]
LAS	101	5.0[bc]	18.8 [b]	76.2[bc]	Choice –[b]	2.5	11.8[ab]	690[b]	430[b]
CES	38	5.3[ab]	57.9[a]	81.6[b]	Choice[c]	2.5	11.4[b]	660[ac]	443[c]
NS	93	0[c]	14.0[b]	67.7[c]	Choice -[b]	2.4	11.5[b]	646[c]	416[d]
Total	328	6.7	36.0	81.4	Choice	2.5	11.7	668	421

[a,b,c]Values within a column containing a common superscript are not different ($P > 0.05$).

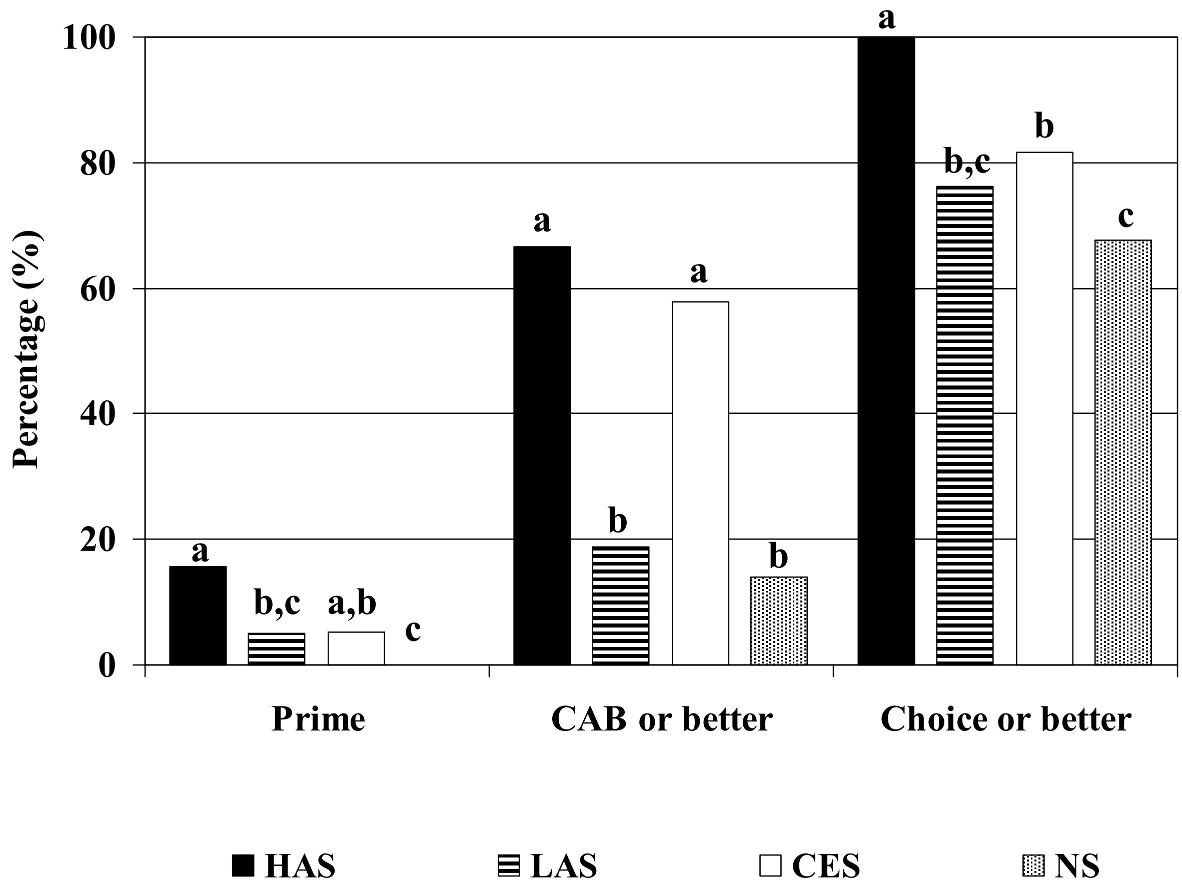

Figure 1. Distribution of quality grades by high accuracy (HAS), low accuracy (LAS), calving ease (CES), and natural service (NS) sire groups.
[a,b,c]Bars within a set containing a common superscript are not different ($P > 0.05$).

Discussion

The difference in net value between calves from the HAS group when compared to the other groups, illustrates that the current marketing strategies that exist in the market place today for weaned or preconditioned calves do not account for or pay cow/calf producers for the true differences in economic value due to the genetic merit of their calf crop. If it is a priority for a producer to capture the full value that is created from improved genetics through the use of artificial insemination one must first know the value of the genetic base that exists in his or her cow herd from which the AI sired calves were produced. To determine that value and position one's self to negotiate a fair feeder calf value for future calf crops, individual carcass data must be captured on a subset of progeny. This means in the beef production setting that exists today, a producer must either retain full or partial ownership of the calves or make sharing of production and carcass data a contractual term of sale.

The economic analysis of this trial was designed so the base price and grid premiums/discounts were constant, thus eliminating the potential effect market seasonality could play on any particular sire group relative to when the respective cattle in a group were harvested. Historical data of quality grade premiums illustrates that in spring markets for fed cattle there is a steady increase in quality grade premiums reaching a peak sometime between mid-April and mid-May before sharply decreasing. Consideration of that fact illustrates to optimize net return on spring born calves, with genetics capable of achieving a high percentage choice, and which will be harvested between 13 and 18 months of age, it is imperative for those calves to be finished and ready to be marketed at as young of an age as possible. Calves in the HAS group when compared to all other groups were harvested at the same yield grade with a higher average quality grade at a younger age, which corresponds to the time of year when traditionally the choice/select spread would be at its highest point. Therefore, the differences in value that existed among sire groups may have been amplified if the analysis were to include the historical seasonality of fed cattle markets.

The difference in expected lifetime value of heifers from the HAS group over heifers from the NS group further illustrates the value that is created from reproductive management practices, however, creating added value is worth nothing, unless steps are taken to capture part of the added value. The value differences shown between the two groups of heifers are based off of the value that had been added in those herds through previous use of AI to sires with potentially but not necessarily similar EPD accuracies and/or genetic merit in relation to the high accuracy sire used in this trial. What is unknown at this time is the potential value that can be created by adhering to a strict management system that includes AI only to sires with high accuracies and genetic merit similar to that of the high accuracy sire used in this trial, and the extent to which that value could be magnified.

While the intention of this trial was not to determine the effect of different sires on the health of cattle of different genetic backgrounds, the differences in treatment rate that existed among the different sire groups is a noteworthy point. The differences that existed in this trial raise questions for future research to determine whether the heritability of disease resistance is higher than the values reported by Muggli-Cockett et al., 1992, or if through the use of high accuracy AI sires there can be indirect selection pressure applied to their progeny for disease resistance.

Conclusions and Implications

Estrus synchronization and artificial insemination to sires with high accuracy are both reproductive management tools that provide the opportunity to increase the profitability and marketability of terminal calf crops in addition to increasing the value of cow herds. Furthermore, while artificial insemination to sires with high accuracy may not always result it optimized performance for every trait, it offers the greatest probability of making improvements in the traits to which selection pressure is applied.

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