Maximizing Efforts

Speakers explore how to get the most out of cow herd reproductive efforts.

*by **Kasey Brown,** associate editor; **Shauna Rose Hermel,** editor; & **Troy Smith,** field editor*

As the 2013 Applied Reproductive Strategies in Beef Cattle (ARSBC) Symposium in Staunton, Va., Oct. 15-16 wound down, speakers were charged with focusing on how cattlemen could get the most out of cow herd reproductive efforts. Following up on that charge, Wednesday afternoon's speakers addressed the inherent advantages of artificial insemination (AI), using natural-service sires in multi-bull pastures and fetal programming, as well as embryo transfer (ET) and gender-sorted semen.

Capitalizing on advantages of AI

AI gives breeders many advantages in terms of management, economics and genetic improvement, said Scott Greiner, extension beef cattle specialist with Virginia Tech.

"There are lots of reasons to AI, and we've spent this conference … talking about those benefits," Greiner said. AI and estrous synchronization help enhance reproductive efficiency, jump-start non-cycling cows to start cycling, shorten breeding and calving seasons, increase the average age of calves and their uniformity at sale time, increase pay weights, improve management of cows and calves, and improve the herd's genetics, said Greiner.

"As we look at making genetic change in beef cattle, there's really four critical areas," said Greiner, pointing to accuracy of selection, selection intensity, genetic variation in the trait and generation interval. "How quickly we can change genetics and how effectively we can do that are influenced by these things."

One of the big reasons to AI is the opportunity to use proven, high-accuracy bulls, said Greiner, describing accuracy as the correlation, or relationship, between the true breeding value of a bull and his estimated breeding value.

"In a perfect world, that relationship is 1," he explained. "That means with 100% confidence, or correlation of 1, that we truly know what that bull's breeding value is. That never happens. We can approach that, but we never know with 100% confidence."

On the other end of the spectrum is 0, which Greiner called equivalent to randomly picking a number and putting it down on paper. Yearling bulls with a performance pedigree generally have accuracies of 0.05-0.30. AI sires that have been widely used in numerous herds may have accuracies of 0.9 and greater.

AI offers advantages in accuracy of selection, selection intensity and even genetic diversity.

Greiner explained that the industry deals in Beef Improvement Federation (BIF) accuracies, which are more conservative than true accuracies (see Table 1) and should give cattlemen greater confidence in the predictive power of the EPD.

Accuracies have value in showing us how much an individual's EPDs might change with more data added from additional progeny and additional herds, Greiner noted. Breed associations publish possible change values that can be used to establish a range in which the true EPD would fall (see Table 2).

Greiner said he finds it useful to plot that possible change on the percentile table as depicted in Fig. 1. The green circle encloses the range in which the proven bull's probable true birth weight EPD would be expected to occur two-thirds of the time.

PHOTOS BY TROY SMITH

►Accuracies have value in showing us how much an individual's EPDs might change with more data added from additional progeny and additional herds, Virginia Tech Extension Beef Cattle Specialist Scott Greiner noted. Breed associations publish possible change values that can be used to establish a range in which the true EPD would fall.

Table 1: Relationship between "true" accuracy and BIF accuracy

True accuracy	BIF accuracy
0.1	0.01
0.3	0.05
0.6	0.20
0.8	0.40
0.9	0.56
0.95	0.67
0.99	0.86
0.999	0.99

Source: Scott Greiner, ARSBC presentation, Staunton, Va., 2013.

Table 2: Accuracy and possible change

	BW accuracy	BIF accuracy	Possible change	'True" EPD range
Sire A	+1.0	0.25	±2.0	-1.0 to + 3.0
Sire B	+1.0	0.90	±0.3	+0.7 to +1.3

Source: Scott Greiner, ARSBC presentation, Staunton, Va., 2013.

Table 3: Progeny records and accuracy

BIF accuracy	Heritability		
	Low (0.1)	Moderate (0.3)	High (0.5)
0.05	4	2	1
0.20	22	7	4
0.40	70	22	13
0.56	167	53	30
0.99	3,800	1,225	700

Source: Scott Greiner, ARSBC presentation, Staunton, Va., 2013.

The red box indicates the range in which the lower-accuracy bull's probable true accuracy would be expected to fall. Whether he changes favorably or unfavorably, the high-accuracy sire is going to be a calving-ease sire. Not so for the unproven bull.

"Keep in mind that from a statistical standpoint, the chances are equal that the young bull will get better in terms of calving ease and lower birth weight," he emphasized. "That chance is equal to him getting poorer from the context of being a heavier-birth-weight bull." There is also a chance that he would fall out of that 67% confidence-interval box.

Greiner said accuracy is influenced by data (both quantity and quality), including pedigree, individual performance and progeny data; heritability; and genomics.

Greiner shared a table (Table 3) showing how the number of progeny records influence accuracy for traits of low, moderate and high heritability. As heritability goes up, fewer progeny are needed to achieve higher accuracy levels.

Genomics are now being applied in several breeds to enhance EPDs, Greiner noted. Genomic results are incorporated into EPDs as a correlated trait through national cattle evaluation, adding information and enhancing the accuracy of the EPDs cattlemen are already using.

Fig. 1: Possible change for high-accuracy sire (green circle) and low-accuracy sire (red box) depicted in Table 2 plotted on percentile table

	CED	BW	WW	YW
1%	15	-2.9	71	124
2%	14	-2.2	68	119
3%	14	-1.9	66	116
4%	13	-1.6	65	114
5%	13	-1.3	64	112
10%	11	-0.6	60	106
15%	10	-0.1	57	102
20%	10	0.3	55	99
25%	9	0.6	53	96
30%	8	0.9	52	94
35%	8	1.1	51	91
40%	7	1.3	49	89
45%	7	1.6	48	87
50%	6	1.8	47	85
55%	5	2	45	83
60%	5	2.2	44	81
65%	4	2.5	43	79
70%	3	2.7	41	76
75%	3	3	40	73
80%	2	3.2	38	70
85%	1	3.6	35	66
90%	0	4	32	61
95%	-3	4.7	27	51

Source: Scott Greiner, ARSBC presentation, Staunton, Va., 2013.

"How much the genomic result impacts accuracy is dependent on several factors," said Greiner. "One of those is how much of the genetic variation does that genomic test explain in the trait itself." The more variation it explains, the larger its influence on accuracy.

Using examples from Angus, Greiner said most of the traits for which there are genomic tests explain between 35% and 49% of the genetic variation of the trait. That means that for most traits, genomic results would be similar to having eight-20 progeny records (depending on the trait). That can increase the confidence level in buying unproven yearling bulls.

Regarding selection intensity, Greiner noted that a significant number of proven sires are superior to breed average for multiple traits. These proven bulls can be used as AI sires to provide genetic reach with confidence and predictability.

AI also helps manage genetic antagonisms, Greiner said. Several traits are antagonistic to each other, like calving ease and growth, growth and mature size, marbling and carcass fat, and marbling and ribeye area. Calling

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them "curve benders," he noted that several proven sires have favorable combinations of these antagonistic traits.

Some producers worry that AI will reduce genetic variation, but Greiner offered a different view. AI gives the opportunity to select multiple sires of differing pedigrees but similar genetic merit, so pedigrees can be diverse without compromising uniformity in genetic quality. Additionally, he noted that AI helps a crossbreeding program by requiring fewer bulls and fewer breeding pastures.

Additional benefits include simplification of natural-service sire selection in AI herds. For instance, if a maternal sire is used to AI heifers, a higher-birth-weight-EPD, terminal sire can be purchased as a cleanup bull, generally at a lower price point.

The advantage of AI calves being born earlier in the season in a tighter group with better genetics interact to add value to AI-sired calves, noted Greiner, sharing documented added value shared by commercial cattlemen Tim Sutphin (at the 2010 ARSBC Symposium) and Terry Slusher (earlier during this symposium).

In terms of non-EPD traits such as udder scores and other phenotypic traits, the AI companies have in place systems to help evaluate and rate bulls.

In conclusion, Greiner noted, "Every great proven bull was once a young, unproven bull — every single one of them. We need to keep that in mind and certainly there's a need to test those young, exciting bulls, get them proven and then put them to work."

— by Kasey Brown & Shauna Hermel

Natural-service bull performance and production

Natural-service breeding remains a dominant management practice among U.S. cow-calf producers — especially in commercial herds. Particularly in western range areas, producers often manage large groups of cows in large multi-sire pastures. Even though a battery of bulls shares the work, producers can determine sires of individual calves through DNA testing. Researchers using parentage testing have found that bulls in a common breeding pasture certainly don't share the work equally.

►Bulls with the greatest impact on profitability weren't the bulls with the highest weaning or yearling weight EPDs, or the ones that sired the heaviest calves, said Dan Drake of UC–Davis. Bulls that sired the most calves had the greatest positive economic impact.

As a member of University of California–Davis (UC–Davis) Extension personnel, Dan Drake has been involved with paternity and performance research showing that some bulls are overachievers and others are slackers. Drake shared what research suggests regarding how bulls really affect ranch economics.

According to Drake, the three-year study was based on data collected from more than 5,000 sire-identified calves representing 15 calf crops on three California ranches. Calves came from both spring- and fall-calving herds. Breeding seasons ranged from 60 to 120 days, but all ranches used a 25:1 cow-to-bull ratio in breeding pastures of 100 acres or less.

"The average number of calves sired per bull was 18.9. In every calf crop, some bull distinguished himself by siring over 40 calves. Some bulls sired very few," said Drake. "One bull actually sired 64 calves in a crop. One bull sired one calf, and more than one bull sired no calves at all."

Drake said the study revealed some interesting things about the most prolific bulls. For instance, some bulls successfully mated with 10-12 cows per day. It was not uncommon for one-third of a bull's single-season progeny to have been sired during one 24-hour period. Also, nearly all of the difference in bull prolificacy was represented in the first half of the breeding season. Prolific bulls generated the most conceptions in weeks three, four and five.

In a multi-sire pasture situation, how many calves a bull sires has greater impact on profitability than the performance of his calves.

Drake said the study suggests that varying prolificacy of herd bulls has implications for home-raised replacement females, since most heifers born in the first half of the calving season were daughters of prolific bulls. Selection of early replacement females from prolific sires would be predicted to have a positive effect on herd fertility.

According to Drake, the study illustrates how important reproduction is to profitability, because prolific bulls had the greatest positive impact to the ranches, economically.

"It wasn't the bulls with the highest weaning weight or yearling weight EPDs. It was not the sires of the heaviest calves," said Drake. "It was the bulls that sired the most calves."

— by Troy Smith

►Researchers using parentage testing have found that bulls in a common breeding pasture certainly don't share the work equally.

PHOTO BY SHAUNA ROSE HERMEL

Implications of fetal programming

While studying the impact of protein supplementation during winter grazing, University of Nebraska researchers observed how supplementation had little effect on beef

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cow reproductive performance as previously believed. However, evidence suggests supplementation of the pregnant cow does affect her calf.

According to Rick Funston, a reproductive physiologist at Nebraska's West Central Research and Extension Center, the research illustrates how the nutritional status of cows during pregnancy can have far-reaching consequences for their calves as a result of fetal programming. Funston explained the eventual impacts on steer calf performance and the reproductive performance of heifer calves saved as herd replacements.

►"Consequences of nutrient restriction must be considered not only for the dam, but for the calf she carries," stated Rick Funston of the University of Nebraska's West Central Research and Extension Center.

Funston said data were collected on three consecutive calf crops born to cows that, prior to calving, had grazed winter range and received protein supplement. That was compared with data from calves born to cows that grazed winter range but received no supplement, as well as data from calves out of cows wintered on cornstalks, with and without supplemental protein. While subsequent cow reproduction was not hindered by protein restriction, steer calves born to protein-restricted cows exhibited lighter weaning weights and lighter finished weights. Evidence also suggests their potential for achieving quality grades of Choice or better was reduced.

Evidence suggests supplementation of the pregnant cow affects heifer and bull progeny.

Cow nutrition also appeared to have a fetal-programming effect on heifer fertility. Among heifer calves saved and developed as replacement females, those whose dams were protein-restricted exhibited lower reproductive performance. Supplemented cows produced daughters with higher pregnancy rates, and more of those heifers delivered their first calves early in the calving season.

"Consequences of nutrient restriction must be considered not only for the dam, but for the calf she carries," stated Funston.

Funston said there is considerable evidence from studies of human health and nutrition that shows the effects of fetal programming. He cited evidence from human populations showing that malnutrition during times of war impacted the next generation. When humans were subjected to severely restricted diets and other stresses, their children were more likely to eventually develop metabolic disorders.

"There is gene-signaling or silencing that is triggered by nutrition factors experienced by parents — fathers, as well as mothers."

— by Troy Smith

Embryo transfer: the last 20 years

ET can let breeders improve their herd genetics over time, expand their herd quicker and market individual cow families, said Randall Hinshaw, veterinarian with Ashby Herd Health Service Inc. He explained some "old truths" from his 30 years of experience in embryo transfer.

The donor is the largest variable in embryo production — not the FSH (follicle-stimulating hormone) protocol, not the practitioner nor the environment, said Hinshaw. He said it depends upon the follicular wave, and some donors are just suited for superovulation.

The recipient (recip) is the largest variable in the conception rate, not the embryo or the practitioner. However, chance is the largest variable in small groups.

Ultrasound has changed the practice of ET, Hinshaw said. There are many benefits, but the biggest for ET are being able to determine the sex of the fetus, to assess superovulation before breeding, and to understand follicular dynamics.

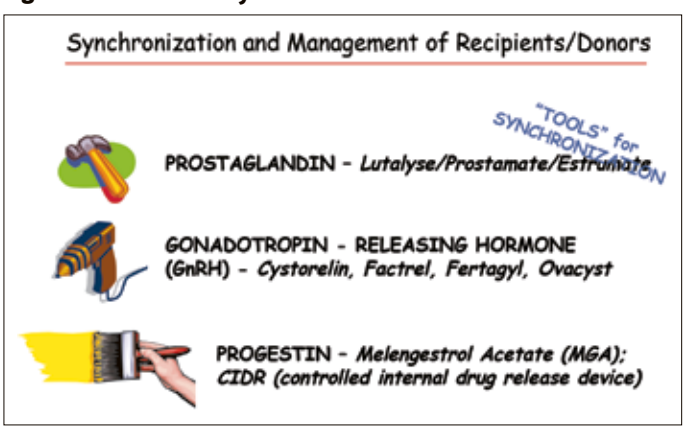
No matter which protocol is used, there are three tools for synchronization, Hinshaw explained. Prostaglandin administered between Day 5 and Day 20 of the estrous cycle regresses the corpus luteum (CL). Gonadotropin-releasing hormone (GnRH) either resets follicle development or starts the ovulation of a follicle by causing a surge in luteinizing hormone (LH). He noted that donors do not need estradiol anymore, because GnRH does the same thing with similar results. Progestin [melengestrol acetate (MGA) or controlled internal drug release (CIDR®) device] inhibits heat and blocks ovulation. With these tools, it is possible to collect from multiple donors at the same time.

►The donor is the largest variable in embryo production, explained Randall Hinshaw, veterinarian with Ashby Herd Health Service Inc. The recipient is the largest variable in the conception rate.

Per collection, he said the average is about eight embryos, though it can range from zero to more than 18.

With frozen embryos, he said to expect 55%-60% pregnancy rates using Grade 1 embryos. Results will be 10%-15% lower with Grade 2 embryos and 20%-30% lower with Grade 3 embryos. Using fresh embryos

Fig. 1: Three tools for synchronization



Source: Randall Hinshaw, ARSBC presentation, Staunton, Va., 2013.

generally results in pregnancy rates 7%-10% better than with frozen embryos.

Using sorted semen reduces transferable embryos by about 50%, and the availability of sorted semen is bull-dependent. He noted that he has seen better results in virgin heifers, and that splitting embryos improves output. It can also be used with *in vitro* fertilization (IVF), where a donor's ovaries are aspirated transvaginally, the oocytes are matured and fertilized in a laboratory dish, and the embryos are then transferred.

Advantages to IVF are that it can be done every other week and it works on problem donors. Hinshaw added that valuable semen can be used on multiple donors this way, and he is able to aspirate pregnant cows. However, it is costly, yields lower conception rates, and results in higher pregnancy wastage and more fetal anomalies. Logistics also poses a problem.

Cost of production for ET for one donor can be about $800, with the estimated cost per embryo around $105. With five donors, the cost per embryo is reduced to about $81.

— by Kasey Brown

Potential for gender-sorted semen is growing

Whether you call it gender-selected, sex-sorted or just sexed semen, University of Idaho animal scientist John Hall said he believes it is a technology that will see increased use among commercial cow-calf producers, though it probably won't happen right away. Hall said AI with sexed semen has much potential, but the technology has limitations, and its application can be challenging.

While the ability to select calf gender was more readily embraced by the dairy industry, Hall said adoption by the beef industry remains slow. The number of beef sires for which sexed semen is available has grown. However, the genetic diversity accessible through sexed semen remains low compared to the use of conventional semen. For one reason, sexed semen costs more. There are also challenges to its application.

Hall said sexed semen research involving beef cattle remains somewhat limited. Results of heifer research are consistent with studies in dairy heifers that indicate a 10%-20% decrease in AI conception rates with sexed semen compared to conventional semen.

The dairy experience has discouraged use of sexed semen in fixed-time AI, which is becoming an increasingly popular application of AI for mature beef cows. Hall said beef cow research suggests using sexed semen after detected estrus is best, but fixed-time AI is feasible. Generally, there is a 10%-20% decrease in pregnancy rates compared to conventional semen, with greater variability in success.

►Under current conditions, an average premium of $200 per head is required to provide a sufficient marketing advantage to warrant the use of gender-sorted semen, said John Hall, University of Idaho.

Several factors affect success rates. Hall said cows or heifers that are inseminated based on estrus or exhibit estrus before fixed-time AI have greater pregnancy rates to sexed semen.

A $200 marketing advantage for one gender over another may be sufficient to encourage use of gender-sorted semen in the beef industry.

"Animals not in heat are not good candidates," emphasized Hall.

Timing of insemination with sexed semen appears to have an affect on pregnancy rates, since sexed semen remains viable for a shorter time after insemination. Hall said inseminating estrous cows at the normal fixed time, but delaying insemination of non-estrous cows until after inducing ovulation with GnRH may offer better results.

"The GnRH would be given to non-estrous cows at the normal insemination time, but insemination would be done 20 hours later," explained Hall.

Sire selection is another consideration when using sexed semen, as bull fertility differences appear to be magnified after semen is sorted for sex. Hall said increasing sperm dose offers little improvement.

Using sexed semen in superovulated cows to produce embryos also results in decreased reproductive efficiency. According to Hall, researchers noted a 20%-35% reduction in the number of transferable embryos when using sexed semen.

In vitro fertilization drastically reduces the number of sorted sperm needed to fertilize an oocyte. Instead of millions of sperm, IVF requires only 600-1,500 sorted sperm to fertilize an oocyte (egg). Hall said this greatly increases the potential number of sexed offspring from a sire.

Pregnancy rates from IVF cultured embryos fertilized with sexed semen range from 30%-50%. While these pregnancy rates may seem low, they are offset by the number of embryos that can be produced.

Currently, the most common beef industry application of sexed semen is to increase the number of animals of the desired gender in purebred operations. It may be used to increase the number of sons from a popular sire or to produce more daughters from a maternal line. The latter also might be applied in commercial operations seeking to produce more replacement heifers. Hall explained how the University of Idaho has used this strategy to produce Hereford-Angus-cross females by inseminating selected cows with X-sorted semen.

Hall foresees the day when commercial operators may use sexed semen to shift the gender ratio of calves produced to more steers. For example, small- to mid-sized operations that currently must sell mixed loads of calves might be able to market load lots of steers. Hall warned that a sufficient marketing advantage would have to be achieved. Under current conditions, an average premium of $200 per head is probably required. Improvements to sexed-semen technology — higher pregnancy rates in particular — are needed to make application in commercial operations economically viable.

— by Troy Smith

Editor's Note: *Greiner, Drake and Funston spoke during Wednesday's ARSBC session focused on genetic and management tools to get the most from reproductive efforts, while Hinshaw and Hall spoke during the final session on current topics in reproductive management. Visit the Newsroom at* www.appliedreprostrategies.com/2013 *to listen to their presentations and to view their PowerPoint slides and proceedings papers. This comprehensive coverage of the symposium is compiled by the* Angus Journal *editorial team. The site is made possible through sponsorship by the Beef Reproduction Task Force.*