AGRICULTURAL

MU Guide

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Genetics of Reproduction: Considerations for Sire Selection

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The beef industry has made tremendous use of genetic selection to improve economically important traits. Most recently, much of that progress has been through the implementation of expected progeny differences (EPDs). Expected progeny differences make it possible to compare the genetic merit of two or more animals for any number of traits. Most EPDs involve growth or carcass traits, because most producers are paid by the pound, or in some instances by merit of individual carcasses. For the most part, selection of female reproductive traits has been ignored even though reproduction plays a vital role in the economics of any beef operation. Recent studies suggest that to maximize profit in a typical cow/calf operation, reproduction should receive the greatest emphasis. Even in a fully integrated beef operation, reproduction warrants equal emphasis with production and consumption traits.

To illustrate the importance of reproduction, consider the herd characteristic of calves weaned per cow exposed for service. Contrast two herds, each with 50 cows. Assume an average weaning weight of 475 pounds at a value of $0.65/lb in each of the two herds. However, one herd has 85 percent calves weaned per cow exposed while the other has 75 percent. That is equivalent to more than a $1,500 difference in value in the current calf crop. This doesn't consider any other effects on profit, such as feed costs that might be associated with cows that did not wean a calf. In this example, it is easy to see how reproduction is vital in maximizing profit.

It has been difficult to apply genetic selection for female reproductive traits. There seems to be limited consensus on how female reproduction should be expressed. Suggested traits include lifetime pregnancy rate, postpartum interval and calving date. However, it is much easier to gather accurate data on birth and weaning weights than on any of these reproductive traits. This presents a problem if EPDs were calculated for female reproductive traits. Also, female reproductive traits appear to be only slightly heritable, as shown in Table 1. Heritabilities range from 0 to 1; values closer to 1 indicate that a trait responds better to selection.

Table 1. Heritability of female reproductive traits.

Trait	Heritability
Days to calving	.08
Calving date	.04
Calving day	.05
Lifetime pregnancy %	.04
First rebreeding post-calving	.10
Age at first breeding	.19
Age at first estrus	.15

The low heritabilities for cow reproductive traits suggest that selection response based on those traits would be slow. However, there may be other traits that respond to selection and indirectly affect cow reproduction.

Birth weight

Obviously, heavier birth weights will lead to increased difficulty in calving, or dystocia, resulting in additional losses of calves and possibly cows. Even though calving difficulty is scored on a scale of 1 to 5, we might think of dystocia on more of a continuous scale. In other words, just because we didn't have to assist a cow at calving doesn't mean she didn't experience dystocia as opposed to a "normal" parturition, or *eutocia*.

Decreasing dystocia may provide a reproductive benefit to the cow/calf enterprise. In a study involving almost 2,000 cows, Laster and co-workers (1973) described the reproductive performance of cows that experienced dystocia versus those that did not. When the 45- to 60-day artificial insemination period was evaluated, 74 percent of the cows that calved with no difficulty were detected in estrus while 59 percent of the cows that experienced dystocia were detected in estrus. Additionally, there was a 16 percent advantage in conception rate to those cows that experienced no dystocia. Not surprisingly, these researchers found a strong relationship between calving difficulty and calf birth weight. Therefore, decreasing birth weights may be a consideration in reducing the postpartum interval, especially in an operation where dystocia or

Table 2. Postpartum reproductive performance in cows exhibiting short versus normal duration labor.

Labor duration	Number of cows	Postpartum interval (days)	% in estrus by breeding season	Services/ conception	October pregnancy, %
Short	67	52.4	91.4*	1.15	89.5**
Normal	60	54.4	81.7	1.23	75.6

*P < .10
**P < .05

Source: Doornbos et al., 1984.

Table 3. Selection for low birth weight and high yearling weight in Angus cattle.

Line	Number	Sires	Birth weight lb	Birth weight EPD, lb	Weaning weight lb	Weaning weight EPD, lb	Yearling weight lb	Yearling weight EPD, lb
High	87	4	77.8	7.3	455	31.3	750	56
Low	83	5	69.7	.9	441	19.6	735	42
Difference			8.1	6.4	14	11.7	15	14

Source: Arnold et al., 1990

length of postpartum interval has been a problem. By decreasing the postpartum interval, cows have more chances to be bred and should achieve higher conception rates.

The postpartum interval may also be reduced by shorter duration of labor. In a study by Doornbos and co-workers (1984) involving 127 cows, about half of the females were allowed to calve normally unless assistance was needed. The calves of the other cows were taken beginning at Stage II of labor. Stage II is described by these researchers as that point in parturition at which the cow begins an abdominal press. Thereafter, postpartum reproductive performance was evaluated (Table 2.) Ten percent more of the cows that experienced short-duration labor had been observed in estrus by the beginning of the breeding season, and about 14 percent more were pregnant at palpation. If lighter birth weight calves result in shorter duration of labor in cows, then again reproductive efficiency might be enhanced.

If lower birth weight in calves correlates with better future reproductive performance of their dams, then certainly birth weight should receive emphasis in sire selection. Many producers may hesitate to reduce birth weights, and it may not be necessary for many operations. Although selection for any single trait over a period of time can produce unwanted results, if a herd shows a moderate or high number of assisted births, then birth weight may need to be considered in selecting a sire.

Regardless of the breed of the selected sire, birth weight EPDs provide a means of lowering birth weight through individual sire selection. Arnold and co-workers (1990), evaluated the efficacy of birth weight EPDs in purebred Angus cattle. Low and high birth weight EPD sires with accuracies of at least 0.8 were identified for each of the lines. Sires in each of the lines had to have yearling weight EPDs of at least 44 pounds. Progeny from each of the sire lines were evaluated for birth, weaning and yearling performance. Based on the sire EPDs for birth, weaning and yearling weight, an expected response difference was calculated and compared with the actual progeny performance difference (Table 3). The expected response difference between the lines for birth weight using EPDs was 6.4 pounds while the observed birth weight difference was 8.1 pounds. The expected response difference between the lines for yearling weight using EPDs was 14 pounds, while the observed yearling weight difference was 15 pounds. This study supports the use of EPDs to select bulls that have low birth weight genetics but still excel for growth.

Scrotal circumference

Many purebred breeders have been collecting yearling scrotal circumference data for some time. In fact, several breed associations have developed yearling scrotal circumference (SC) EPDs. Even though a large amount of research has been dedicated to evaluating relationships between scrotal circumference and male fertility traits, could there be any existing relationships with female fertility traits? Brinks and co-workers (1978) estimated a genetic correlation of −.36 between yearling scrotal circumference and age at puberty in females, indicating that bulls that have the genes for larger scrotal circumference will also have paternal sibs or daughters that reach puberty earlier. More recently, Morris and others (1993) estimated a genetic correlation of −.64 between the same traits in Angus cattle, indicating even a stronger relationship than in the first study. The presence of such a genetic correlation could provide a beneficial “correlated response” in age at puberty in heifers by selecting sires with genes for larger scrotal circumference. The low heritability of female reproductive traits in gener-

Table 4. Genetic correlations between yearling scrotal circumference and female reproductive traits.

Trait	Genetic correlation
Age at first breeding	−.39
Age at calving	−.14
Age at first calving	−.38
Pregnancy rate	.34 to .56
Calving interval	−.42
Days to calving	−.25 to −.41

al would result in a slow response in female reproductive performance through direct selection for those traits. Considering the recent research indicating that scrotal circumference is moderately heritable, we may be able to select indirectly for age at puberty by using bulls with genes for larger scrotal circumference.

Table 4 shows a number of favorable genetic relationships between scrotal circumference and female reproductive traits. All of the relationships are moderate in size and favorable in direction. Many of these traits are probably associated with age at puberty in heifers.

Although many research studies have evaluated the relationships between scrotal circumference and female reproductive traits, there have been only limited reports of selection studies based on sire scrotal circumference. Morris and co-workers (1993) suggest that advantages in age of puberty in females would occur by selecting bulls with larger scrotal circumference. Based on direct selection for scrotal circumference in 141 Angus sires, these researchers were able to reduce age at first estrus in daughters by 21 days relative to a randomly mated control line, while increasing scrotal circumference by 1.6 cm in male progeny. Additionally, average calving day was reduced by almost five days.

Many seedstock breeders collect yearling scrotal circumference data and as a result, several breed associations now compute SC EPDs. However, limited information is available on the selection response based on SC EPDs. Based on only one year's data, a study using Hereford cattle at Auburn University showed that daughters of bulls from a high SC EPD line reached puberty 62 days earlier than daughters from bulls of a low SC EPD line (Hough, 1991; Hough, American Hereford Association, Kansas City, Mo., personal communication).

Summary

Reproductive performance plays an important role in the profitability of any beef operation. Designed crossbreeding systems that take advantage of maternal heterosis should always be considered. However, other considerations for selecting sires within-breed may enhance reproductive performance in the herd, both in cows to which those bulls are mated and in their resulting female progeny. Attention to both birth weight and scrotal circumference EPDs in sire selection may provide beneficial correlated responses in the postpartum interval and age at puberty.

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