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IMPROVING COWHERD REPRODUCTION VIA GENETICS

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A beef cow's job is not an easy one. She is expected to conceive at slightly over one year of age to calve by the time she is two and rebreed shortly after that while weaning a healthy, viable calf. Furthermore, we demand she consistently repeats this cycle for the rest of her life — one stumble and, in the words of California's terminating governor, hasta la vista, baby!

To be sure, producers are best served when the cow successfully performs her task for many years, as the longer her productive life the more profitable she is to the enterprise. Is there anything that can be done to help her out? Certainly, there are environmental factors we can manage that will give her a leg up. For example, by providing adequate nutrition, a proper vaccination regimen and mating her to easy-calving sires (particularly when she is young) we increase the odds of her success. While a cow's environment has a substantial impact on her reproductive performance, her genetic makeup can too. This paper explores the genetics of female reproduction and offers suggestions on how to improve the reproductive performance of your cowherd via genetics.

Crossbreeding

The obvious place to start a discussion about the genetics of female reproduction is with the factor far and away has the greatest effect on it — crossbreeding. It has long been recognized crossbreeding enhances virtually all aspects of reproductive performance. Studies too numerous to list here have established the reproductive superiority of crossbred over straightbred cows.

In one of an abundance of studies with similar findings, scientists at the U.S. Meat Animal Research Center (MARC) concluded two-breed rotational cross cows produced 20% more calves over their lifetime than straightbreds due to the favorable impact of heterosis on dam fertility/longevity and calf survivability brought about by the improved calving and mothering ability of the dam (Cundiff et al., 1992). Furthermore, they estimated when mated to a bull of another breed the two-breed cross cows would wean 36% more weight over their lifespan than straightbred cows raising straightbred calves. The dramatic increase is attributable to the positive influence of heterosis on reproduction and production in the dam and well as increased growth and survivability in their calves.

Given the overwhelming evidence of the crossbred cow's reproductive supremacy and the fact reproduction is a major piece of the profitability puzzle (by most accounts exceeding all other functions by a wide margin in relative importance), it is difficult to conceive of a situation where a commercial enterprise would not benefit financially from a crossbred cowherd.

Am I implying selecting animals within a breed for reproductive performance is not a worthwhile endeavor? No! Reproductive progress can be made via selection (which I will address later); however, it would take years of intense selection within a breed to yield the kind of improvement achieved in one fell swoop by simply crossbreeding.

Therefore, crossbreeding makes a logical cornerstone in any effort to enhance cowherd reproductive performance. With crossbreeding as the foundation, the selection of superior animals of multiple breeds as inputs to the crossbreeding system can be considered a supplemental means of further boosting reproductive function; however, identifying reproductively superior animals has its challenges, as I will explain.

Indirect Selection

Because the assessment of a cow's reproductive performance is generally determined later in her life, it seems logical to look for early indicators to hasten the process. For example, it is a commonly-held belief females with a propensity toward fatness will excel reproductively.

Though research has shown increased fatness, to a point, is strongly and favorably associated with reproductive performance on a phenotypic scale, the few attempts to assess the relationship on a genetic level show an unfavorable, though weak, relationship. Using data from the Red Angus Association of America (RAAA), researchers at Colorado State University (CSU; Beckman et al., 2006) derived genetic correlations ranging from -.12 to -.22 between body condition at various ages and *stayability* (by industry convention, *the probability of a cow remaining in the herd through 6 years of age*). At the American Simmental Association (ASA), we have found a correlation of -.19 between an animal's genetic propensity for backfat in the feedlot and their inherent stayablity. We (ASA) have also calculated a -.11 genetic correlation between backfat and *heifer pregnancy* (*the likelihood of a heifer being pregnant at the end of the breeding season*) using RAAA data.

Admittedly, these unfavorable correlations between fatness and reproduction may seem illogical. We have all seen a higher proportion of thin cows open at pregnancy test time. Keep in mind, however, the aforementioned correlations are genetic. The relationships we actually observe, i.e., phenotypic correlations, are influenced by a combination of underlying environmental and genetic relationships. There is little question females within a herd lucky enough to experience an environment for increased body condition (e.g., extra energy intake) are likely to have better reproductive performance than their herd mates. Furthermore, this strong and positive environmental relationship between fat and reproduction apparently overwhelms what appears to be a slightly negative genetic relationship — yielding the strong, favorable phenotypic relationship we typically observe.

Frankly, there is not enough evidence about the genetic relationship between fatness and reproductive function to make recommendations based on it at this time; however, though it may fly in the face of conventional wisdom, it appears selecting "easy-fleshing" genotypes will not gain us ground reproductively.

Scrotal circumference has been considered as a predictor of female reproductive performance. Though the preponderance of evidence indicates a strong to moderately favorable relationship between scrotal circumference and age at puberty in related females, research is less clear on the relationship between scrotal circumference and subsequent measures of reproduction. In a study based on a large population involving several breeds at MARC, Martinez-Velazquez et al. (2003) found a slightly unfavorable (0.15) relationship between scrotal circumference and age at first calving and no relationship between scrotal circumference and first pregnancy, first calving and first weaning rates. Their conclusion was selection on scrotal circumference would not be effective in improving female reproduction. These findings are in agreement with some studies and contradicted by others. For those interested, Martinez Velazquez et al. (2003) provides an excellent literature review on the subject. Given the conflicting evidence, it may not be advisable to base selection decisions on scrotal circumference with the intent of enhancing maternal reproduction.

As for other traits that may be related to reproductive function, Rogers et al. (2004) found increased levels of milk EPD increased the risk of females being culled. This finding is consistent with ASA data showing an unfavorable (-0.15) genetic correlation between milk and stayability. Other ASA genetic correlations of note: -0.26, 0.35, and -0.19 between stayability and mature weight, maternal calving ease and marbling, respectively. Based on these findings, we would expect females inherently lower milking, smaller mature sized, easier calving and less marbled to stay in the herd longer; however, none of these relationships are strong enough to make a sizable impact on stayability by selecting for them. Furthermore, other than mature weight because of its strong relationship to early growth, determining the genetic level of a young heifer for these traits by simply observing them, which is what most commercial producers are limited to, is not possible. Therefore, a different tactic will be required if we wish to improve reproductive performance via selection. Namely, select for it directly — which, as I will point out, is not a trivial task.

Direct Selection

A well-entrenched view of both commercial and seedstock producers is the “cows left standing” after culling on the components of reproduction (e.g., pregnancy status and calf loss) are genetically superior. By extension, it is presumed a great deal of progress in reproduction is made through rigorous culling and the retention of heifers out of dams making it to advanced ages. Though this may seem like a reasonable deduction, it is generally not the case.

Unfortunately, little genetic headway is made by simply culling cows that do not achieve reproductive thresholds. This may seem counterintuitive. Why wouldn’t getting rid of the offenders improve your genetics for reproduction? The main reason lies in the fact measures of reproduction tend to be lowly heritable (estimates typically run between 5-20%). And, with lowly heritable traits, an animal’s own performance is not a good indicator of its genetic level for the trait. Therefore, many open culls may be genetically above average or even superior for reproduction. By the same token, several cows kept because they are bred will be genetically inferior for it — certainly not an outcome that will yield much improvement.

So, how do we directly select for reproduction? Because a cow’s reproductive performance is expressed later in life, and even then it only provides a very cloudy picture of her genetic merit, are we relegated to making little to no selection progress for reproduction? Heck no! We can clear the clouds with reproductive EPDs.

Though EPDs always provide the best estimate of an animal's genetic merit, they are especially valuable when applied to low-heritability traits. This is because, when an animal's own record is a poor indicator of its genetic makeup, gathering information on its relatives is the only means we currently have of getting a clear picture of the animal.

You may ask yourself, "If an animal's own performance does not tell us much, what can be gained by records on its relatives?" It is not that a single relative record brings much to the mix (obviously it adds even less than the animal's own record); it is strength in numbers – an animal can have many relatives with records, but only one record on itself. Through the use of EPDs we utilize information on all of an animal's relatives and, in doing so, chip away at the cloud with each record that flows in.

With a low-heritability trait expressed later in life like reproductive function, the cloud clears slowly – but it will clear. In fact, if an animal has enough progeny records, we can see its genetic merit for reproduction as clear as a bell.

Fortunately, the seedstock industry now has EPDs that are, for the most part, direct measures of reproductive function: stayability (STAY) and heifer pregnancy (HP). Researchers at CSU (Snelling et al., 1995) developed the prototype for STAY, which was unveiled to the industry by the RAAA a few years later. The United States breeds currently calculating STAY: Gelbvieh, Limousin, Red Angus, Salers and Simmental.

Colorado State University later developed HP based on work by Doyle et al. (2000) and implemented it for the RAAA National Cattle Evaluation in 2001. While the Angus Association of America has released a trial version, the RAAA is the only breed to publish an official HP at this point. Unfortunately, neither STAY nor HP is currently calculated on non purebred seedstock, though there are plans to do so in the future.

Though STAY and HP have potential shortcomings (e.g., seedstock breeders' culling practices are probably not in lock step with the commercial industry and breed association culling records tend to be sketchy), in my opinion they are the most effective selection tools available for improving reproductive function. What's more, based on computer simulation efforts by USDA researcher M. D. MacNeil (personal communication), the economic impact of stayability when selecting a sire to keep replacement females is nearly twice of the next closest trait, while the relative importance of heifer pregnancy is on par with the most important carcass or growth traits – so these reproductive EPDs certainly warrant a great deal of attention in the selection process.

Obviously, if you are a commercial producer you do not have the luxury of using STAY or HP to select replacement females; however, if you select sires with superior EPDs in these areas the reproductive function of your cowherd is likely to improve over time. Given their relationship to stayability, you may also gain some reproductive ground by selecting sires with lower milk, smaller mature size and better maternal calving ease EPDs. (In the future, these relationships will be accounted for in the computation of reproductive EPDs in the manner birth weight is incorporated in the prediction of calving ease — eliminating the benefit in considering them separately. However, they are not currently factored into the calculation of STAY or HP.)

Summary

In closing, I must reiterate crossbreeding needs to be at the center of any effort to improve the reproductive function of your cowherd. The dramatic impact of heterosis on reproductive performance is crystal clear — no herd should be without it! Though reproductive improvement through selection is possible, it is generally limited to utilizing reproductive EPDs when selecting your herd sires. By combining crossbreeding with the selection of superior sires you will position your herd to excel in the most vital area of beef cattle production — reproductive function.

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