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Standardized Calculation and Interpretation of Basic Cow Herd Performance Measures

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This NebGuide explains how to properly calculate and interpret basic standardized beef cow herd performance measures.

Introduction

Commercial cow-calf producers commonly use the term "percent calf crop," but what does it mean? Does percent calf crop represent the number of calves born relative to the number of cows bred, or perhaps it is the number of calves born relative to the number of cows exposed to a bull? Some might calculate percent calf crop as the number of calves weaned compared to the number of calves born, or the number of cows bred, or the number of cows exposed. Each of these mathematical "interpretations" of percent calf crop could be justified as a reasonable definition of the term. In fact, when students or producers are asked to calculate percent calf crop from a set of hypothetical herd information, given only their perception of what the term implies, multiple answers are typically generated, all mathematically correct. This creates a management issue, because how can percent calf crop be improved if producers have multiple perceptions of what the term implies?

In the early 1990s, this issue was recognized and a task force consisting of both producers and academics were given the charge of developing standardized definitions for a variety of basic cow herd performance measures, including percent calf crop. When standardized definitions and calculations are used, comparisons can be generated, and herd management strengths and weaknesses are more easily identified and managed.

Calculation of Exposed Females

When calculating a percentage term, selecting the proper denominator (the number located below the line in a fraction) is critically important. Using corn production as an analogy, the farmer selects and plants seed, the seed grows, and the crop is eventually harvested and sold. While the crop farmer realizes that every planted seed will not grow, he expects a majority of those seeds to germinate, emerge, and grow to bear large ears of corn. For the commercial cow-calf producer, the "crop" to be harvested and eventually sold is weaned calves, but when were the "seeds" of those calves "planted"? Calves that are born are analogous to seeds that emerged, confirmed pregnancies are analogous to seeds that germinated, and the ova (eggs) of females naturally or artificially exposed to the bull are analogous to the seeds that were initially planted. If during the breeding season 100 cows were exposed to a bull, the ideal hope is that 100 cows will become pregnant, give birth, and raise their calf to weaning. For various reasons including nutrition, poor fertility, venereal disease, etc., some cows may not conceive and others may lose their calf during the year, but when exposed, the cow-calf manager's intent was for all of them to produce and wean a calf. When the corn is planted, the farmer's intent is for those seeds to grow and bear fruit. Likewise, the proper and most meaningful denominator for most cow herd performance measures is the number of females exposed to the bull.

To simplify, the initial number of exposed females represents the total number of females in the breeding herd. However, some adjustments are required. Prior to the start of the breeding season, if females are identified to be culled with no intention of them calving, they should be removed from the initial exposed female number. Obviously, it may be impractical to physically remove them if they are still nursing a calf yet to be weaned, but since they are not expected to produce a calf in the upcoming calving season, they should not be included where they would have a negative effect on the calculation of various production measures.

Females purchased or transferred into the herd that are expected to produce a calf during the upcoming calving season should be added to the initial exposed female number, even if those heifers or cows were not exposed on the producer's own operation. Similarly, if exposed females are sold or transferred out of an operation with the expectation that they will produce a calf during the upcoming calving season, they should be subtracted from the exposed female number. In both cases, there was likely a monetary value associated with bull exposure, and an adjustment to the exposed female number is justified.

In contrast, there should be no adjustment to the exposed female number when exposed, nonpregnant females are sold or removed from the herd. If the expectation was for these females to produce a calf when placed with the bull, failure to breed or to maintain the pregnancy represents a reproductive failure that should be captured when the various production measures are calculated. No monetary value was gained because of bull exposure. Similarly, there should be no adjustment for death loss of exposed females. The loss of these females represents a potential problem that should be identified and managed. Removing such females from the exposed female number will artificially inflate the production measures because the denominator or devisor is reduced.

Calving Percentage

Calving Percentage = (Number of Calves Born) ÷ (Number of Exposed Females) * 100

Calving percentage calculates the percentage of full-term calves relative to the number of exposed females. It doesn't matter if the calf was born alive or dead, provided it was full-term. Aborted calves, however, are not considered full-term and are not included in the number of calves born. This performance measure is an important calculation as it provides an indication of a cow herd's reproductive efficiency and management during gestation.

A goal for herd calving percentage should be 90 percent or higher. When calculated values are lower than desired, it's important to investigate potential causes so management can be adjusted as needed and problems corrected. Low calving percentages may be indicative of 1) inadequate nutrition, 2) mismatched genetics relative to the environment, 3) low fertility or bull power, and/or 4) the presence of reproductive disease.

A primary goal of cow-calf production is for every cow to produce a calf every 12 months. This requires the cow to be rebred within approximately 80 days of calving, assuming a 285-day gestation period. Simultaneously, milk production and associated nutrient requirements peak approximately two months post-calving, which corresponds with breeding. Consequently, reproductive performance is highly dependent upon the nutritional status and associated body condition scores (BCS) of the cow herd. In short, inadequate nutrition that results in poor body condition increases the postpartum interval (the period of time from calving to first post-calving estrus), which makes it more difficult to get cows rebred within a confined breeding season, and overall pregnancy rates are decreased. Over a nine-year period, only 76 percent of thin cows (BCS $\leq$ 3) were confirmed pregnant compared to approximately 95 percent of optimally conditioned beef cows (BCS = 5 or 6). For more detailed information, see EC281, *Body Condition Scoring Beef Cows: A Tool for Managing the Nutrition Program for Beef Herds*. In addition, it's possible that undernourished females are more likely to lose calves in-utero than cows of optimal body condition, and in extreme cases of nutrient deprivation, the female may simply fail to cycle. If she fails to cycle, she will not conceive.

It's important to realize that breeding decisions impact the nutritional requirements of the cow herd. If the producer strives to increase milk production of replacements in an effort to improve weaning weights, nutrient requirements of the cow herd will eventually increase. If the producer selects to produce faster gaining feedlot offspring without realizing the associated potential impact on mature size, replacement females might become larger in mature size and require more feed to maintain adequate body condition. If the environment (precipitation, soil types, etc.) of a particular area can support the increased demands of milk production and body weight, the producer should wean more pounds of calf. However, if the environment is unable to support increased nutritional demands of the cow herd, cows will eventually lose body condition, and reproductive performance will be negatively affected. Astute managers recognize the interrelationships that exist between breeding decisions, nutritional requirements, agronomic management, and reproductive performance.

Low fertility or inadequate bull power also could decrease the calving percentage. In such cases, even optimally conditioned cows (BCS 5 or 6) would be expected to have pregnancy rates less than 90 percent. A breeding soundness examination (BSE) should be conducted annually, approximately 30-60 days prior to the start of the breeding season, on all bulls, including those used in previous years.

The BSE consists of a physical evaluation of the bull including palpation of the internal reproductive glands, measurement of scrotal circumference, and evaluation of semen quality. To pass the BSE or to be considered a satisfactory potential breeder, the bull must be structurally sound and in good physical health, must have at least 30 percent sperm motility with 70 percent normal sperm morphology, and have a minimum scrotal circumference relative to the bull's age. Bulls that are 18-21 months of age require a minimum scrotal circumference of 32 cm, whereas 2-year old bulls should have a minimum scrotal circumference of 34 cm. A larger scrotal circumference is often associated with greater fertility and offspring that reach sexual maturity at younger ages.

Even if bulls are reproductively sound, an inadequate number of bulls relative to pasture size, terrain, synchronization, or number of females may result in low pregnancy rates and low calving percentages. A bull-to-cow ratio of 1:25 is often recommended, but several factors can affect this ratio. A good rule of thumb is that a bull can service one cow per his age in months (i.e., a 15-month old bull should service 15 cows). Mature bulls can typically service more cows than yearling or 2-year old bulls. If cows are maintained in a confined area rather than on large pastures, the bull may service up to 30 percent more cows. If cattle are synchronized so the majority of cows show estrus simultaneously, the bull-to-cow ratio should be reduced. When multiple bulls are run simultaneously, social hierarchies among bulls may dictate the number of cows each is allowed to serve. More dominant bulls will likely have access to a greater percentage of the cow herd compared to more submissive, often younger bulls. Thus, dominant bulls that have low semen quality, fertility, or libido could prove detrimental to reproductive performance in multisire pastures. At the same time, fertile bulls with high-serving capacity may be used to effectively breed 40-50 cows within a confined breeding season. Not only is it important to place fertile bulls in the pasture with cows, but producers must recognize that several other factors can and do affect the reproductive performance of bulls during the breeding season.

The presence of a multitude of different reproductive diseases including, but not limited to, Leptospirosis, Infectious Bovine Rhinotracheitis (IBR), Bovine Virus Diarrhea (BVD), Vibriosis, and Trichomoniasis may reduce the fertility of infected animals or cause abortions, resulting in fewer calves born and a reduced calving percentage. In many cases, the infected mature cow may not show symptoms of the disease. Pre-breeding testing and proper vaccination for those diseases common to a producer's area represent the best control and prevention of such losses. Don't forget the bull. If infected, he represents the primary vector of disease transmission through the herd.

To more accurately pinpoint potential causes of low calving percentages, pregnancy diagnosis of the cow herd is recommended. Approximately 30-60 days after the breeding season, an experienced veterinarian can either rectally palpate or use ultrasound to determine which cows are pregnant. The pregnancy percentage represents the number of confirmed pregnant females relative to the total number of cows exposed to the bull.

Pregnancy Percentage = (Number of Exposed Females Diagnosed as Pregnant) ÷ (Number of Exposed Females) * 100

If the pregnancy and calving percentage values are very similar, it would indicate that management efforts to improve the number of calves born should focus on enhancing breeding performance of the cow herd in subsequent years. Also, to reduce feed costs, the nonpregnant cows should be culled once their current suckling calf is weaned. However, culled open cows are still considered "exposed" for the purpose of calculating performance and reproductive measures. In contrast, if the pregnancy percentage is significantly higher than the calving percentage, potential causes of gestational losses, such as reproductive disease, should be investigated and managed.

It is important to recognize that pregnancy diagnosis via rectal palpation or ultrasound requires extreme skill, and diagnostic errors can occur. If a cow was diagnosed pregnant but failed to calve, should it be assumed that she aborted? Not necessarily. If a fetus could not be located or if other physical signs of abortion do not exist, it is more likely that the cow was misdiagnosed, and for the purpose of calculating pregnancy percentage, this cow should be considered open. While this adjustment will have no effect on the calculation of calving or weaning percentages, it is important, particularly for small herds. The managerial adjustments that should be implemented to counteract poor conception rates (low pregnancy percentages) may differ significantly from those implemented to counteract in-utero losses (abortions).

Calf Death Loss Percentage

Calf Death Loss Percentage, based on calves born = (Number of Calves that Died Prior to Weaning) ÷ (Number of Calves Born) * 100

Calf Death Loss Percentage, based on exposed females = (Number of Calves that Died Prior to Weaning) ÷ (Number of Exposed Females) * 100

Calf death loss represents the number of full-term calves that died from birth to weaning, and the percentage value may be calculated relative to either the number of full-term calves born or the number of females exposed. In most cases, the percentage value will be higher when calculated using the number of calves born because the denominator (number of calves born) is less than the number of females exposed. It is unlikely that all exposed females conceived and produced a calf. Aborted calves are not considered full-term calves and are not included in the calculation. Combined with cause of death information, this performance measure can provide valuable insight into 1) genetic selection, 2) the calving environment, 3) the herd health program, and/or 4) nutritional management.

Once heifers or cows are bred, the greatest loss of calves occurs at or shortly after parturition. A summary of calf death losses sustained at the USDA-ARS Livestock and Range Research Laboratory in Miles City, Mont., over a 15-year period representing 13,296 calvings revealed that a majority of calf deaths (57 percent) occurred within 24 hours of calving, and 70 percent of those calf losses were associated with dystocia. High birth weight is the primary factor affecting incidence of dystocia. When producers select for increased weaning or yearling weight, birth weight may be indirectly increased, if not monitored. The most effective way to manage birth weight and minimize the incidence of dystocia is through proper genetic selection and usage of bulls with low to moderate birth weight EPDs and/or high calving ease EPDs, particularly when used on heifers.

If there are significant losses of moderately sized, normal calves within the first two days of calving, the calving environment should be evaluated. In the 15-year summary of calf death losses incurred at the Miles City experiment station, 6 percent of calf death losses were associated with exposure-chilling due to cold and wet conditions. While it may not be possible to eliminate all such losses, a warm, dry calving environment is critically important to maximize survivability of newborn calves, particularly for late winter and early spring calvings in Nebraska.

Approximately 13 percent of the calves were lost post-calving because of disease — primarily pneumonia and scours. In both situations, frequently more than one causal agent can be identified. Pneumonia is inflammation of the lung tissue, and symptoms include rapid breathing, fever, dry cough, loss of appetite, and nasal discharge. Common viruses that may initiate pneumonia include IBR (infectious bovine rhinotracheitis), BRSV (bovine respiratory syncytial virus), PI_3 (parainfluenza 3), and BVD (bovine virus diarrhea) among other known and unknown viruses. Once damage is initiated, bacteria will often infect the compromised tissue. Scours is a symptom of many different diseases, including pneumonia, and may be caused by a variety of different infectious agents. Common bacterial causes of scours include *E. coli*, Rota virus, Corona virus, and Cryptosporidium.

Keeping herd health simple, two primary factors determine if calves will get sick: 1) ability of animals to resist disease, and 2) level of the disease challenge. Provided the calf's ability to resist disease is greater than the disease challenge, the calf should remain healthy.

Immunity is critical to establishing disease resistance. During the first few days of life, most immunity comes from colostrum. Adequate consumption of colostrum within the first 24 hours of birth is critical to maximize transfer and absorption of antibodies from cow to calf. This is known as passive immunity. Cows may be vaccinated during the final three months of gestation for various organisms that may cause scours and/or pneumonia. Provided cows have adequate protein consumption (1.5 to 2.0 lb/day), antibodies should be generated and transferred to colostrum. Active immunity or individual resistance to disease is established whenever the animal is exposed to the disease causing agent; for older animals, this is most effectively accomplished via vaccinations. Disease resistance is further enhanced through good nutrition and management. Strong calves that stand to suckle shortly after calving have greater disease resistance than weak calves that struggle to stand. Warm and dry calves have greater resistance than those born in cold, wet, or muddy conditions.

Disease challenges occur whenever a calf is exposed to a disease organism, and the level of challenge is associated with the quantity and multitude of different organisms present. Sanitation is important for maintaining low disease challenge levels.

Often, multiple, interrelated reasons will cause the calf death loss percentage to be higher than desired. Thus, it is important to maintain comprehensive records of all contributing factors surrounding calf death losses so those factors can be more adequately managed. Once calves reach 24 hours of age, a goal for subsequent death loss to weaning should be less than 1 percent.

Percent Calf Crop or Weaning Percentage

Percent Calf Crop or Weaning Percentage = (Number of Calves Weaned) ÷ (Number of Exposed Females) * 100

The "crop" of a commercial cow-calf producer to be "harvested" and sold is weaned calves. Therefore, percent calf crop may be more accurately termed the weaning percentage, as it represents the percentage of exposed females that weaned a calf. Percent calf crop or weaning percentage is effectively a cumulative summation of all previously identified and discussed factors that may reduce the number of weaned calves. Breeding decisions and genetic makeup of the herd affect nutrient requirements. If the environment is not capable of supporting those nutrient requirements, cows will likely have reduced body condition and reproductive performance resulting in reduced pregnancy rates. When cows are thin, they are more susceptible to disease which may increase in-utero losses, increase stress at calving, and increase potential losses associated with weak calves.

Pounds Weaned per Exposed Female

Pounds Weaned per Exposed Female = (Total Pounds Weaned) ÷ (Number of Exposed Females)

Commercial cow-calf producers generate revenue based on total pounds of calf weaned and sold. Simplistically, there are only two ways to increase total pounds of calf weaned: 1) increase the size or average of each calf weaned or 2) increase the number of calves weaned. While the term "pounds weaned per exposed female" is rather obscure, it is more meaningful than a simple "average weaning weight." It combines into one figure, the herd reproductive rate, calf death loss, and genetics for growth and maternal traits. A 700-lb average weaning weight may appear impressive, but if it's associated with a 70 percent calf crop, the pounds weaned per exposed female is only 490 lb. In contrast, a producer who generates a 90 percent calf crop that only averages 600 lb will actually produce more total pounds of calf available for sale at the time of weaning (540 lb weaned per exposed female).

Selection for enhanced growth genetics and milk production should increase the size or weight of each calf weaned. However, as previously discussed, selection for too much growth and/or milk production may have negative impacts on reproduction ultimately functioning to decrease total pounds weaned. In addition, calves born earlier in the calving season are typically heavier at weaning, on average, than those born later in the calving season. Thin conditioned cows have a longer postpartum interval and, consequently, if bred, will calve later in the calving season, producing a younger, lighter calf at weaning. Reproductive diseases also can affect the weaned body weights of individual calves. For example, given an extended breeding season, cows may have an early term abortion, return to estrus, and be bred late in the season. Each year, the cow will be diagnosed as pregnant, but the calf is simply born later in the year. Each year, the weaned calf will likely be younger and lighter weight until eventually, the cow turns up open. This commonly occurs with Trichomoniasis.

The impact of reproduction and death loss percentage on total pounds of calf weaned can be illustrated by determining the weaning weights required to produce the same pounds of weaned calf given changes in calf crop (weaning) percentage. If it were possible for 100 exposed cows to wean 100 calves that averaged 540 lb each, 54,000 lb of weaned calf would be produced. If the calf crop is a more reasonable 90 percent, the required average weaning weight to produce 54,000 lb of calf is 600 lb. If the calf crop percentage drops to 80 or 70 percent, the required average weaning weight would increase to 675 or 771 lb, respectively. Pounds weaned per exposed female is a valuable production calculation that can help producers manage tradeoffs to optimize both growth rate and reproductive performance.

Summary

Routine monitoring of standardized performance measures can provide valuable information over time, particularly when coupled with comprehensive records of managerial change. When producers understand how each of the values is calculated, records can be more effectively evaluated to determine the potential impact of associated decisions on important measures of commercial cow herd performance.

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