

MU Guide

Determining Reproductive Fertility in Herd Bulls

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The most important factor influencing the profitability of a beef operation is the percentage of the calf crop weaned, which, in turn, is determined mainly by the number of cows bred during the breeding season. The herd bull influences overall herd fertility more than any other single animal. Because the bull also supplies half of the genetics to all of the calves he sires, bull selection can be the most powerful method of genetic improvement in the herd. Accordingly, loss of fertility by a bull can cause substantial loss to a potential calf crop. Since more than 90 percent of the beef cows in the United States are bred by natural service, it is important that bulls be managed to optimize breeding performance.

Several factors influence a bull's fertility. A bull must be developed properly and have reached puberty to be fertile. Other determinants are libido and social dominance as well as physical characteristics, such as scrotal circumference, mating ability, and semen quality play.

Puberty and bull development

The most commonly used definition of puberty in bulls is when an ejaculate collected by electroejaculation contains at least 50×10^6 total sperm with at least 10 percent progressive motility, or headfirst movement. The age and weight at which puberty occurs are affected by the energy content of the feed that the bull receives. High energy content can increase weight, height and scrotal circumference without affecting age at puberty or first mating. However, extremely low energy rations can delay puberty and potentially impair sperm production. In addition, bulls that are undernourished at a young age may never develop appropriately when compared with bulls that are properly fed.

The age and weight at which puberty occurs also vary greatly among breeds and level of nutrition during development; however, research with various breeds suggests that a practical indication of imminent puberty is when scrotal circumference is between 27 and 29 cm. However, simply because a bull can produce semen

does not translate directly to fertility. Sperm quality and quantity continue to increase for several months after the initiation of semen production. About 35 percent, 60 percent, and 95 percent of 12-, 14-, and 16-month-old bulls, respectively, are reproductively mature and produce good quality semen.

Breeding soundness evaluation

The American Society for Theriogenology developed minimum guidelines for a bull to pass a breeding soundness evaluation (BSE). The evaluation includes a physical examination, measurement of scrotal circumference, and evaluation of semen quality. To pass a breeding soundness evaluation, a bull must have at least 30 percent sperm motility, 70 percent normal sperm morphology, and a minimum scrotal circumference based on age (Table 1). Bulls meeting these minimum requirements are classified as satisfactory potential breeders. If a bull does not pass one of these tests, he is considered a "classification deferred" animal (meaning it is recommended that the bull be tested again) or he is classified as an unsatisfactory potential breeder. Bulls should be tested four to six weeks before the breeding season. This allows for time to retest bulls where unsatisfactory results are obtained, or time to find a replacement herd bull.

Table 1. Minimum scrotal circumference requirements for bulls to pass a breeding soundness evaluation, by age.

Age in months	≤15	>15–18	>18–21	>21–24	≥24
Scrotal circumference (cm)	30	31	32	33	34

Source: Chenoweth, P.J., J.C. Spitzer, and F.M. Hopkins. 1992. A new bull breeding soundness evaluation form. *Proceedings of Annual Meeting, Society for Theriogenology*, San Antonio, Texas. Pp. 63–71.

Mating ability

The purpose of the physical examination portion of a breeding soundness evaluation is to determine a bull's mating ability. Mating ability can be described as the

physical capabilities needed to successfully breed a cow. A bull must be able to see, smell, eat and move normally to successfully breed cows. The physical examination includes scrutiny of a bull's eyes, teeth, feet, legs and nutritional level (evaluated by body condition score). Any disease or injury that affects joints, muscles, nerves, bones or tendons may cause a bull to be structurally unsound. In addition to structural unsoundness, diseases or injuries to the penis or prepuce can result in an inability to breed by natural service. These abnormalities will be detected only by careful examination or by observing an attempted mating of a cow. A bull that has high-quality semen but is physically unable to breed cows is unsatisfactory for natural service.

Scrotal circumference

As scrotal circumference increases, so does the daily production of high-quality sperm. There is a positive genetic correlation between a sire's scrotal circumference, the scrotal circumference of his sons, and the pregnancy rate of his daughters. A negative genetic correlation exists between a sire's scrotal circumference and age at puberty in his daughters. This indicates that bulls with a larger scrotal circumference are likely to sire sons with larger scrotal circumference. The daughters are likely to reach puberty at younger ages and are more likely to be cycling by the beginning of the breeding season and more likely to become pregnant early when compared with the offspring of bulls with smaller scrotal circumference.

Two types of measuring tapes are commonly used for measuring scrotal circumference — a manual measuring tape and the Coulter spring-loaded tape, which contracts around the scrotum with a uniform tension. Scrotal circumference is measured by placing a measuring tape around the scrotum at the widest point (Figure 1). This measurement is an indirect estimate of the mass of testicular tissue, which is directly related to sperm quantity and quality. Studies of various breeds and ages of bulls indicate that as scrotal size increases, the probability of a bull passing a breeding soundness evaluation also increases. Additionally, bulls with small scrotal circumference at a year of age tend to have small scrotal circumference at two years of age.

Semen quality

Semen quality is determined by the volume of the ejaculate and by the motility and morphology of the sperm cells. It is important to remember that substandard nutrition, extreme environmental temperatures and disease can reduce semen quality, and that the quality of semen from a single bull may change over time.

Sperm motility is calculated by evaluating the percentage of spermatozoa with forward movement in a sample ejaculate. This is calculated by placing a drop of semen on a microscope slide and observing (at 100x magnification) the number of spermatozoa with

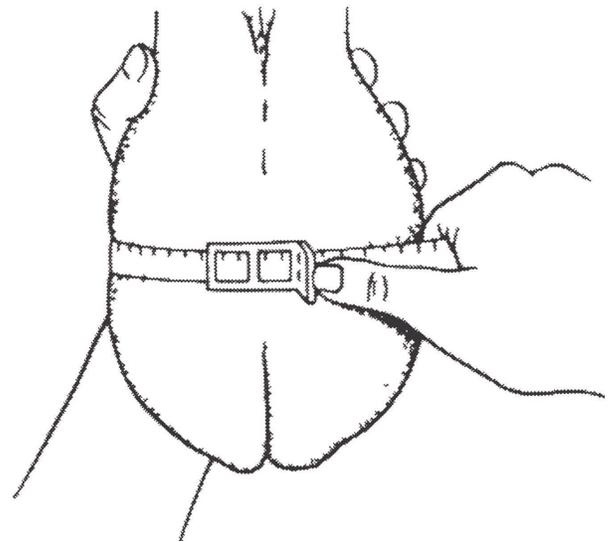


Figure 1. Scrotal circumference is measured by holding the testicles to the bottom of the scrotal sack and placing the tape around the widest point.

forward movement in relation to those with other than forward movement.

Sperm morphology is calculated by evaluating the number of normal spermatozoa in a sample ejaculate in relation to sperm with primary and secondary abnormalities. Primary abnormalities originate in the testis during spermatogenesis. Secondary abnormalities originate in the epididymis, during sperm transport. The designation of primary and secondary abnormalities refers to the origin of the defect and not to the severity of the defect. Therefore, both types of abnormalities are equally important when evaluating sperm quality.

Sperm morphology influences pregnancy rates. In a recent study, bulls with less than 20 percent abnormal sperm elicited pregnancy rates at least 4 percent higher than randomly selected bulls (Table 2). Therefore, selection of bulls with greater than 80 percent normal sperm can increase overall pregnancy rates in a herd.

Is a single BSE valid for the life of a bull?

Sperm production is a continuous process. However, a breeding soundness evaluation measures sperm production at a specific point in time. Therefore, the results of a breeding soundness exam may change over time. Out of 34 young bulls (less than 2 years old) that failed their first breeding soundness evaluation in a study conducted at the University of Missouri, 26 passed a second evaluation and were classified as satisfactory potential breeders. Other studies have shown that semen quality in young bulls can improve for up to 16 weeks following puberty.

Conversely, a bull that passes a breeding soundness evaluation can fail a subsequent evaluation. Because sperm production is continuous, many factors can affect it. Injury, disease, fever and extreme environmental conditions can all decrease sperm production. Injury to

Table 2. How sperm quality affects the pregnancy rate of a herd.

	Year 1		Year 2	
	Random group	≥80% normal sperm	Random group	≥80% normal sperm
Cows exposed	655	675	1,282	808
No. of bulls	26	27	51	33
No. pregnant	571	656	1,179	769
% pregnant	87%	93%	85%	90%
% increase		6%		5%

Note: Bulls were selected randomly or had at least 80% normal sperm cells. All bulls had a scrotal circumference greater than 32 cm and passed a breeding soundness evaluation.

Source: Wiltbank, J.N., and N.R. Parish. 1986. Pregnancy rate of cows and heifers bred to bulls selected for semen quality. *Theriogenology* 25:779–783.

the penis or testis can also result in infertility in bulls. Therefore, it is important to realize that the results of a single breeding soundness evaluation are not valid for the life of a bull, and testing a bull annually, usually a month before breeding season, is recommended.

The future of semen testing

Research is being conducted to identify which characteristics of semen influence bull fertility rates. These characteristics include the ability of sperm to bind, penetrate and fertilize an oocyte. Research is also under way to develop tests that will more accurately determine the fertility of individual bulls. It may one day be possible to predict the fertility of individual bulls either by a semen sample or by a DNA sample.

Fertility factors not tested in a breeding soundness evaluation

Libido

Libido refers to the desire to mate and is thought to be a highly inherited trait. This is because there is more variation in libido between sons of different sires than between sons of the same sire. It is important to remember that scrotal circumference, semen quality, and mating ability (evaluated in a BSE) are not related to libido. Therefore, a bull that passes a breeding soundness evaluation may have poor libido, or a bull with good libido may fail a breeding soundness evaluation.

A bull's libido affects the pregnancy rate of a herd and, therefore, can influence the success of an entire breeding season. For this reason, it is important to evaluate a bull's desire to mate before the breeding season begins. This can be done by placing a bull in a pen with an estrous female and recording the bull's eagerness to mate over a five-minute period. A bull's eagerness can range from no sexual interest to successfully mating with the female. Libido can be more practically evaluated by closely watching a bull after introducing him to a cow herd.

Male-to-female ratio

Since variations exist between bulls in their desire to mate, recommendations for bull-to-cow ratios range from 1:10 up to 1:60. However, practical bull-to-cow ratios vary greatly, depending on the capability of individual bulls and the situation they are placed in (e.g., synchronized or nonsynchronized herds). Bull age also affects bull-to-cow ratios. Yearling bulls have a lower serving capacity than older bulls. Therefore, it is important to remember that young bulls should be used at a lower bull-to-cow ratio than older bulls.

Individual 2- and 3-year-old bulls with high reproductive capacity have been used in nonsynchronized single-sire breeding groups of as many as 60 cows with no decrease in estrous detection or fertility. When cows are synchronized and bred by natural service, greater pressure is placed on the herd bull. Therefore, more bulls will be needed to breed a herd of synchronized cows than will be needed to breed the same number of nonsynchronized cows.

Maximum bull-to-cow ratios will vary depending on mating ability, semen quality, and libido of individual bulls. Bull-to-female ratios can usually be increased in single-sire breeding groups; however, bulls should be observed closely during the breeding season to ensure that they continue to mate successfully. Poor performance of a bull in a single-sire breeding group will affect the entire calf crop of that group.

Social dominance

A definite social ranking develops among bulls, and this ranking may affect the number of cows a given bull will service in a multiple-sire herd (Table 3). Livestock managers must be aware of these relationships to ensure normal breeding rates. For example, a dominant bull with poor semen quality or low libido could reduce pregnancy rates for an entire herd even when more fertile, subordinate bulls are present.

Table 3. Percent calf crop sired by individual sires in multiple-sire pastures.

Social rank	Pasture				
	1	2	3	4	5
Bull 1	30%	34%	44%	92%	75%
Bull 2	21%	29%	18%	3%	25%
Bull 3	12%	21%	16%	3%	0%
Bull 4	10%	6%	4%		
Bull 5	9%	4%	4%		
Bull 6	9%	1%	4%		
Bull 7	5%	1%	2%		
Bull 8			2%		
Bull 9			2%		
Bull 10			0%		
Number of calves born	73	64	43	28	32

Source: Adapted from Lehrer, A.R., M.B. Brown, H. Schindler, Z. Holzer, and B. Larsen. 1977. Paternity tests in multisired beef herds by blood grouping. *Acta Vet. Scand.* 18:433–441.

A bull's seniority is the major factor influencing its social ranking; the dominant bull in a breeding cadre is likely to be an older bull. Therefore, it is important not to introduce a young (yearling) bull into a herd with an older, more mature bull. This can be avoided by separating cows into single-sire breeding groups. In multiple-sire breeding groups, multiple bulls tend to breed the same sexually responsive females. This leads to females being bred by more than one bull as well as the potential for increased injury to bulls of any age.

Summary

Since reproductive traits are not highly heritable, greater selection intensity is required to achieve genetic improvement in a herd. Selection intensity for female reproductive traits is usually low because selection of

replacement females in commercial herds is usually based on age or weight and not reproductive performance. As a result, greater selection intensity is required in selection of herd bulls to achieve the desired level of genetic improvement. Structurally sound bulls with a large scrotal circumference and high semen quality should be selected as herd sires. Moreover, it is important to remember that semen quality of an individual bull changes over time and, for a bull to be fertile, libido and mating ability should be evaluated periodically.

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For further information

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