

# Beef Sessions

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## Update on Veterinary Breeding Soundness Evaluation of Bulls

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### Abstract

What is breeding soundness evaluation of bulls? The term breeding soundness evaluation is often used to describe a bull's ability to get cows pregnant. However, too often there are broad expectations when this term is used. This presentation will discuss those facets necessary to identify bulls that are capable of getting a reasonable number of cows pregnant in a limited breeding season.

### Introduction

High reproductive efficiency is the most important factor for economic success in cow-calf enterprises, typically having greater impact than growth rate, feed efficiency and carcass quality. Therefore, in order to be profitable and assure optimal animal welfare, each cow on a farm or ranch should raise a calf to weaning each year. For optimal utilization of ranch resources all calves should be born in a relatively short period of time, thereby facilitating surveillance of calving, performance of health maintenance procedures and the ability to take advantage of seasonal marketing opportunities. Bull breeding soundness evaluations prior to breeding is one tool that helps ensure that only bulls with a high likelihood of achieving pregnancy will be utilized.

In order for high reproductive efficiency, well developed bulls capable of breeding at least 25 - 35 fertile females in a limited breeding season of 70 days or less must be used. Depending upon terrain, pasture size and age of the bull, a fertile mature bull with high libido may serve 40 to 50 or more cows in a limited breeding season. High bull-to-cow ratios reduce bull costs per calf born, thereby increasing net income. A thorough breeding soundness examination can eliminate bulls with low reproductive potential and help identify bulls capable of high reproductive efficiency.

The two general methods of evaluating the breeding soundness potential of bulls are: 1) breeding a significant number of normal females and assessing pregnancy outcomes; or 2) evaluating anatomic and semen characteristics to predict the bull's fertility. Obviously predicting a bull's potential prior to breeding is much more efficient than allowing him breeding access to a herd to just see how he does. To date there is no single measurement or test that is a reliable predictor of fertility in all circumstances, although some criteria are more reliable than others.

The current standards adopted by the Society for Theriogenology in 1992 provide a uniform method of assessing a bull's likelihood of accomplishing pregnancy in 25 or more open, healthy, cycling cows in a 65-70 day breeding season.<sup>8</sup> It should be emphasized that there are very few sterile bulls. Most bulls will eventually get most cows pregnant if left together a sufficient period of time on an adequate plane of nutrition. However, unlimited breeding seasons negate the opportunity to take advantage of labor, health maintenance procedures and marketing opportunities. Equally important is the consideration for animal well-being, such as cows being repeatedly mounted and served before becoming pregnant, calves born in inappropriate times of the year such that environmental conditions compromise their health and survivability, and the potential for injury in bulls with low breeding efficiency.

How is a breeding soundness evaluation used in the United States today? The answer is three-fold. First, breeding soundness evaluations are performed prior to the breeding season to ensure that subfertile bulls are not utilized. Second, bulls are evaluated for breeding soundness prior to sale. Unfortunately this procedure may lead to considerable disappointment and consternation for bull sellers as not all bulls possess those attributes necessary to qualify them as Satisfactory Potential Breeders at the time presented for examina-

tion. Factors such as age, body condition, weather stress, lack of testicular development, and musculoskeletal injury or conformation flaws may dictate that a bull is not breeding sound at the time of evaluation. Bulls that are not satisfactory are frequently disqualified from selling, thereby causing loss of marketing opportunity for bull producers. Third, bulls are presented for breeding soundness evaluation after infertility is suspected. Although occasionally this procedure has diagnostic value for the herd, often sufficient time has lapsed during the breeding season that transient problems may have resolved and the bull may be a satisfactory breeder at the time of evaluation.

### Breeding Soundness Evaluation

What is a breeding soundness evaluation? Bull breeding soundness evaluation consists of examination for physical soundness and evaluation of semen quality. A breeding soundness evaluation (BSE) is NOT a semen exam, although semen evaluation is a component of a breeding soundness evaluation. A breeding soundness evaluation does NOT guarantee that a bull is highly fertile nor rank bulls with respect to fertility. A breeding soundness evaluation will NOT ensure that bulls are free of virus or other infectious agents in their semen. A breeding soundness evaluation DOES identify bulls that possess undesirable heritable traits or that are not likely to achieve a high pregnancy percentage in a limited breeding season.<sup>2</sup> A breeding soundness evaluation considers the physical characteristics of a bull necessary for mobility and athleticism in the pasture, his structural soundness, his overall and reproductive development, the size and health of his testes and the quality of his semen. Classification is determined by physical evaluation and the bull's ability to meet minimum thresholds for testicular development, sperm motility and normal sperm morphology.

#### Physical Examination

Breeding soundness evaluation begins with assessment of a bull's conformation, body condition and overall physical health. He should be of sufficient size for his age, free of obvious disease and should carry adequate muscling and body fat to ensure he is capable of freely walking within the herd to identify females in estrus, then mounting and completing coitus. Feet and legs should be free of defects that limit this mobility. Acute or chronic laminitis, post-legged conformation and screwclaw are some of the more common musculoskeletal conditions that limit a bull's agility and athleticism. Post-leg and screwclaw are potentially heritable conformation attributes with undesirable consequences in the herd.

#### Scrotum and Testes—Puberty

Onset of puberty is usually considered to be when the bull's first ejaculate has at least 50 million sperm per ml with at least 10% progressively motile. There is wide within-breed variation of when puberty occurs. For example, Herefords are reported to reach puberty from 273-364 days of age, Angus from 273-350 days and Charolais from 231-371 days of age.<sup>6</sup>

Sperm concentration, percentage progressively motile sperm, proportion of sperm with normal structure and seminal protein concentration all increase until at least four months after puberty. Age at puberty and scrotal circumference in bulls are correlated with age at puberty of his female offspring such that bulls that reach puberty earlier and have large scrotal circumference sire heifers that reach puberty early.

#### Scrotum and Testes—Weanling Bulls

The first selection and culling of bulls is generally at weaning when they are seven to 10 months old. Relatively few calves clearly display abnormal development and conformational traits at this age, and consequently most culling is based on the breeder's assessment of the bull's growth potential. The main reproductive criteria for selection of bulls at this age is testicular development. Yearling bulls with small testicles are not likely to catch up over time and still have small testicles at two years of age. Young bulls with small testes should be culled as they have a low probability of attaining adequate scrotal circumference by one year of age. Scrotal circumference measurements in weaned bulls are helpful to predict yearling SC. Simmental, Angus and Zebu derived bulls, predominantly Santa Gertrudis, must have a minimum SC of 23 cm at 198-291 days of age to have a nearly 100% probability of attaining  $\geq 30$  cm SC by 365 days of age. Other continental breeds, predominantly Charolais, and Polled Hereford bulls require  $\geq 26$  cm SC to reach  $\geq 30$  cm SC by 365 days of age. If minimum requirements for SC are increased to be 32 cm at 365 days of age, an additional 2 to 3 cm would be needed at weaning. Coe and Gibson evaluated 264 bulls representing 13 beef breeds and found that at 200 days of age calves with SC  $> 23$  cm had a 95% probability of achieving SC  $> 34$  cm by 365 days of age whereas, calves with SC  $< 23$  cm only had a 54% probability of achieving SC  $> 34$  cm by 365 days.<sup>9</sup>

Culling at weaning minimizes expenses associated with maintaining cull bulls or inadvertently entering them in performance test programs. Likewise, weanling bulls that do not have both testes well descended in the scrotum should be culled regardless of scrotal circumference (SC). Cryptorchidism is not common in bulls, but is considered to be a heritable trait which should not be propagated.<sup>4,15,17</sup>

### Scrotum and Testes—Yearling Bulls

Many people recommend final selection of bulls for breeding potential should be at 12 to 16 months of age. By this time puberty is complete and most conformational abnormalities are apparent. A large scrotal circumference at a young age indicates early maturity in the bull and his offspring.

Numerous studies of performance station bulls indicate drastic differences in semen quality according to age.<sup>4,6</sup> The following table reflects this information:

Percentage of 254 yearling bulls of various beef breeds with satisfactory semen quality.

Age (mo+15d)	n	Mean scrotal circumference (cm)	% with satisfactory semen quality
12	40	33.8 (28.5-39.5)	40.0
13	100	34.5 (28-41)	55.0
14	84	34.1 (28-45)	55.9
15	30	34.9 (27-41)	73.3

Clearly, a few months makes a tremendous difference in the amount and quality of semen a bull may produce.

One troublesome aspect of breeding soundness evaluation in yearling bulls is the presence of sperm with proximal cytoplasmic droplets. Proximal cytoplasmic droplets are one of the most frequent sperm abnormalities in young bulls, and this abnormality may be associated with immaturity as well as with testicular degeneration. Since this abnormality is associated with immaturity the percentage of affected sperm declines as the bull completes puberty and most bulls will have satisfactory semen quality in the near future. Therefore, some examiners tend to ignore proximal droplets when examining yearling bulls such that a higher percentage of these bulls will be classified Satisfactory Potential Breeders than bulls that are examined according to established guidelines. Fertilization rates are markedly lower for bulls with at least 30% sperm with proximal cytoplasmic droplets, and as the percentage of droplets decreases fertilization rates increase.<sup>1,3</sup> Therefore, according to accepted standards, if the yearling bull is physically sound and meets the other minimums, the presence of proximal cytoplasmic droplets such that there is less than 70% normal sperm in the ejaculate would dictate that the bull be placed in the Deferred category.

### Scrotum and Testes—Examination

Bull testes are maintained in the scrotum, a protuberance of the ventral abdominal skin. The scrotal wall consists of skin, sweat glands, the tunica dartos,

and is lined by the tunica vaginalis parietalis, which is an extension of the parietal peritoneum. The testes are maintained in this location in order to assist with thermoregulation that is essential for normal spermatogenesis. The testes must be cooler than core body temperature, and there is a temperature gradient of 4 to 6° C from base to apex of the scrotum. Elevated core body temperature such as may occur with febrile conditions may elevate core testicular temperature with resultant failure of normal sperm production. Likewise, any condition of the scrotum that interferes with normal thermoregulation may also impair spermatogenesis. Such conditions include wounds, scars and ischemia of the scrotum which might result from frostbite in severely cold environments. The tunica dartos functions in conjunction with the cremaster muscle, part of the spermatic cord, to elevate the testes toward the abdomen to reduce heat loss in periods of cold, or to relax and provide greater surface for heat loss during times of normal or excess heat load within the scrotum.<sup>15,17</sup>

The spermatic cord exits the inguinal ring and consists of the testicular artery, vein and nerve, the ductus deferens, and the cremaster muscle. A few centimeters dorsal to the testicle the testicular artery forms an extensive pampiniform plexus with the testicular vein. The function of this plexus is for venous blood to cool arterial blood before the artery enters the testicle proper. After leaving the pampiniform plexus the testicular artery continues ventrally to enter the testicle at its distal pole.

Measure the scrotal circumference by firmly forcing the testes ventrally in the scrotum and placing a flexible centimeter tape around the largest circumference. Evaluate the scrotum for presence of scars or other pathology.<sup>2,8</sup> The testes should be freely moveable within the scrotum and no more than 10% difference in size between the paired testes. Palpate each testicle gently for texture that should be firmly resilient. Palpate each testicle deeply to assess areas of firmness that might indicate granulomas, fibrosis or calcification. Softness or a mushy feel are consistent with testicular degeneration. Extreme firmness along the mediastinum testes is consistent with irreversible testicular damage. The vaginal cavity is the potential space between the tunica vaginalis parietalis lining the scrotum and the tunica vaginalis visceralis covering the testis. There should be no adhesions or fluid accumulation in this space. Palpate the head, body and tail of the epididymides for completeness and for the presence of pain or granulomas. Palpate the spermatic cord for aneurysms or other abnormalities.

The minimum threshold for scrotal circumference is based upon age of the bull. Those thresholds are as follows:<sup>8,18</sup>

Age	Threshold
≤ 15 months	30 cm
>15 to 18 months	31 cm
>18 to 21 months	32 cm
>21 to 24 months	33 cm
>24 months	34 cm

### *Testicular Degeneration*

Degenerate testes palpate as softer than normal. With chronic testicular degeneration the testes may become fibrotic or ultimately calcified, which are quite firm on palpation.<sup>17</sup>

Approximately 56 days are required to complete the entire process of spermatogenesis in the bull leading up to mature sperm ready for ejaculation. Therefore, the sperm examined in the ejaculate began development approximately two months previously. Testicular heating, such as might happen with climatic heat, infections, frostbite, scrotal trauma, fever, and fat around the testes and spermatic cord, leads to production of abnormal spermatozoa. A variety of stresses such as pain, shipping, systemic illness and environmental changes may alter sperm production by altering the hormonal environment of the testes. One recent report indicates fusarium mycotoxins HT-2 and T-2 may be associated with impaired spermatogenesis.<sup>1</sup> Gossypol and heavy metals such as cadmium have also been implicated to alter normal spermatogenesis. The basic effects of abnormal sperm on fertility are the inability to fertilize ova or the formation of defective embryos which fail to survive.

### *Internal Reproductive Organs—Examination*

Evaluation of internal reproductive organs is an integral continuation of the physical examination. Evacuate the rectum and by rectal palpation identify the urethralis muscle and prostate gland. Bulls rarely develop prostatic disease, and the normal organ is palpable as a somewhat firm transverse band at the cranial extent of the urethralis muscle approximately wrist deep along the ventral midline of the bull's pelvis. Immediately cranial and dorsolateral to the prostate are the paired vesicular glands. Normal glands are resilient to palpation and the glands are somewhat tear-drop shaped, 2 to 4 cm in diameter and 10 to 15 cm long. Just cranial and medial to the vesicular glands lie the paired ampullae which are the termination of the ductus deferens. The paired ampullae narrow and pass under the prostate to empty into the urethra at the colliculus seminalis. The ampullae are 1 to 1.5 cm in diameter, thick walled and 10 to 12 cm long. Their function is to store mature sperm ready for ejaculation.

The internal inguinal rings are palpable openings in the abdominal wall a few centimeters cranial and

approximately 45 degrees ventral to the brim of the pelvis. Examine for fat, omentum or intestines entering the ring. Bulls with inguinal rings larger than 5-6 cm may be more prone to development of inguinal hernia.<sup>17</sup>

### *Penis, Prepuce and Sheath—Examination*

The sheath is an extension of the ventral abdominal skin and should be of appropriate size for the bull. Examine the preputial hairs on the end of the sheath for accumulation of blood or exudates which might indicate penile or preputial injury. Sandy or gritty material on the preputial hair may indicate the presence of urolithiasis. Palpate the entire sheath and penis for areas of swelling or fibrosis. Palpate the dorsum of the distal bend of the sigmoid flexure for evidence of prior hematoma of the penis.<sup>2,8,17</sup>

The penis and prepuce are usually examined during semen collection. Examine closely for lacerations, penile hair rings, persistent frenulum, urethral fistulae, or scarring of the prepuce.

### *Semen Collection*

Semen may be collected from bulls by several methods. The ideal method would collect the entire ejaculate in a manner that approximates coitus by the bull. The best approximation of coitus available today is the artificial vagina (AV). Equipment is not expensive or complex and with patience most bulls can be trained to serve an artificial vagina. The advantages of this method are that libido and mating ability may be evaluated while collecting a physiologic ejaculate from the bull. Ejaculate volume and sperm concentration are more highly correlated with natural coitus than by other methods of semen collection. Disadvantages of this technique are that most bulls require an animal which will stand to be mounted by the bull and most bulls require a period of training to allow semen collection in this manner. Because of the time involved for training, this method is not practical for routine breeding soundness evaluation of range bulls.

The ampullae are the dilated termination of the ductus deferens and serve as reservoir for the next ejaculate. Massage of the ampullae per rectum will cause stored semen to be expressed from the ampullae, resulting in emission of semen from the urethra. The skilled palpator gently massages the seminal vesicles toward the urethra, followed by gently massaging the ampullae toward the prostate, and then stimulates the urethralis muscle to contract while an assistant collects the cloudy fluid as it drips from the penis or prepuce. Ideally, the penis should be extended and held by an assistant prior to the rectal massage. Disadvantages of this method are that a skilled palpator is required and there can be no assessment of libido, mating ability, erection ability or ejaculation. Most often the penis does not

extend and the semen sample dribbles down the preputial cavity and off the preputial hairs. Consequently, the semen samples are often contaminated with bacteria and smegma from the prepuce. Additionally, the volume and sperm concentration of the sample are extremely variable. Advantages of this method are that no electroejaculator or mount animal is necessary to harvest the sperm sample and that most bulls don't object vigorously to this collection technique.

#### *Electroejaculation*

The most common method for collection of bull semen is electroejaculation.<sup>7,11,13</sup> Commercially available low-voltage, low-amperage machines are designed to electrically stimulate the pelvic genitalia via a rectal probe. This stimulation induces the bull to achieve penile engorgement which progresses to penile extension, erection and ejaculation. The stimulation is delivered in the form of a modified sine wave and begins with small voltage for a duration of 2 to 3 seconds followed by a rest period of up to three seconds. Electroejaculators may be battery operated or require direct connection to household current, and the operator may manually control the magnitude of current applied and the frequency and duration of pulses, or they may be programmed to gradually increase the intensity and/or frequency of pulsations leading to ejaculation. There are breed differences in how readily bulls ejaculate with electroejaculation and some breeds are more prone to vocalize during the stimulation procedure.<sup>7,13</sup> Thorough rectal palpation prior to introduction of the rectal electrode stimulates the bull to relax the retractor penis muscles and significantly aids with penile extension.

Rectal probes should be of appropriate diameter for the size of the bull for optimal effectiveness, and the stimulating electrodes on the probe should be confined to the ventral one-third to one-half in order to avoid stimulation of dorsal and/or dorsolateral pelvic musculature which provide obvious discomfort to the bull. Smaller hand-held finger electrodes are also available whereby a palpator introduces the hand bearing the electrode into the rectum and positions the electrodes over the seminal vesicles, prostate and ampullae to induce the bull to ejaculate. Advantages of these electrodes are that the stimulating current is directed directly to the target tissues with minimal undesirable stimulation of the other pelvic musculature or nerves. Disadvantages of these electrodes are that a skilled palpator is necessary to maintain electrode contact with the pelvic organs during stimulation and ejaculation.

Before beginning electroejaculation palpate the bull's pelvic genitalia per rectum, being particularly careful to gently massage the urethralis muscles, the vesicular glands and the ampullae. This preparation greatly facilitates the electroejaculation procedure. Al-

though there is wide variation among bulls, most bulls begin to achieve penile engorgement after eight to 15 stimulations, followed by penile extension and erection. As stimulation increases three to five jets of clear preseminal fluid will be ejaculated followed by four to eight jets of the opaque, sperm-rich fraction. Most operators collect a minimum of 3 ml of ejaculate for microscopic evaluation. The volume of the ejaculate and sperm concentration of the collection are largely determined by how much prostatic and vesicular gland fluid is collected before collecting the sperm-rich fraction. Occasionally a bull will release urine down the urethra during the electrostimulation. This sample should be discarded and begin anew to collect the semen sample. Regardless of the method of stimulation used, the operator may wish to grasp the free portion of the penis with a dry surgical sponge in order to hold the penis in extension for thorough examination of the penis and prepuce.

#### *Sperm Motility Evaluation*

The semen should be protected from temperature shock and a drop should be placed on a clean, dry microscope slide for estimation of motility. Although mass motion may be observed at low power, high power observation under a cover slip is preferred to assess the percentage of progressively motile sperm in the ejaculate. Concentrated samples should be sufficiently diluted with warm, fresh physiologic saline in order to visualize individual sperm under high power. Automated sperm evaluation equipment is marketed but has not gained large scale use in the United States.<sup>12</sup> The threshold for Satisfactory Potential Breeder is a minimum of 30% progressively motile sperm.<sup>2,8</sup>

#### *Sperm Morphology Evaluation*

Sperm morphology should be evaluated under oil immersion in order to adequately evaluate individual sperm. Prepare a slide by mixing diluted sperm with eosin-nigrosin similar to a blood smear for evaluation with a light microscope. Alternatively, dilute a drop of the ejaculate with 10% neutral buffered formalin and prepare the slide similar to a blood smear for examination with a phase contrast microscope. Count a minimum of 100 sperm cells classifying them according to normal morphology or those with primary or secondary abnormalities.<sup>2,3,4,8</sup>

### **Classification for Breeding Soundness**

Following evaluation according to the criteria described above bulls are classified according to their suitability for breeding on the day of evaluation. Those bulls that are conformationally sound, free of ocular and musculoskeletal defects and that produce at least 70% morphologically normal sperm that are at least 30%

progressively motile are classified as Satisfactory Potential Breeders. Bulls that do not meet these criteria are placed in one of two categories. Those bulls with temporary conditions which are likely to resolve and allow the bull to meet the above thresholds are placed in the category of Classification Deferred. Bulls in this category are usually juvenile, have an injury or lameness that is likely to resolve or suffer from summer heat induced testicular degeneration. If this classification is used the veterinarian should recommend a date for re-evaluation of the bull. Bulls with undesirable heritable defects, small scrotal circumference that do not meet the minimum for their age, debilitating injury or disease, or with permanent testicular degeneration should be classified as an Unsatisfactory Potential Breeder.<sup>8</sup>

### Ancillary Tests for Evaluating Breeding Soundness

Since 1992 the only additional published suggestion for evaluating breeding soundness evaluation is the Fertility Associated Antigen (FAA) test. This test is suggested for use in addition to the Veterinary Bull Breeding Soundness Evaluation. While intriguing, this test needs further study to prove its value in selecting breeding bulls.<sup>16</sup>

Some producers and states advocate or require testing for Trichomoniasis in potential breeding bulls. Epidemiological studies indicate prevalence may range from 0-6% of bulls in a population depending upon herd size, bull age and management practices. Culture of prospective sires may be indicated at the time of breeding soundness evaluation.<sup>10,14</sup>

### Summary

A summary of over 1000 breeding soundness examinations performed in Alabama found 29% of all bulls to be Unsatisfactory Potential Breeders. The bull population consisted of bulls sold in bull sales, bulls that were recently purchased, bulls being offered for sale by private treaty and herd bulls.<sup>5</sup>

There are very few sterile bulls in the cattle population. If allowed sufficient time, most bulls will eventually achieve nearly 100% pregnancy in a herd of fertile, healthy females. However, the goal of the breeding soundness examination is to identify bulls with a high likelihood of getting a large percentage of females pregnant in a controlled breeding season. Most authors agree that a bull considered to be a satisfactory potential breeder by routine breeding examination should get 25-35 cows pregnant in 70 days. A breeding soundness examination does not reflect a bull's soundness in the past nor does it define the bull's future ability to cause conception. It does allow a prediction of the bull's current

potential fertility and the overall effect is to improve the genetic base for fertility within herds or breeds.

A smaller percentage of bulls are classified Satisfactory for Breeding Soundness than with the previous guidelines utilized from 1976 to 1992. This difference is largely due to the fact that previously bulls with large scrotal circumference scores but marginal semen quality were classified Satisfactory. Although large SC indicated greater sperm production capacity, increased sperm numbers were not necessarily associated with increased pregnancy percentage. Conversely, bulls with small SC score but excellent sperm morphology were also classified Satisfactory. Those bulls had limited sperm producing capacity that prevent a bull from achieving an acceptable pregnancy percentage in a limited breeding season. Difference in progressively motility scores had little effect on pasture breeding efficiency.

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