Developing Young Bulls

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Introduction

Bull development encompasses a broad array of physiological activities. In essence, the biological processes that occur during sexual development of the bull have broad ranging practical implications and dictate many managerial decisions for both the commercial and purebred producer. Bull development is the progression of the prepubertal animal towards maturation involving differentiation and morphogenesis of the reproductive tract. Development is influenced and driven by the inherent genetic makeup of the animal and initiated by increased levels of reproductive hormones. This process is greatly influenced by nutrition, environment, and other exogenous factors (Lawrence, 1997).

Puberty in the bull is defined as the age at which an ejaculate contains 50 million spermatozoa with a minimum motility of 10% (Evans, 1995). Such an ejaculate should have an adequate number of sperm cells to cause a pregnancy. However, as the bull matures, the number of sperm cells per ejaculate and the cell motility will continue to increase. Additionally, scrotal circumference is a reasonable predictor of puberty. Most bulls have undergone puberty when scrotal circumference reaches 28 to 29 cm (Boyles, Taylor, 1994). Caution must be taken with scrotal circumference measurements, however, as they function only as a predictor of sperm output. A breeding soundness examination is necessary to determine the actual number of sperm cells, sperm motility, and sperm cell abnormalities. Puberty occurs at approximately 11 months of age, though it can vary in individuals depending on biological type, nutrition, and health status (Taylor, 1994).

The reproductive organs of the bull consist mainly of two testicles, which are housed within the scrotum. The scrotum is a specialized organ which is involved in the thermoregulation of the testicles (Fayrer-Hosken, 1997). Male sex cells or spermatozoa are formed in the seminiferous tubules of the testicles, and spermatogenesis is simply the maturation process that results in the formation of sperm cells from germ cells. Sixty days is usually required to produce mature sperm. The epididymus and vas deferens function to store and transport sperm. Accessory gland secretions are essential for initiation of sperm cell motility and also provide a supportive and nutrient-rich environment for spermatozoa. The spermatozoa and accessory gland secretions coalesce to produce semen. Normally, 1.2 billion cells/ml are present in the ejaculate of a mature bull. Control of bovine male reproduction is a finely orchestrated system. A thorough understanding of anatomy and physiology can provide insight for proper management strategies used with bull development.

After reaching puberty, bulls require a 14 to 16 week adjustment period that involves a series of seminal quality changes before the ejaculate is considered adequate for breeding. Factors such as scrotal circumference, concentration of sperm cells, percentage of normal sperm cells, progressive motility, and seminal protein concentration all increase during this transition period. Therefore, young bulls require this transition period, and should not be expected to pass semen quality criteria until they have completed this phase of the maturation process. As a result, bulls should not be subjected to culling based on inadequate semen quality until they are at least 15 months old, but rather retested after a period of rest (Selk). A penile extension, which is free of adhesions and pus during a BSE are positive observations. Physical characteristics such as eyesight, general health, structural soundness, and the palpation of reproductive organs are also important to determine reproductive potential. In addition, the use of libido testing to determine sex drive is becoming more widely used. A sizable difference in libido test scores of yearling bulls has revealed significant differences in conception rates among bulls of different scores (Selk). However, selection and/or culling on the basis of testes size is advocated and suggested for young bulls. At one year of age bulls should have a minimum scrotal circumference of 32 cm, preferably 34 cm (Selk).

Bull Test Stations

Evaluation of performance traits to increase productivity and profitability of the cow-calf operation are of paramount importance. Test stations are located throughout the United States to provide a standard, impartial post-weaning test for rate of gain, soundness, and condition. The average daily weight gain from weaning to yearling is a moderately heritable genetic characteristic of young beef bulls. Therefore, we can assume that bulls with a higher rate of gain will be expected to transmit this trait to their offspring. However, if high gaining bulls are to be of any real value to the beef industry they must be reproductively sound. As a result, test stations must not only measure performance traits, but also include valid assessments of reproductive potential and structural soundness. The useful life span and longevity of a bull can be greatly diminished by poor foot and leg conformation. Additionally, these structural problems are heritable and can be passed on to future generations.

A wide range of test station management and feeding practices exist. Bulls generally begin test at approximately 8 months of age or shortly after weaning, and bulls that enter a test program are required to have been born within a specified time span, usually 90 days. Junior bulls are usually spring born calves, whereas, senior bulls are born in the fall. The length of test can vary from 112 to 140 days, with a 14 to 28 day adjustment period occurring before onset of the test (Cates, 1991). The current trend is to shorten the test to 112 days because of decreased costs and a belief that growth rate can be accurately measured within this shorter time interval.

Basic objectives of a bull test station are to demonstrate and evaluate post-weaning growth in beef bulls, which allows producers to identify breeding bulls with superior, economically important traits. When evaluating growth, feeding management is critical to properly manage development and correctly rank bulls based on their genetics for growth. Diets fed range from approximately 60 to nearly 80% total digestible nutrients (TDN) (Cates, 1991). It is important that these energy levels are not detrimental to overall bull health, structural soundness, or reproductive capacity. Various measurements used to quantify performance are taken through-out the test period to identify high performing bulls in terms of gain and efficiency that are also reproductively and structurally sound. Only bulls that meet minimum guidelines for growth per-formance and reproductive capacity are available for sale. These criteria may be based on averages for a particular breed or through use of indices which compare bulls to their contemporaries.

Although, a complete breeding soundness examination is desirable for bulls that complete a performance test, remember that bulls may not have completed the transition period and are not biologically capable of producing an acceptable ejaculate until they are at least 15 months of age. Junior or senior test bulls will be approximately 13 months old when they come off test. Scrotal circumference, however, can be used to select or cull junior test bulls because minimum criteria can be set and enforced as early as 12 months of age. Reproductively, it is important to recognize the important physiological changes during pu-berty and the transition period when establishing seminal quality standards for young bulls. Therefore, a bull performance testing program acts to provide an environment in which bulls can be fairly evaluated in terms of overall perform-ance, which includes, growth, fertility, and soundness.

Test stations are designed to evaluate bulls so that genetic progress can be made. However, through 50 years of data, it was found that only the Angus breed had shown any significant improvement in rate of gain (Cates, 1991). Only 35% of bulls that finish a performance test pass standards that make them eligible for sale (Cates, 1991). A small percentage of bulls not meeting sale criteria went to slaughter, but many of these bulls were taken out of the test station and presumably sold as breeding stock. Therefore, the explicit purpose of the test station was not met. These patterns exemplify the use of test stations merely as a marketing tool used to sell bulls and not as a means of collecting information for breed improvement. This could be a plausible reason for limited genetic progress of various breeds utilizing testing programs.

Effects of Overnutrition

Overfeeding has been known to interfere with reproductive capacity for more than 70 years. The feeding of high energy impairs spermatogenesis, structural soundness, libido, and overall reproductive performance. Beginning in 1909, reproductive impairment of male animals was first recognized by an absence of sexual interest (Cates, 1991). Two specific reasons were named as the cause that included a combination of overfeeding and lack of exercise. Observations were also made that younger animals were less likely to be affected by overfeeding and lack of activity. However, prolonged diets that allow for long term fat deposition increase the risk of reduced breeding capacity.

Dietary effects on reproduction have been studied. Bulls developed on a forage-based diet (free choice forage and 8 lb concentrate) exhibited greater activity than concentrate fed bulls (Hentges et al., 1964). Higher activity levels can better prepare bulls for the upcoming breeding season. One major effect of high energy is laminitis of the hoof. Bulls fed a forage diet had a 5% incidence of laminitis compared to 70% of concentrate fed bulls. In addition, 100% of forage fed bulls completed copulation with faster sexual response in mating trials, versus 10% of bulls fed a concentrate diet (Hentges et al., 1964). During early feeding periods, bulls fed a concentrate diet had superior semen quality, however, forage-fed bulls exhibited the highest quality semen at the end of the trial. Seminal quality was based on the number of sperm cell abnormalities present in a sample of semen. In another study, bulls were either fed a high or moderate energy diet for 140 days. The moderate energy intake group was limit-fed to gain about 2 lb/day on a 70% TDN ration. The other group was fed the same ration free choice. Bulls fed moderate-energy diets had significantly greater libido or sex drive than those fed the higher energy (Morrow et al., 1981).

The detrimental effects of overfeeding were also documented in a study using Hereford bulls (Skinner, 1981). Bulls were put on a feeding trial from 3 to 24 months of age. On the high plane of nutrition bulls were fed to gain about 3.85 lb/day, whereas, the bulls on a lower plane of nutrition were fed to gain only 2.2 lb/day. The age at which sperm cells first appeared in the ejaculate was not reduced by high levels of nutrition, however, the number of abnormal cells were elevated in bulls on a high plane of nutrition by 52 weeks of age and throughout the rest of the feeding trial. Moreover, as abnormalities increased, sperm motility declined. Highly fitted performance tested two year old bulls have been reported to have unusually low breeding potential when subjected to a breeding soundness exam-ination (Barth et al., 1989). When these bulls were examined 75 to 90 days after the sale, only 36 to 43% were classified as satisfactory potential breeders. At 5 to 6 months, the bulls were again reexamined, and only 68 to 71% were classified as satisfactory potential breeders. Unsatisfactory bulls had reduced semen quality, when compared to satisfactory breeders.

Depending on management, performance tested bulls can lose 250 pounds or more after purchase (Cates, 1991). It is estimated that breeding effectiveness during the first year on pasture may be reduced 75% compared to that of bulls in good breeding condition. In a study using bulls that were 12, 15, and 24 months of age, bulls were fed either a high (80% concentrate and 20% forage) or a moderate energy (100% forage) diet (Coulter et. al, 1984, Coulter et al., 1987, Coulter et al., 1988). Semen quality and daily sperm cell production were reduced in bulls fed high levels of energy. Epididymal sperm reserves were also reduced by as much as 75% in some cases. The bulls fed a high energy diet had the greatest backfat at all ages. In addition, these bulls had a larger scrotal circumference at 12 months of age, however, this difference disap-peared by the time bulls reached 15 months of age. In another breeding study, continental bulls with less back fat sired more calves, as compared to bulls with greater amounts of back fat (Coulter et al.,1989). Undernutrition however, also impairs spermatogenesis and reproductive per-formance in beef bulls. Therefore, optimal levels of energy used for bull development must be determined so that growth and efficiency can be properly measured without negatively affecting reproductive function.

It is well recognized that scrotal circum-ference is an important tool for bull selection. As scrotal circumference increases, age at puberty in bulls and heifers decreases. There is a high correlation between scrotal circumference and sperm output. It has also been documented that as scrotal circumference increases, motility, percent normal sperm, semen volume, and semen con-centration increase, and percent abnormal sperm decrease (Boyles). Bulls possessing a larger scro-tum have the potential to breed more cows and the potential to breed more cows earlier in the breeding season. Therefore, scrotal circumference is highly associated with the reproductive capacity of the bull.

The testicles have two functions including the production of spermatozoa and testosterone (Boyles). Optimally, sperm production occurs at 4° to 8° F below normal body temperature, and the scrotum is important for thermoregulation, providing protection against both extremely cold and hot temperatures. It has been hypothesized that low fertility of performance tested bulls is associated with high energy diets causing scrotal insulation due to the deposition of fat on the scrotum. Scrotal insulation allows temperature of the testes to increase because of reduced temperature regulation in the scrotal neck and has been associated with reduced sperm quality and poor fertility. Several research studies have examined the effect of scrotal insulation on semen quality. In one particular study, scrotal fat and scrotal neck fat were measured using ultra-sonography after completing a 112-day perform-ance test that utilized a 70% TDN diet (Lemaster et al., 1999, Schrick et al., 1998). Ultrasono-graphy was also used to measure backfat at the 12 to 13th rib. However, there was no relationship between scrotal fat and backfat. Therefore, these results imply that deposition of fat into the scrotum does not occur in performance tested bulls and therefore, may play a small role, if any, in the reduced fertility often observed. Breeding soundness examinations were also used to correlate backfat with seminal quality. However, no relationship between these factors was detected. Therefore, fertility of performance-tested bulls was not affected by backfat (Lemaster et al., 1999, Schrick et al., 1998).

In another study evaluating the effects of dietary energy, scrotal surface temperature was measured using infrared thermography (Coulter et al., 1997). The dietary energy level had no effect on the average scrotal surface temperature, however, bulls fed the moderate energy (100% forage) diet exhibited a larger temperature gradient from top to bottom in the scrotum than those fed the high energy (80% concentrate and 20% forage) diet. Bulls fed the high-energy diet had greater difficulty cooling the scrotum compared to bulls fed the moderate-energy diet.

Usage of thermograms has shown increased testicular warming of bulls fed high energy diets. However, there is inconclusive data to support the hypothesis that scrotal fat is responsible for increasing testicular temperature (Schrick et al., 1998).

To evaluate the effect of dietary energy on daily sperm production, bulls were fed either a high (80% concentrate, 20% forage) or medium (100% forage) level of energy. Bulls fed a medium-energy diet had 12% greater daily sperm production than bulls fed the high energy diet (Coulter et al., 1987). In addition, diet influ-enced scrotal circumference at 12 months of age. Bulls fed the high-energy diet had a greater scrotal circumference (36.1 vs 33.9) than bulls fed the medium energy diet. Although this and other studies show increased scrotal circum-ference with higher energy, there is some conflicting data in this area.

Management of Young Bulls

Currently, more producers within the cow-calf industry use yearling bulls rather than older bulls. Advantages that favor the use of yearlings include a shorter generation interval and a less expensive purchase price (Selk). Yearling bulls will not breed as many cows as two-year olds and require higher levels of management during and after the breeding season, but with proper management, yearling bulls can be used in most production systems.

Use of yearling bulls is an excellent way to get an additional year of use from bulls reducing the per cow bull depreciation cost. In addition, yearling bulls potentially sire more calves during their useful life than older bulls and the bull cost per calf produced is reduced. New bulls should be acquired at least 60 to 90 days before the breeding season (Boyles). This will allow new bulls time to acclimate to your feeding regime and climate, to become familiar with each other, and to establish a social structure within the herd.

When purchasing young, highly fitted or conditioned bulls, a plan to gradually reduce fleshiness should be considered and implemented before the breeding season. Research at Kansas State University has shown that young perform-ance tested bulls have normal fertility and libido when allowed to return gradually to a moderate fleshiness and hearty physical condition before the breeding season (Selk). To do this effectively, it is a good practice to start them on a diet similar to the test diet but limit bulls to only 60 to 70% of their previous intake. Concentrate levels should then be reduced by approximately 10% per week until the optimal amount of condition loss has been reached. This period of let down should be complete by the time bulls are turned out for breeding. Drastic shifts in nutritional levels can have negative effects on semen production, so it is important that diet modifications are done gradually. Rapid changes that allow for great losses in condition over a short period of time may cause a reduced calf crop in the following year due to poor overall reproductive perform-ance. It is also important that young bulls get plenty of exercise, so that at the beginning of the breeding season they are physically fit and ready to work. Facilities designed with separate feeding and watering areas will force bulls to exercise. Bulls that are physically fit have an opportunity to breed more cows because they often retain a higher libido longer into the breeding season. Also exercise can reduce the incidence of injuries caused from fighting and riding. Overlooking proper bull management while focusing on the cow herd can be disastrous, since the bull contributes 50% or more towards improvement of herd genetics (Hermel, 1995).

Proper management of yearling bulls is necessary for success. Yearling bulls should only be run with other yearling bulls when placed with females. This will reduce the incidence of physical abuse on young bulls by older animals and will increase the amount of cows bred by yearling bulls. In addition, cow to bull ratios should be reduced to about 50% of that main-tained with older bulls. Some producers have successfully rotated yearling bulls in and out of the breeding pasture every two weeks. For many extensively managed operations this will require additional management and labor that may not be available. However, rotation of work then rest is beneficial in maximizing the use of yearling bulls.

Yearling bulls should be used for only 60 days or less. Longer time periods can be detri-mental to growth and have negative long term effects on bull performance. After removal from the cow herd, yearling bulls should remain separated from older bulls through at least their second winter. Care should be taken that these bulls receive adequate nutrition and regular supplementation until the next breeding season. These animals will need to replace condition they lost during the breeding season, and they are continuing to grow and will need increased nutrition to maintain growth during this time. Proper care of young bulls when they are young will result in more attractive and productive mature bulls that have a much higher salvage value.

Summary

Ideal nutritional programs for young bulls should be moderate in cost, meet growth requirements, and avoid excessive condition. Diets should be formulated to avoid digestive problems that may have an impact on animal performance or affect structural soundness. In most cases the advantages of yearling bulls will promote their use. Most yearling bulls can be used effectively, if they are critically selected, properly developed and carefully managed.

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