MANAGING BULL DEVELOPMENT TO OPTIMIZE FERTILITY

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Bulls that are managed for sale as yearlings usually are fed high-energy diets in the post-weaning period to maximize rates of gain in body weight. High-energy diets with adequate protein, vitamins and minerals are likely to result in a larger scrotal circumference (SC) at a year of age; however, at least part of this increase in size is likely due to scrotal fat [1]. There are conflicting reports about whether testis size and age at maturity is significantly affected by nutritional intake in the post-weaning period [2-5]. The larger testis size seen in some studies when calves received superior postweaning nutrition likely was due to greater numbers of germinal cells supported by each Sertoli cell rather than larger numbers of Sertoli cells or greater potential size of seminiferous tubules [6]. Therefore, bulls with slower weight gains in the postweaning period might have smaller testes at a year of age, but no reduction in potential adult testis size or semen production capability.

Nearly all research in bull development has been concentrated in the postweaning period. This has overlooked a very important period of development in a bulls life, i.e., calfhood. There are indications of a strong effect of calfhood nutrition and health on age at puberty and testis size implying earlier maturity and larger lifetime testis size. Scrotal circumference was smaller in yearling bulls raised by first-parity dams, compared to those raised by older dams [7,8]. This may have been due to lower milk production by first-parity dams, an in-utero effect, or both. The effect of reduced calfhood nutrition is mediated through gonadotropin secretion. Calves destined to become later maturing bulls with smaller testes had lower amounts of LH secretion during the period of the early gonadotropin rise at 8-16 weeks of age [9]. Furthermore, augmenting circulating LH concentrations at the time of the early gonadotrophin rise, by treating calves with GnRH, hastened pubertal development [10], while inhibiting the early gonadotrophin rise delayed it [11]. FSH treatments in calfhood also increased SC and hastened spermatogenesis [12]. In that regard, FSH has been considered a main driver of Sertoli cell proliferation in prepubertal animals [13]. Since Sertoli cell multiplication ceases at 20–25 weeks of age in bulls, final testis size in bulls is likely determined in calfhood [12].

Studies done to investigate the effects of calfhood nutrition on pubertal development, confirmed that superior calfhood nutrition resulted in higher gonadotropin secretion which was mediated by metabolic hormones. This resulted in larger testes at a year of age and an earlier onset of spermatogenesis [14,15,16]. These studies indicated that calfhood is an extremely important phase of development that likely has life long implications for a bull. Maintaining health and nutrition in calfhood begins with insuring adequate colostum intake at birth, vaccination against bacterial and viral diseases during calfhood as well as at weaning age and ensuring good nutritional intake by ensuring milking capacity of dams and creep feeding bull calves at pasture if necessary. Bulls should be vaccinated for clostridial and viral diseases in the prepubertal period and vaccination status should be maintained. Vaccination of prepubertal bulls with an attenutated modified live vaccine (e.g., Pfizer Bovishield) may be an important component of BVD control programs in cow-calf operations. Vaccination can help protect bulls

against acute infections that have been associated with transient and persistent testicular infection and subsequent transmission of BVDV in semen to susceptible cows. In addition, vaccination may help maintain semen quality which may decline during the first 60 days after an acute BVD infection [17,18].

The first opportunity for selection and culling of bulls is after weaning when they are 6 to 8 months old. Since at this time only a few calves will clearly display abnormal developmental and conformational attributes, the main criterion for selection at this time will be weaning weight and testicular development. Hypothetically, bulls that are unlikely to reach the minimum desired SC by 1 year of age could castrated and sold, or fed as steers. This would minimize the expenses associated with maintaining cull bulls or inadvertently entering them in performance test programs. However, a study of 708 bulls fed in a record of performance station in western Canada indicated that SC measurement in weaned bulls was inadequate for predicting yearling SC. A large proportion of bulls met the minimum recommended SC requirements at a year of age even though they were in the bottom 17% of bulls at 240 d of age and would have been culled. However, SC measurements at weaning might be used as a tool to select bulls that would be highly likely to meet the minimum requirements for SC at 1 year of age [19].

Newly selected, or purchased weaned bull calves should not be turned out to rough it until the next breeding season. An ideal nutritional program for young bulls should be established based on breed and frame size of bulls and this can be done with the help of a nutritionist. A well-designed program should be moderate in cost, allow for rapid growth at 2.5 to 3.0 pounds of gain per day, but avoid excessive body condition. Excessive energy intake in young bulls may result in abnormal foot growth due to laminitis [20] as well as abnormal bone and cartilage growth resulting in stiffness and lameness due to osteochondrosis [21]. In addition high-energy diets increase the risk of rumen inflammation and liver abscesses that may lead to the development of infection of the vesicular glands [22].

Final selection of bulls for breeding potential could be done when bulls are 12 to 16 months of age. This is the period during which puberty is being completed and the very rapid testicular development of previous months tapers off. It has been shown that yearling bulls with a small SC measurement at a year of age did not catch up over time and had small SC measurements at 2 years of age as well [23]. By 12 months of age, bulls which will have small testes as adults can be identified. A large scrotal circumference at a year of age would indicate a potential for early maturity in the bull and his offspring. Many conformational abnormalities are visible by this time; however, some abnormalities such as the corkscrew claw defect may not be evident in some bulls until as late as 18 months of age. Many sale committees demand a minimum scrotal circumference measurement for yearling bulls and a satisfactory semen quality test. However, only about 33% of bulls, even if they have adequate SC, will have satisfactory semen quality at 12 months of age because they haven't completed puberty. At 14 and 15 months of age, about 60 and 80% of bulls will have reached maturity (able to produce good semen) [24].

Producers place a lot of pressure on veterinarians to pass yearling bulls for sales because decision deferred bulls sell poorly. What are the chances that bulls presumed to be immature will have improved semen quality within the next few months? Table 1 shows some data from a bull rearing station in western Canada over 4 years. At this station bulls are purchased in the fall at 6-8 months of age and reared for use in community pastures the following spring and summer. About 2/3 ^{rds} of the bulls were Angus and 1/3rd were Charolais. Bulls that were physically sound, but had inadequate semen quality were classified as decision deferred and were retested 7-8 weeks later.

Table 1. Results of breeding soundness evaluations of yearling bulls tested at 13 to 14 months of age (April 15-21) over a 4-year period from 2008-2011. Decision deferred bulls were retested at 15 to 16 months of age (June 11-15) except for the year 2008. Unsatisfactory bulls were culled for such things as small testes, epididymitis and locomotory abnormalities.

Age	n	Satisfactory (%)	Decision Deferred	Unsatisfactory
13-14 mo	524	413 (78.8)	85 (16.2)	26 (5.0)
15-16 mo	71	25 (35.2)		46 (64.8)

We would expect about 15% of physical normal mature bulls to have unsatisfactory semen quality in prebreeding season semen tests. Thus, if the reason for a decision deferred classification in physically normal pubertal bulls is inadequate semen quality, one might expect over 80% of them to have satisfactory semen quality at the age of maturity (16 months of age). However, the data in this study indicated that a much lower percentage (35%) of decision-deferred bulls is likely to have satisfactory semen at maturity. Therefore, it would be very unwise for veterinarians to hope that most decision deferred pubertal bulls will have good semen quality after an additional month or two for maturation.

Prior to 1990 most bulls sold to commercial producers were 2 years old. Then, every year more and more yearling bulls were used as primary breeders in commercial herds. Commercial producers often preferred to grow out yearling bulls themselves to bypass problems associated with overfeeding that often occurred in bulls sold at 2 years of age. When used as yearlings, bulls sire more calves in their lifetime thus reducing the cost per calf produced. Purebred producers also found increased profitability in marketing yearlings rather than feeding and maintaining bulls an extra year to market them as 2-year-olds. However, the variability in age at maturity of yearlings, among and within breeds, resulted in great variability in reproductive performance of young bulls from disastrous reproductive rates to rates comparable to that of older bulls.

With proper management yearling bulls can consistently be used successfully as primary breeders. Table 2 shows the results of a 10-year study at the University of Alberta that compared breeding outcomes of yearling vs. 2-year-old bulls [25]. The findings were in agreement with the results of other studies as well [26,27].

Table 2. Pregnancy rates for 1 vs. 2-y-old bulls in 60d breeding seasons at a bull to female ratio of 1:25

				Calves Born	
Bull age	Herds	Cows	Pregnant	1st 4 weeks	1st 6 weeks
14 mo	31	665	83.9%	57%	78%
26 mo	31	650	82.5%	64%	83%

There was a tendency for 2-year-old bulls to produce higher pregnancy rates in the first 4 weeks of the breeding season. Similar results were obtained in other studies [28,29] in which a higher proportion of cows were settled by 2-year-old bulls during the early stages of the mating season compared to those of yearling bulls. The studies indicated that yearling bulls that are carefully selected for breeding soundness will perform well as primary breeders at BFRs of 1:25. Producers wishing to use yearling bulls should select bulls with early birth dates and

demonstrating good sex drive and normal mating ability. Scrotal circumference measurements should be above average and semen evaluation must be done to ensure that the pubertal development period has passed and at least 70% normal sperm are being produced.

It is commonly accepted that the older, socially dominant bulls in mixed age groups will sire the majority of calves; however, in short breeding seasons and high bull to female ratios this is not necessarily so. In our observations, when a sexually active group contained 3 or more estrous females, or when there were 2 or more sexually active groups, dominant bulls were unable to prevent subordinate bulls from mating. This is in agreement with the work of others [30]. Furthermore, after a dominant bull had mated with a female and became interested in another female, subordinate bulls were able to mate with those previously bred by the dominant bull. In one experiment, in which 4 bulls were joined with 120 females, subordinate bulls mated with estrous females later than the dominant bull, but bred as many or more females than the dominant bull. The dominant bull, though of normal semen quality and large testicle size, sired fewer calves than the subordinate bulls.

In the western range land of North America, breeding seasons usually occur in late spring and early summer taking advantage of favorable pasture conditions for milk production and fertility in beef herds. Bulls tend to lose a considerable amount of weight in the breeding season and may continue to lose weight on native pastures that enter dormancy in late summer and early autumn. Bulls that lose weight can be expected to lose approximately 2 cm of scrotal circumference between early spring and autumn. The decline in scrotal circumference may be accompanied by a decline in semen quality. These physiological changes are driven by changes in metabolic and in turn gonadotrophic hormones that result in reduced germ cell proliferation in the testes. Reduced numbers of germinal cells per Sertoli cell result in a decline in testis mass. Bulls that have lost body condition must be fed to allow recovery of body condition over the winter months. An association between body condition and semen quality was found in a retrospective study of 2210 bulls [31]. Bulls with a body condition score of <2.5/5 or >3.5/5 were more likely to have poor semen quality.

Winter nutrition programs will vary between areas of the country and between farms depending on bull body condition and climatic conditions. Generally, a good forage diet at 2% of body weight with a standard mineral supplementation is all that's required. If hay quality is poor and, or bulls need to gain weight, addition to the diet of some grain such as oats will result in rapid gains. In the fall to early winter period, bulls should be treated with an endectocide to control internal and external parasites. Re-immunization against common diseases should also be considered at this time.

An ideal bull wintering facility will allow bulls to be comfortable and protected from severe weather and will provide ample room for exercise and feeder or bunk space to minimize competition. Most producers are aware that each time bulls experience an environment change they will spar off to reestablish pecking order and individual territory whether at pasture or in small pens. Larger pen space allows subordinate individuals to escape fights and reduces the chance of injury as well as destruction of facilities. Larger spaces also encourage more exercise so that bulls and their feet remain fit throughout the winter. However, it is often difficult for bulls to obtain enough exercise in winter facilities to prepare them for the breeding season. Movement of bulls to small holding pastures or fields in early spring to make them walk larger distances between feed and water should improve their physical fitness for breeding.

With the approach of spring bulls need to be evaluated for breeding soundness and any foot care that is needed should be taken care of well in advance of the breeding season. While a

bull is being restrained for these procedures it might be a good time to update the bulls' vaccination status.

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