ECONOMIC CONSIDERATIONS IN BEEF BULL MANAGEMENT

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How Many Bulls Should Your Beef Clients Own?

Bull-to-female ratio (BFR) should guide any decision. On average, each beef enterprises in the U.S. uses a 1:27 BFR for older bulls (2-year-olds and older) and a 1:17 BFR for a yearling bull.[1] Aside from setting an arbitrary ratio, a serving capacity test is a rationale approach to determining cow-to-bull ratio in a breeding pasture.[2] Since a bull investment ultimately becomes a cow cost[3], requiring a bull to breed a few more females reduces the annual breeding cost per cow.

For example, referring to column 1 in Table 1, if a bull is purchased for $2000 as a two-year-old and is kept for 3 breeding seasons, the estimated annual maintenance (carrying) costs will be $995. At a 1:27 BFR , the cost per exposed cow equals $36.85. However, if the BFR is changed to 1:35 (i.e. exposed to 105 females during lifetime), the cost per exposed cow equals $28.42, which is nearly a 23% reduction in bull cost per exposed cow from the original 1:27 BFR. The same inferences apply to the use of yearling bulls.

Another reason for minimizing a bull inventory is that not spending more money than is needed for bulls, frees up cash for use in other areas of a ranching operation. For example, if the cost of capital is 10%, using $2000 to buy a bull instead of investing the money in an alternative endeavor is a 2000/.10 = $20,000 long term decision.

Does It Make Economic Sense To Use Yearling Bulls?

Economic Analysis

Traditional cow/calf enterprise budgets typically incorporate the costs of maintaining herd bulls into the annual cow costs.[3] Using only these budgets, it is difficult to identify the sources of cost differences among different bull management strategies. An alternative is to remove these costs from the cow/calf budget and focus closely on total bull cost alone in order to compare the breeding cost per cow under selected bull management strategies.

Accumulated bull ownership costs. An economic analysis (Table 1) compares the total costs associated with purchased yearling and two-year-old bulls used for 4 and 3 breeding seasons, respectively. An arbitrary purchase price of bulls was used in the analysis. Obviously, prices paid for bulls will vary depending upon the ranch. However, different purchase prices only change the magnitude of the calculation, *bull cost per cow exposed*, but do not alter the inferences that can be drawn from the results. A host of variable and fixed costs are also included in Table 1. Not every producer will find it necessary to fill in every blank. The costs used in this example are representative of previously published estimates.[4,5]

Bull cost per cow exposed. Calculations for *bull cost per cow exposed* in Table 1 are derived from the sum of bull costs accumulated over 3 or 4 breeding seasons (depending upon age of the bull at first service) divided by total cows mated to these bulls during this time period. Bull-to-female mating densities used were 17 to 27 cows per bull per year (traditional mating load) and 30 to 40 cows per bull per year (heavy mating load). The latter mating load should be easily achievable under sound management.[6]

A *bull cost per cow exposed* economic figure is not synonymous with *bull cost per calf born*. *Bull cost per calf born* will usually be higher in single-sire cow herds because some cows are usually not pregnant at the conclusion of a breeding season. However, in multiple-sire pastures, *bull cost per calf born* will probably be lower for highly fertile bulls. The highly fertile bull

voluntarily achieves a higher mating load than arbitrarily assigned to him. Consequently, he sires more calves than expected.

Many factors influence the bull management strategies used by individual cow/calf producers. Herd size, pasture sizes, rotational schedules, and many other factors, must be considered when developing a breeding system. This economic analysis serves only as a guide to help producers make the most efficient use of bull resources used in the cow/calf enterprise. Producers are encouraged to plug their own figures into Table 1 to arrive at a true picture of bull ownership costs.

Guidelines for Selecting Reproductively Sound Yearling Bulls

Scrotal circumference. The success of settling cycling beef females is highly dependent upon using bulls that have reached sexual maturity (puberty). In individual bulls, puberty coincides with the culmination of several endocrine, anatomical, spermatogenic, and behavioral changes.[7] From a practical standpoint, puberty is considered the point at which a young bull is able to produce greater than 500 million sperm/ml with greater than 50% progressive motility.[8] When this degree of semen quality is present, a bull should be able to settle cows under natural mating.

Testicular weight has been shown to correlate positively with sperm production.[9,10] Bulls with larger testicles produce more spermatozoa, have higher epididymal sperm reserves, and tend to have a lower percentage of abnormal spermatozoa.[11-16] Testicular weight is also positively correlated with scrotal circumference.[11] Results from the US Meat Animal Research Center, Clay Center, NE indicate that scrotal circumference more accurately predicts male puberty than either the age or weight of an individual bull, regardless of breed or breed cross.[7] Consequently, measurement of scrotal circumference (SC) has emerged as an excellent method for identifying sexual maturity and, hence, sperm producing capability in young bulls.

Minimum age-related scrotal circumference values have been published for different age ranges of bulls of several Bos taurus breeds.[17] In the absence of breed-specific information, the American Society of Theriogenology guidelines should be followed. For example, 15-month-old bulls should have a minimum scrotal circumference of 30 cm.[18] For bulls of Bos indicus breeding, a scrotal circumference of 32 cm is recommended.[8]

If yearling herd bull prospects are being selected from bull calves at weaning, a formula has been developed to predict the SC that bulls from specific breeds will attain at a year of age based on SC measured at weaning.[19] Based on this formula, bulls generally need 21 cm SC at weaning to reach 32 cm at 365 days of age.

Breeding Soundness Examination. Breeding soundness examinations (BSE) of yearling bulls (15 months of age) should follow the current recommendations of the American Society for Theriogenology.[18] To qualify as a satisfactory potential breeder, a yearling bull must have all of the following:

- physical soundness
- minimal scrotal circumference of 30 cm (if alternate guidelines are not published for the breed of bull being evaluated)
- minimum of 30% progressive sperm motility
- minimum of 70% morphologically normal sperm cells.

From a practical standpoint, probably only those yearling bulls with SC ≥ 34 cm should be selected. Approximately 5% of bulls with scrotal circumference measurements ≥ 34 cm fail a breeding soundness examination because of questionable semen quality[6,13,20,21] whereas nearly all bulls with SC < 30-31 cm fail because of no semen production or semen of poor quality.[6,20,21]

Poor semen quality has been attributed to a combination of low motility and morphologic abnormalities consisting of abnormal head shapes, proximal cytoplasmic droplets, detached heads, distal protoplasmic droplets and bent tails.[20,21] Even in bulls with adequate testicular size, persistence of certain sperm abnormalities can adversely affect fertility. Bulls with > 30% proximal cytoplasmic droplets have been shown to have severely depressed *in vitro* fertility.[22] In studies where testicle size was related to subsequent herd fertility, bulls with SC less than 30 cm had poor conception rates.[6,23] Reduced conception is probably related to cows receiving insufficient numbers of sperm per ejaculate.[6]

For most beef breeds, puberty begins at a scrotal circumference of 26 to 30 cm (average 23 cm) and is completed after 3 to 4 months.[24] At the beginning of puberty, ejaculates contain a high percentage of pear-shaped or microcephalic (smaller than normal) heads and proximal cytoplasmic droplets or coiled tails. As bulls age from 11 to 14 months, their scrotal circumferences increase approximately 1 cm per month and the percentage of abnormal sperm ejaculated decreases.[13,24] Head defects disappear first.[13,24] Approximately 80 to 85% of yearling bulls will pass an initial breeding soundness examination.[21,25] This rate is similar to the percentage of satisfactory breeders found when bulls of all ages are examined.[26,27]

Serving capacity test. Traits evaluated in the breeding soundness examination (scrotal circumference, sperm morphology, and sperm motility) have not shown a strong relationship to subsequent mating ability and fertility of bulls.[28-30] Consequently, a serving capacity test (SCT) has been developed to objectively assess fertility of bulls prior to pasture mating conditions.[31-33] Serving capacity is defined as the total number of services a bull achieves in a 21 day pasture mating period.[6]

The SCT was developed in Australia in the mid-1970's to evaluate mating ability of 18-month-old (long yearling) virgin bulls.[6] A SCT predicts natural serving capacity of individual bulls based upon the number of services a bull completes in a standardized 40 minute or 20 minute (modified SCT) time period.[6] Whereas the main function of a BSE is to detect bulls of low fertility, the SCT is capable of identifying bulls with the very highest fertility.[29]

Use of both the breeding soundness examination and serving capacity test on a group of bulls would accurately identify the most fertile bulls. Long-yearling bulls with high serving capacity and large testicles typically are very successful in getting cows pregnant early in the breeding season.[30,33,34] Furthermore, they can withstand exceptionally high mating loads, e.g. a bull with SC of 34 cm and a SCT of 12+ has the potential to successfully settle 80 cows that cycle in the first 3 weeks of the breeding season.[6]

When SCT has been adapted to yearling (12-15 month) bulls, some studies have reported serving capacity tests to be an accurate predictor of bull fertility,[35,36] whereas other researchers found SCT to be ineffective in always correctly categorizing bulls.[37-39] In the latter studies, bulls classified as having high serving capacity based upon a pre-breeding SCT maintained a similar post-breeding SCT score and high fertility (high pregnancy rates) under natural mating conditions. However, some bulls that received a low serving capacity score prior to breeding had better fertility than predicted, i.e. pregnancy rates comparable to high serving capacity bulls. A SCT conducted post-breeding in these bulls subsequently showed a score similar to high serving capacity bulls. Sexual experience apparently improved the reproductive prowess of the bulls. Consequently, these researchers concluded that a single SCT was not useful in predicting the fertility in yearling bulls that do not initially score high.

A more recent SCT study conducted by Landaeta-Hernandez, et al[40] supports the notion that a maturing and/or learning process occurs with some yearling virgin bulls. Using *Bos taurus* bulls, their study showed that a subpopulation of low scoring SCT bulls will improve their score if tested multiple times. Their overall calculation of gain in accuracy from multiple repeated

measurements showed that the variance of the libido score is reduced to 73% by repeating the test four times and an additional reduction of variance to 69% if the test was repeated eight times.

Data from these SCT studies[35-40] present some problems with interpretation because test procedures varied in some manner from the SCT as originally described by Blockey. However, it would appear that a serving capacity test is, in fact, a useful tool to employ in assisting commercial producers with a desire to stock breeding pastures with yearling bulls of only high fertility. The data indicates that if a yearling bull has a high pre-breeding serving capacity score, the bull should demonstrate high fertility in the breeding pasture. Likewise, seed stock producers that sell yearling bulls with serving capacity information will find SCT values are useful when formulating a sale offering of high serving capacity bulls, but problematic when selling medium and low serving capacity bulls, because some of them will be misclassified. Furthermore, producers raising pure Bos indicus or Bos indicus composite breeds may find SCT less useful because these genotypes appear to show an inherently lower mating activity. Since serving capacity is considered a highly heritable trait, improved reproductive performance of bulls can be realized by selecting against sire lines whose sons display poor mating ability.

Other criteria. Research by Marks and Ax[41] showed that bulls with increased fertility produced sperm with greater affinity to bind heparin-like complex sugars that are commonly found in the reproductive tract of females. Subsequently, a 30-kDa heparin-binding protein named *fertility-associated antigen* (FAA) was identified in sperm membranes of beef bulls with greater fertility potential.[42] In a survey of 2191 beef bulls from several countries that were identified for the presence or absence of FAA, those possessing FAA produced 9% more pregnancies than bulls without FAA.[42] Although such a test can identify highly fertile sperm, it should not be viewed as a substitute for a serving capacity test or breeding soundness evaluation of a bull..

Pasture Management of Yearling Bulls

Bull-to-female ratio. Well grown 14-15 month old bulls can successfully settle at least 25 cows during a confined breeding period.[34,43] Young bulls with high libido can withstand considerably higher mating loads, allowing production of 30 to 35 (or more) calves per breeding season. [34,44] As demonstrated with mature bulls in natural service, reproductive efficiency is more dependent upon libido and fertility than an arbitrary bull-to-female ratio. Once mating loads are established and bulls are in breeding pastures, it is recommended to routinely monitor mating behavior. Frequent observation of the bull battery allows early detection of spontaneous illness and injury.

Length of breeding season. Yearling bulls have performed very well during a breeding season of 60 to 90 days.[43-45] However, given the same number of estrus females, yearling bulls typically settle fewer cows early in the breeding season compared to two-year-old bulls.[45] Consequently, it is not unusual to experience a slight reduction in the number of cows calving during the first 21-28 days of the calving season in cows bred by yearling bulls. The delayed onset of calving may reflect, in part, an initial sexual naivety of yearling bulls that is overcome over time. In situations where a herd reproduction goal is to shorten the breeding season, the bull battery should probably include only mature bulls.

Age groups. It is a sound management practice to stock multiple-sire breeding pastures with sires of the same age. Compared to bulls of the same age, mixed-age groups of bulls achieve lower pregnancy rates.[46] If management constraints dictate that bulls of different ages must be used together, it is imperative that yearling bulls are not mixed with older sires. Since the social ranking that a bull holds in a mixed-age group of bulls strongly influences its sexual activity, yearling bulls are usually subordinate to older dominant males and, therefore, are afforded little opportunity to mate.[47]

Nutritional Management of Yearling Bulls

Overfeeding (BCS >7) yearling bulls prior to their first breeding season can have a detrimental effect on libido and semen quality. The greatest danger in overfeeding is that a permanent impairment of semen quality develops in some overweight bulls, even after they reduce to a normal weight.[48] These bulls tend to retain fat on the dorsal pole of the testicle and in the spermatic cord, which interferes with testicular thermoregulation.

For 2 to 3 months prior to the breeding season, fat bulls must be nutritionally "let down". They should gradually change from a high concentrate diet to a high forage diet. Also, they should be forced to exercise. Separation of water source and feeders will encourage exercise.

Breeding Season. During the breeding season pasture quality can decline to a level below the nutrient requirements of growing yearling bulls, which have higher nutrients requirements than cows later in the breeding season. Bulls that lose condition will need to be hand fed energy supplements daily or protein supplements every other day to help maintain their body weight.

Post-breeding Season. Following the breeding season, yearling bulls should be grouped away from cows and with bulls of their same age. Bulls that remain with cows tend to continue to lose weight. Bulls should be fed a reconditioning ration designed to improve their body condition to a body condition score of 6.[49]

Health Promotion

The bull battery should follow the same vaccination protocol (except brucellosis) and parasite control program used for the cow herd. Typical respiratory-related viral diseases that should be vaccinated for include IBR, BVD, PI3, and BRSV. IBR and BVD also cause reproductive problems. Herd immunity should also be bolstered for additional reproductive-related diseases associated with leptospirosis and vibriosis. In some herds vaccination for trichomonosis and neosporosis may be necessary. Another vaccination that should be included in the health maintenance program for ranches is 7- or 8-way blackleg.

Bulls should also receive an annual treatment for internal and external parasites.

Biosecurity should be on the mind of any rancher that buys a bull on a routine basis. Purchased bulls should be screened for the presence of tuberculosis, brucellosis, bovine leukosis virus, and persistent infection with BVD virus. Johne's Disease is another condition that is emerging as an important disease in cattle.

WHAT IS THE BENEFIT-TO-COST OF A BREEDING SOUNDNESS EVALUATION?

Ranching operations that do not routinely perform breeding soundness evaluations (BSE) on their bull battery are giving up probably 5-6 % more pregnancies in the cow herd.[50] Do not be surprised to fail 10-15% of bulls when BSE evaluations are done on a bull battery year after year.

Two different economic models will be presented during the seminar to illustrate the benefit-to-cost of a BSE. The magnitude of the benefit-to-cost of a BSE is dependent upon the production profile and cost structure of the ranch in question.

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TABLE 1

Annual Bull Cost and Bull Costs Per Cow Exposed

Cow:Bull Ratio	Traditional[a]		Heavy Usage[b]	
Bull Age Purchased	2 yr. old	Yearling	2 yr. old	Yearling
Variable Costs (VC) /Yr.				
Summer Pasture[c]	$72.00	$72.00	$72.00	$72.00
Hay[d]	112.50	112.50	112.50	112.50
Meadow Aftermath[e]	15.00	15.00	15.00	15.00
Supplement[f]	16.87	16.87	16.87	16.87
Salt/Mineral[g]	18.00	18.00	18.00	18.00
Veterinary/Medicine	50.00	50.00	50.00	50.00
Miscellaneous	7.00	7.00	7.00	7.00
Repairs	23.00	23.00	23.00	23.00
Labor[h]	72.00	72.00	72.00	72.00
Interest onVC[l]	19.32	19.32	19.32	19.32
Total VC/Yr.	$405.69	$405.69	$405.69	$405.69
Fixed Costs/Yr.				
Depreciation of Facilities	$ 15.00	$15.00	$ 15.00	$ 15.00
Depreciation of Bull[j]	416.67	187.50	416.67	187.50
Interest on Bull (10%)[k]	137.50	112.50	137.50	112.50
Death Loss (1%)	20.00	15.00	20.00	15.00
Total Fixed Costs/Yr.	$ 589.17	$ 330.00	$ 589.17	$ 330.00
Total Costs/Bull/Yr.	$994.86	$ 735.69	$994.86	$ 735.69
Breeding Seasons	3	4	3	4
Total Cost for Life of Bull	$2,984.58	$2,942.76	$2,984.58	$2,942.76
Total Cows Exposed	81	98	120	150
Bull Cost/Cow Exposed	$ 36.85	$ 30.03	$ 24.87	$ 19.62
Difference in bull cost per cow exposed		($ 6.82)		($ 5.25)

[a] Assumes 27 cows per bull for three years when the bull is purchased as a two year old, and 17 cows per bull for the first year of yearling bull usage with 27 cows per bull for three years thereafter.

[b] Assumes 40 cows per bull for three years when the bull is purchased as a two year old, and 30 cows per bull for the first year of yearling bull usage with 40 cows per bull for three years thereafter.

[c] 6 AUM s at $12.00 per AUM.
[d] 3,750 lbs. at $60.00 per ton.
[e] 60 days at $0.25 per day.
[f] 150 lbs. at $11.25/cwt.
[g] 110 lbs. at $0.164/lb.
[h] 8 hours at $9.00/hour.
[i] 1/2 of variables costs at 10%.
[j] Purchase price of bull ($1,500.00 for yearlings, $2,000.00 for 2 year olds) minus cull value ($750.00) divided by number of breeding seasons.
[k] Based upon average bull investment (purchase + salvage value ÷ 2)