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Invited paper:

Assessment and Management of Breeding Bulls[1]

Artículo invitado:

Valoración y manejo en sementales

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Abstract

Reproductive statistics on the farm are greatly influenced by the fertility and the handling of the bulls. Bull fertility is influenced by number and quality of spematozoids, libido and mounting skills, as well as by the social interactions between the animals in the reproductive field o corral. The procedures for evaluating a bull include the Breeding Soundness Evaluation (BSE), and tests of sexual desire and mounting skills. The new BSE criteria established by the American Society of Teriogeneology, include new standards for scrotal circumferance, motility, spermatazoon morphology. In practice, these new standards have proved to be stricter than the previous ones, affecting young *Bos indicus* bulls in particular. There are a series of tests to evaluate sexual desire in bulls which include an evaluation of libido, and the certification of service capacity. In this article the repeatability of certain tests is discussed, and its relationship with reproductive efficiency and the factors which affect it, as well as the expression of sexual desire in the bull. The factors to discuss include bull breeding methods, the bull/cow ratio, social effects and genotype differences. Since there is no relationship between sexual desire and reproductive capacity in bulls, the optimum estimation of bull breeding soundness should include the evaluation of both. To optimize bull use, they should be evaluated each year and the use of young and old bulls in the same breeding area should be avoided.

Key words: Bull breeding soundness, libido, management.

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Resumen

Los indices reproductivos del hato estan influídos en gran manera por la fertilidad y manejo del toro. La fertilidad del toro esta influídas por el numero y calidad de los espermatozoides, libido y habilidad de monta asi como por las interacciones sociales entre los animales en el potrero de monta. Los procedimientos de evaluacion del toro incluyen la Evaluacion Reproductiva (BSE; Breeding Soundness Evaluation) y pruebas de deseo sexual y habilidad de monta. Los nuevos criterios de la ER establecidos por la Sociedad Americana de Teriogenologia incluyen nuevos patrones para la circunferencia escrotal, motilidad y morfolcgia del espermatozoide. En la practica estos nuevos patrones han probado ser mas estrictos que los anteriores, afectando especialmente a toros jovenes *Bos indicus* Existe una serie de pruebas para evaluar el deseo sexual en toros las cuales incluyen la evaluacion de libído y la calificacion de la capacidad de servicio. En este artículo se discute la repetibilidad de algunas pruebas, sus relaciones con el rendimiento reproductivo, y factores que las influyen, asi como la expresion del desec sexual en el toro. Los factores a discutir incluyen los métodos de cria del toro, la proporción toro:vaca, efectos sociales y diferencias genótipicas. Como no existe relación entre el deseo sexual y la evaluacion reproductiva, la estimacion mas óptima de la capacidad reproductiva del toro debe incluir la evaluación de ambas. Para optimizar el mejor uso de los toros, éstos deben de ser evaluados cada año y debe de evitarse el uso de toros adultos y jóvenes en el mismo potrero de monta.

Palabras clave: evaluacion reproductiva, libido y manejo de toros

Introduction

Although artificial technologies for cattle breeding are rapidly improving, natural breeding is still the most common procedure used in beef cattle operations throughout the world. Where natural breeding is employed, the reproductive capabilities of bulls assume great importance. Herd reproductive rates are greatly influenced by both bull fertility and bull management. Bull fertility is influenced by a number of factors, which include;

a) sperm numbers and semen quality,

b) libido and mating ability, and

c) social interactions among animals in the breeding pasture.

A number of procedures are available to assist in bull selection, including the following measures of production and reproduction traits:

1. Growth rates, ratios and scores (birth weight, adjusted weaning and yearling weights, average daily gain, gain ratio, frame score, muscling score).

2. Breeding soundness evaluation (BSE).

3. Venereal disease testing (vibriosis, trichomonosis).

4. Libido/serving capacity testing.

Some of these procedures may not be available or feasible in all regions.

This is particularly true for those procedures requiring more sophisticated technology. This discussion will emphasize the reproductive aspects of bull assesment and management, with emphasis on procedures and technologies that are universally applicable.

The ideal bull reproductive assessment includes a physical and reproductive examination (including measurement of scrotal circumference), semen collection and examination, testing for infertility disease and an assessment of libido or serving capacity. However, performing all of these tests is not practicable in all situations, leading to a three tiered approach as follows.

1. A full physical and reproductive examination (including per-rectal exam and scrotal measure) with semen collection on problem bulls only.

2. As above, plus assessment of semen quality on all bulls.

3. As for 2, plus assessment of libido/serving capacity on all bulls.

It takes approximately twice as much time (and cost) to include each successive step. Approximately 75-80 percent of 'problem' bulls may be identified with step 1 only, a further 5-10 percent are when 2 is included, and most of the remainder when 3 is added.

Disease testing is often undertaken in situations where a problem is suspected.

Bull breeding soundness evaluation (BSE)

New criteria have been established by the American Society for Theriogenology for bull BSE assessment (3). This new system incorporates a number of major departures from the previous system including the following:

*Replacement of the numerical scoring system by recommended minimum standards for scrotal circumference, sperm motility and sperm morphology. Bulls must pass all categories to be satisfactory.

*Replacement of "questionable" with a "classification deferred" category.

General Procedures. The primary mission of the natural breeding bull is to impregnate all available females as early in the breeding period as possible. For this, he needs to have good eyesight and musculo-skeletal conformation as well as the necessary reproductive equipment and sex-drive to produce and deliver sufficient numbers of fertile spermatozoa in the female tract.

The traditional BSE consists of the following steps:

1. Physical examination (including musculo skeletal structure and eyesight).

2. Reproductive examination (including scrotal circumference measurement).

3. Collection and examination of semen.

In addition, a libido/mating ability test may be included, as may special tests for diseases (e.g. vibriosis or trichomonosis). These procedures will add predictive value to the assessment process and may be specifically indicated in some situations, although they are not generally part of the routine BSE.

Scrotal circumference thresholds. Scrotal circumference is one of the most important measures in bulls. Bulls with larger scrotal circumferences usually produce more sperm, and of better quality, than bulls with smaller circumferences. Also, this trait is moderately to highly heritable and positively associated with age at puberty in related females. As female age of puberty is favourably related to subsequent production, selection for larger bull scrotal circumference should improve herd reproductive performance. This consideration may be particularly important for some *Bos indicus* breeds, even though most of the data to date has been obtained with *Bos taurus* bulls.

The thresholds in table 1 have been established for all breeds of bulls, assuming they are puberal. The minimum recommended threshold for gross motility is fair (F). The minimum recommended threshold for individual motility is 30% (table 2).

Sperm morphology threshold. The minimum recommended threshold for sperm morphology is 70% normal spermatozoa.

Note: Categorization of sperm abnormalities (e.g. APrimary® or ASecondary@ abnormalities) is not required for the final score, although it may be useful to record them to monitor progress.

Evaluation categories.

Satisfactory: Bulls which equal or surpass the minimum thresholds for scrotal circumference, sperm motility and sperm morphology, and which do not show genetic, infectious or other problems or faults which could compromise breeding or fertility.

Unsatisfactory: Bulls below one or more thresholds and unlikely to ever improve their status. Also, bulls which show genetic faults or irrevocable physical problems (including infectious disease) which would compromise breeding or fertility.

Classification Deferred: Any bull

Table 1. Scrotal circumference threshold established for all breeds of bulls, assuming they are puberal.

Age range	Scrotal circumference threshold
<15 months	30 cm
15<18 months	31 cm
18<21 months	32 cm
21<24 months	33 cm
>24 months	34 cm
Sperm motility thresholds	
Mass Activity (Gross Motility)	Rating
Rapid Swirling	Very Good (VG)
Slower Swirling	Good (G)
Generalized Oscillation	Fair (F)
Sporadic Oscillation	Poor (P)

Table 2. Recommended threshold for gross motility.

Percent progressive motility	Rating
$70%	Very Good (VG)
50 - 69%	Good (G)
30 - 49%	Fair (F)
#30%	Poor (P)

which does not fit into the above categories and which could benefit from a retest. Includes bulls with an "immature" semen profile as well as any bulls whose semen is substandard but considered to be capable of improvement. *It is not uncommon for peripuberal bulls to show higher levels of certain types of spermatozoal abnormalities which are associated with immaturity. Such bulls will usually require a second examination before being classified as satisfactory.1 Also from whom a satisfactory ejaculate could not be obtained for reasons unknown as well as bulls with treatable problems such as seminal vesiculitis or footrot. In general, if any doubt exists about a bull fitting into either the satisfactory or unsatisfactory categories, he should be considered as a candidate for a retest and placed into the "classification deferred" category.

Bull behavior and sex-drive.

Definitions. Libido is the "willingness and eagerness" of a bull to attempt mount and service. Mating ability is the competence of the bull in completing service. Serving capacity is a measure of the number of services achieved by a bull under stipulated conditions and includes aspects of both libido and mating ability. Bull sex-drive is a measurable trait. Testing procedures designed for the bull generally rely upon several or more of the following findings:

1. Libido in bulls has a large genetic component
2. Bulls are polygamous and tend to distribute their services among receptive females.
3. The greatest single stimulus for a bull to attempt mount and service is the immobile rump of a female, or something similar in appearance.
4. Prestimulation of bulls increases their sexual response.
5. Competition among bulls can increase their sexual response.

Test Repeatability and Predictability. Testing procedures for bull sex-drive have included reaction time to service, exhastion tests, libido scores and serving capacity scores. The ideal test of bull sex-drive should be simple, quick, highly repeatable, pre-

1 Bulls must be puberal to be eligible for BSE classification.
Also, veterinarians should work with breed associations and clients to improve scrotal circumferences of bulls above minimal threshold levels.
Forms and factsheets are available to members from the Society for Theriogenology, Association Offices, 2727 W. 2nd Street, Hastings, Nebraska USA 68902-2118.

dictive of reproductive performance and esthetically acceptable. Unfortunately, no single test fulfills all of these criteria. However, current procedures do allow relative differences between bulls to be reliably estimated. For example, in one study, moderate phenotypic correlations (r = .67 and .60 respectively) between libido and serving capacity scores were obtained in yearling *Bos taurus* bulls tested on different days; reaction times to service were not significantly correlated with each other or with other scores. In this study, 57% of the young bulls did not achieve a service in both serving capacity tests and thus were not scored. When 26 yearling *Bos taurus* bulls were assessed eight times (two tests per day on four occasions within 2 months), four tests were required before subsequent test results were similar. Here there was evidence of a learning curve for competent sex-drive expression in young bulls. This phenomenon was also observed in another study where yearling bulls with low serving capacity scores improved with mating experience. Based upon such observations, a minimum of three exposures prior to categorizing has been recommended for young bulls.

In general, best success with bull sex-drive assessments has been obtained when results are used to place bulls into categories or groups. Thus, Hereford bulls maintained their relative ranking for both libido scores and fertility when assessed at both 16 and 40 mo of age, and high correlations were obtained for mating activity rankings between simulated pasture tests and subsequent pen tests (r = .82 to .91) in *Bos taurus* bulls.

In conclusion, libido and serving capacity tests are useful in placing bulls into groups which will then reflect their test results in pasture mating activity. Bulls obtaining poor to moderate results may require more than two tests for adequate categorization. Young bulls can improve their scores (and ranking) with mating experience.

Relationships with Reproductive performance. Although cattle fertility is influenced by many factors, there is evidence that bull libido is of considerable importance. Blockey, for example, obtained better first-cycle pregnancy rates in heifers mated with higher serving capacity bulls when compared with bulls of low serving capacity. A more recently published study showed differences in pregnancy rates between high, medium and low serving capacity Hereford bulls. Other studies have also shown advantages in expressed fertility for bulls of higher sex-drive. Libido and semen quality both influenced pregnancy rates of Brangus bulls in Florida, with libido having most effect. Other studies have indicated either that bull libido assessment provided greater prediction of bull fertility than did semen assessment alone, or that BSE assessment alone was insufficient to adequately predict bull fertility. Using multi-sire mating and progeny identification by blood typing, Coulter and Kozub (4) showed that the number of services performed in prior libido/serving capacity tests was positively correlated with fertility up to a certain point only (approximately four

services), above which fertility actually declined with subsequent services.

Despite this, other studies have shown poor or inconclusive relationships between bull libido/serving capacity assessment and herd fertility. In some studies, although higher libido bulls serviced more often, and serviced more females, than did lower libido bulls, more pregnancies did not result.

The apparently conflicting results of some of these reports may be explained by the following. In some trials, bulls were not placed under sufficient breeding stress to cause real differences, low fertility bulls were not included, and investigators concentrated on single trait effects on herd fertility. This latter approach is often disappointing as cattle fertility is influenced by a number of factors of which bull libido is but one. Breeding soundness components (scrotal circumference, sperm motility and morphology) can each influence fertility, but they do not appear to be genetically linked with behavioral traits such as libido. Thus bulls may be superior in one or more traits but their fertility can be compromised by deficiencies in others. This was illustrated in a study by Farin *et al.* (6) in which 92 beef bulls were placed into satisfactory and questionable BSE categories, and into high (score 9 to 10) and medium (score 7 to 8) libido categories prior to single-sire mating with groups of estrus synchronized heifers. Here, even though bulls at the lowest end of the BSE scale were not used, there was a difference in pregnancy rate of 9.1% between bulls in the satisfactory and questionable categories. There appeared to be little relationship between the BSE and libido categories. Bulls of high libido achieved a similar overall pregnancy rate to that of bulls of medium libido, despite their achievement of more overall services and more females serviced, apparently because a

Table 3. Least-Square means of mating performance within breeding soundness examination and libido classifications.

	Exam classifications		Libido	
	Sat.	Quest.	High	Medium
No. bulls	80	12	69	23
No. mounts	146.3	120.7	112[c]	155[d]
No. services	47.8	42.4	52.8[e]	37.5[f]
Mounts:services	5.8	4.8	3.1[e]	7.5[f]
Serviced/estrus (%)	73.5	71.4	81.3[e]	63.5[f]
Pregnant/serviced (%)	56.1	50.8	51.8	56.1
Pregnant/estrus (%)	44.8	36.7	43.7	37.8
Total pregnancy rate (%)	45.6[g]	36.5[h]	41.5	40.6

c,d Means differ (P < .05). e,f Means differ (P < .01). g,h Means differ (P < .10). Farin *et al.* (6)

lower percentage of serviced females become pregnant in the high libido group. In this case, differences in libido between bulls were masked by differences in semen fertility (table 3).

In conclusion, libido and serving capacity tests are useful in identifying bulls which have superior breeding activity (i.e. serve more often and serve more females than do other bulls). However, the BSE is also important in identifying differences in ability to impregnate at those services. Best bull fertility prediction requires separate assessments.

Factors affecting bull sex-drive.

Age and rearing effects. Age and(or) experience of bulls can influence their relative efficiency of mating, and consequently their libido scores and rankings. Mating ability does have a learning component (2).

In trials with young tropical beef bulls, libido score increased with bull age between 16 and 31 months of age; a finding which differed from results with *Bos taurus* bulls in more temperate regions. Coulter and Kozub (4) found that age affected sexual behavior traits in crossbred bulls, with yearling bulls showing lower libido and a higher proportion of mounts than older bulls. More work is needed to differentiate the effects of age and inexperience from environmental and rearing effects. In this respect, prolonged nursing was considered to retard the expression of normal sexual behavior in Angus bulls in one study, while another asociated lowered bull libido with the feeding of high concentrate levels. Ologun et al. (7) identified negative relationships in yearling beef bulls between sex-drive and production traits such as ADG, while in another study, underfeeding had no adverse effects on bull sexual behavior. Zebu bulls raised on open range showed more sluggish sexual responses compared with those reared more intensively. Although, no permanent sexual inhibitions attri-

Table 4. Mating performance as affected by age of Hereford and Angus bulls.

	Age (yr)		
	One	Two	Three+
No. bulls	29	36	27
No. mounts	207.1	120.0[d]	85.8[d]
No. services	54.5	37.6	40.5
Mounts:services	6.6:1	5.4:1	4.5:1
Serviced/estrus	69.4	73.8	72.0
Pregnant/serviced	39.6[c]	59.4[d]	62.2[d]
Pregnant/estrus	30.2	40.3[d]	50.7[e]
Total pregnancy rate	30.9[c]	41.5[d]	49.9[e]

c,d,e, Means differ ($P < .05$). Pexton *et al.* (10)

Table 5. Comparison of bull and synchronization trials with *Bos taurus* and *Bos indicus* cattle.

	Bos taurus[a]		*Bos indicus*[b]
	SMB	PGF	SMB
No. groups	39	53	31
BFR[c]	1:7 to 51		1:15 to 20
Females in estrus (%)	90.8	78.3	77.2
Served/estrus (%)	73.3	70.4	72.0
Total females served (%)	66.1	55.1	55.7
Avg. services per bull	45.1		23.6
Pregnant/estrus (%)	42.4	41.0	40.6
Pregnant/served (%)	56.4	56.1	57.3
Pregnant/total (%)	41.3	42.7	32.6

[a]Pexton *et al.* (8). [b]Williams (9). [c]BFR=bull to female ratio.

butable to rearing methods have been reported in bulls, it is possible that temporary inhibitions may compromise pregnancy rates, particularly when restricted breeding seasons are employed.

Bull to female ratio. The common recommendation of using approximately one bull per 20 to 30 females does not represent optimal bull usage. In addition, it allows sub-standard bulls to go undetected.

In a Colorado study, good reproductive efficiency in pasture breeding was obtained by most bulls at BFRs of 1:44 and 1:60. Comparison of single and multi-sire combinations revealed no effect of number of bulls in the pasture on estrus detection. The overall conclusion was that the reproductive capabilities of individual bulls were more important to reproductive success than either BFR or single vs multi-sire breeding combinations. Farin *et al* (5), mating young bulls with estrus synchronized heifers, compared BFRs of 1:20 and 2:40 and concluded that single sire mating was more efficient. Heifers in single-sire groups were serviced more times than those in multi-sire groups, and approximately 50% of heifers in the latter groups were serviced by both bulls.

Overall, it is certain that bulls are greatly under utilized in many breeding programs. In general, single-sire mating is more efficient than multi-sire mating, even though it may not be practicable in many situations. The individual capabilities of bulls have greater impact on herd fertility than do BFRs and these capabilities can generally be assessed prior to the breeding season.

Table 6. Fertility index correlations with pregnancy rate in young beef bulls.

Interval to mating (mo)	Within or Among mating	Trait in index	Correlation with pregnancy rate
-11	Within	LH	0.75**
	Among	LH, D, Tvol	0.71**
-8	Within	Lib, Bwt, Tvol	0.89**
	Among	Lib, Bwt, Tvol	0.76**
-6	Within	Bwt, Tvol	0.86**
	Among	Bwt, Tvol	0.73**
-2	Within	LH	0.80**
	Among	LH, Age	0.66**
-0.5	Among	Lib	0.45*

LH = induced LH level (* = P < .05). D = dominance value (** = P < .01). Lib = libido score. Bwt = body weight. Tvol = testicular volume. Age = bull age (d). Perry et al. (9).

3.Social effects. Social ranking of bulls within groups can influence their sexual activity (2). Several studies employing blood-typing methods to determine paternity, have shown that dominant bulls can sire the majority of calves in multi-sire groups. Dominance is expressed more strongly and linearly in older bulls (>3.5 to 4 yr) and appears to be more related to seniority than to age or weight, although all factors as well as breed type can be important. This last consideration, i.e. genotype effects, may be important when *Bos indicus* and *Bos taurus* bulls are put together, as reports suggest that the *Bos taurus* bulls tend to be dominant in this situation.

Dominance rank was negatively correlated with sex-drive in one study with yearling bulls (7). If dominance and sex-drive are different traits, then the dominant bull (or bulls) could adversely affect herd fertility through failure to service females while preventing less dominant bulls from serving. Evidence has been presented for such effects occurring in extensive beef operations where it was also shown that social dominance of bulls was a factor in herd fertility. These social effects are probably most evident when older and younger males are combined in the breeding pasture, although mixing different bull genotypes may also cause similar effects.

In conclusion, social effects should be considered in both the breeding pasture and during libido/serving capacity tests. With multi-sire mating programs, more efficient breeding and sire utilization would occur if the bull groups were young (preferably < 3 yr), of similar age size and genotype and had been raised together.

Genotype differences. Anecdotal evidence for breed differences in bull sex-drive, such as differences between beef and dairy breeds in semen collection ease, has long been reported.

Zebu bulls have had a reputation for "sexual sluggishness" and a tendency to mount females in full estrus only. A number of studies in both the US and Australia have shown that Brahman bulls were less successful in libido/serving capacity tests than other breeds particularly when restrained females were employed as stimulis animals. More success was obtained with the use of unrestrained, estrus-induced females and single bull tests. Despite this, the best performing *Bos indicus* bulls were equal to the best of the other genotypes. Interestingly, when different trials employing either *Bos taurus* or *Bos indicus* bulls mated with synchronized females were compared, the *Bos indicus* bulls achieved similar fertility although they displayed less sexual activity.

Pitfalls in Libido/Serving Capacity Testing. In general, successful testing of bulls for libido and mating ability requires careful planning and lots of patience. Some of the pitfalls which may be encountered are as follows:

1. Testing of bulls that are excessively apprehensive or agitated. Here, the best solution is to handle cattle quietly and avoid distractions.

2. Testing of bulls immediately following other procedures such as electroejaculation, vaccination and parasite control measures.

3. Testing under adverse weather conditions, such as in extreme heat, cold, or rain.

4. Testing of bulls in groups in which one or more bulls are markedly dominant, such as with mixed-age groups of bulls. The exposure of only two bulls to test at a time, and subsequent retesting with a different bull, helps to minimize this problem. It should be noted, however, that a dominant bull can exert an inhibitory effect from a distance (eg. from an adjacent pen).

5. Use of inadequate stimuli. Restrained females should be incapable of excessive movement or some bulls may be deterred. The service crates used should not impede mounting and service. If unrestrained females are used, they should be in full estrus.

6. Spreading of venereal diseases. Every precaution should be taken to ensure that diseases such as vibriosis and trichomonosis are not transmitted by such procedures.

7. Injury or undue stress to restrained females. Humane considerations mandate that females be closely monitored for signs of stress and be replaced if these become evident. Mild sedation of females and prior lubrication of their genital regions are also recommended.

Alternative Assessment Procedures. It would be advantageous to develop an indirect method to assess bull sex-drive so as to reduce or eliminate the time, labor and esthetic concerns which occur with libido/serving capacity testing. Earlier attempts at linking luteinizing hormone (LH) or testosterone (T) levels with bull sex-drive were, however, disappointing. Difficulties occurred because of the episodic nature of hormone release and the inhibiting effects of handling or restraint of the animal. The measurement of LH or T levels released by parenteral GnRH administration could

possibly solve some of these problems. However, although several studies have reported interesting preliminary relationships between either induced T or LH and other fertility traits, conflicting results are also reported.

Composite Assessment Systems for Bulls?. It is apparent that a number of factors influence bull fertility, including BSE values and behavioral factors such as dominance and libido. Attempts have been made to combine a number of these factors to improve bull fertility prediction. Perry *et al* (9) assessed a number of traits in young tropical beef bulls at varying intervals from single-sire matings. The traits assessed included BSE values, sex-drive (libido and serving capacity), production traits (ADG and body weight), tick resistance and LH and T responses to GnRH. A step-wise regression procedure was used to select the most suitable combinations of traits highly correlated with pregnancy rate. Fertility indices were calculated from this analysis.

The fertility indices were, in general, highly predictive of pregnancy rate, even 11 mo prior to mating. The lowest correlation was obtained just prior to breeding ($r = .45$; $< .05$) when the only trait included in the index was libido score. Genotype differences had little influence on these indices. Overall, the most important measurements were GnRH induced LH levels, testicular volume, libido and body weight. These factors are derived from each of the main categories separately known to influence bull reproductive performance, i.e. sex-drive, endocrine status and sperm production. The relationships changed with bull age and interval to mating. They illustrate the variability of semen traits during the post-puberal year, with perhaps an increasing emphasis on sex-drive.

Coulter and Kozub (4) also used a regression model to predict bull fertility in multi-sire breeding where paternity was determined by blood typing. Here, the most important traits were scrotal circumference, backfat, sperm morphology (particularly primary abnormalities) and sex-drive. In yearling bulls, this model accounted for 37% of the variance in bull fertility and in 2 yr-old bulls it accounted for 22%.

In conclusion, the best prediction of bull fertility is obtained when bulls are assessed for a number of traits, including sex-drive. Further development of fertility indices, which combine a number of important traits, may lead to improved predictive ability.

Male/Female Relationships. The finding that a strong genetic link exists between bull scrotal circumference and heifer age at puberty in *Bos taurus* cattle holds particular promise for zebu cattle in which both of these aspects are reputedly deficient. Preliminary Florida data indicated that Brahman heifers which were half-sib to Brahman bulls with larger testes reached puberty at an earlier age. However, in an Australian study with mostly *Bos indicus* derived cattle, no relationship was found between age at puberty in heifers and the age and scrotal circumference at puberty in related bulls. This latter study may have been compromised by a lack of precision in detecting heifer puberty in and by the heterogeneity of the cattle employed. In contrast, in an-

other study in Australia, it was found that estimates of bull fertility and cow fertility were genetically related in tropical genotypes (and crosses) with the inference that cow fertility could be genetically improved by indirect selection on bull fertility, or some component thereof (eg scrotal circumference); a conclusion also reached in another study which used Droughtmaster cattle.

Conclusions

Recommendations for Best Bull Usage:

BSE all bulls each year.

Put emphasis on scrotal circumference.

Libido/serving capacity test if possible.

Vaccinate all bulls prebreeding for vibriosis and leptospirosis.

Test older bulls for trichomonosis and vibriosis pre-breeding.

Employ homogenous groups of younger bulls in multi-sire groups and get rid of older (e.g. >7 or 8 yo) bulls unless they are particularly valuable in which case they should be single-sire or "hand" mated.

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