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BULL BREEDING SOUNDNESS EXAMS AND BEYOND: CHANGES IN REPRODUCTIVE SOUNDNESS

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Introduction

Three realities concerning beef cow-calf production are 1) reproductive performance is highly important to the economic sustainability of the operation; 2) reproductive performance can be managed to achieve targets that are attainable within the resources and motivation of the operation; and 3) reproductive performance is influenced by interactions between fertility of the females, males, and effects of the environment and management, The male – either naturally or artificially – contributes substantially to the reproductive outcome of the breeding herd on a higher magnitude than individual cows. Additionally, the beef herd sire is the leading contributor towards genetic change or advancement within the herd. Bull fertility is therefore a paramount issue to manage for beef herd reproductive success.

Even with the rapid development and adaptations of reproductive technologies, the predominant means of breeding beef cow herds involves the utilization of bulls in natural service. Survey results from the 1997 NAHMS Beef Report stated over 90% of all beef cow-calf producers utilize bulls in their breeding programs. Even after over 10 years of further refinements allowing more adaptable measures for artificial insemination and estrus synchronization, the use of breeding bulls continues to play a major role in cow-calf reproduction. Where natural service mating with bulls is employed, the reproductive capability of a bull assumes great importance. Therefore, the understanding of the dynamics of bull fertility and the management of breeding bulls are important components in beef reproduction and production management.

Diverse Natural Mating Expectations for Bulls

The management scenarios producers use bulls in natural service are diverse. Examples of mating systems with natural bull service include:

1) Single-sire mating within small herds or groups (1 to 50 females).
2) Single-sire mating of multiple bulls by rotations within a herd for defined mating periods.
3) Multiple sire mating at highly variable bull-to-female ratios within a herd.
4) Selective multi-sire mating rotations within a herd.
5) Single or multi-sire mating of estrus synchronized females.
6) Natural service following artificial insemination programs (clean-up bulls).

The intensity of bull mating is also extremely variable from operation to operation. NAHMS (1997) documented average mating loads for beef bulls were 1 to 25 females for

mature bulls and 1 to 17 females for young bulls. Field reports reveal bulls are mated to very small, select groups of females (1 to 10) and bulls used in intense mating exposures of over 50 females for variable time periods. The duration of mating exposure for bulls also has wide variation in the beef industry. More and more cow-calf operations have adopted limited breeding seasons of 45 to 60 days; however, some producers still have extended bull exposure periods (greater than 90 days). Bulls may have mating exposure of just a few days to many months depending on the herd breeding program. Some operations utilize bulls in natural service for both spring and fall calving seasons which extends the yearly mating opportunity for beef sires. Breeding system environments are also widely diverse, depending upon the scale and resources of the production settings for beef production. The majority of natural service mating occurs in pasture or forage based grazing systems. These grazing systems may be small and improved, or extensive and sparse with challenging terrain and movement patterns. More intensive breeding programs may utilize total or partial confinement breeding areas with delivered feed and restricted movements. This all serves to illustrate the diversity of management conditions beef bulls are utilized in during natural service. From this, it is apparent expectations for reproductive performance from bulls are diverse and management considerations may be required for each program.

Further management considerations arising with the use of natural service beef bulls include the age bulls are used. For many years now, bulls from 12 to 18 months of age have been developed, selected and successfully used for mating as “yearling” bulls. The one to two-year-old aged bulls are the primary replacement herd additions for beef herds in the United States. These young bulls have special management requirements that contribute towards their immediate and long-term reproductive performance for the operation (Barth, 1997). Breed differences in development and maturity are recognized between *Bos taurus* and *Bos indicus* genotypes necessitating management plans to successfully employ these breed types (Chase et al. 1997). Considerable study efforts have contributed to more knowledge and understanding of the reproductive capabilities of bulls. This paper will illustrate some of the factors known to impact the young beef bull performance when changes in reproductive soundness occur.

Bull Fertility

Fertility, or the ability to impregnate cows, requires four essential attributes of the bull during natural service (Jainudeen and Hafez, 2000) –physical capability and soundness to detect estrus and accomplish mating, innate willingness to mate (libido) and the acquired skill to effectively inseminate (mating ability), testicular development and health to produce sufficient fertile spermatozoa and testosterone and ufficient and healthy spermatozoa to effectively fertilize and sustain embryo survivability.

These necessary attributes must be in place during the natural mating of an individual female in estrus and then repeated subsequently according to the mating load presented to him. Furthermore, the bull is required to adapt to a social hierarchy within the breeding herd. This involves not only any other competing bulls, but also the female social order. All these capabilities must come into place under the environmental and management constraints of the breeding season. The successful attainment or development of these attributes, particularly of young, virgin bulls will determine his reproductive performance

(Barth 1997). Clearly, all bulls and specifically, young bulls do not adequately attain these characteristics and this contributes to a wide biological variation in reproductive performance of natural service bulls. Study data has indicated 15 to 25% of bulls used in natural service have identifiable fertility problems (Coulter et al., 1989). Several breeding trials have shown the minority of bulls (< 30%) often sire the majority of the calves (> 65%; Makarechian et al., 1985; Makarechian et al., 1987; Neville et al., 1987; Holroyd et al., 2002). However, we clearly have expectations that each bull used in natural service will have successful reproductive performance and contribute to the calf crop production of the herd.

Factors Contributing to Infertility or Poor Reproductive Performance

Fertility is a complex interaction of biological and behavioral characteristics (Chenoweth 2002). Evaluation of fertility under natural mating conditions reveals the environment and management can play major confounding factors and alter the fertility potential of bulls previously determined to be potentially satisfactory breeders. This is expressed by the low heritability of fertility due to the high environmental influences (Brinks 1972). Factors considered to be associated with the variability in fertility of bulls, include:

a. Physical faults: weak conformation and structural faults, limb and feet abnormalities, vision deficits, inadequate or excessive body condition and fat deposition, body size incompatibilities, poor physical fitness and exhaustion, developmental or acquired defects of reproductive organs
b. Reproductive faults: testicular development insufficiency, testicular disease/degeneration, reproductive tract injury/disease, seminal changes in quantity and quality, secondary disease effects on spermatozoa production
c. Age: inadequate pubertal development, weak sexual maturity, inexperience, juvenile behavior transitions, age-related weaknesses affecting physical and reproductive soundness
d. Breed-Genotype: breed-related pubertal effects, maturation differences, breed-selectivity of females, heterosis-crossbreeding effects
e. Nutritional effects: inadequate feed resources and growth, undernourishment, over-conditioning, specific deficiencies (Vitamins A, E, Selenium, Copper, Zinc, others), Chronic acidosis and laminitis
f. Diseases and injuries, physiological stress
g. Toxins, chemicals, drugs, radiation exposure
h. Environmental influences: heat stress, cold stress, seasonal influences, acclimation effects, topographical barriers, movement stressors.
i. Management system: mating load, mating season duration, mating environment
j. Sexual behavior: libido, mating ability, sustained mating behavior
k. Social behavior: social hierarchy of females and bull battery, competition for mating, conflicts, adaptability
l. Female factors: Age and breed differences, size discrepancies, receptivity, fertility, disease

Obviously, to characterize infertility or poor reproductive performance to a single factor is difficult when physical, reproductive, behavioral and environmental variables

are all interacting concurrently during natural mating. Thus, identification of bulls with adequate or sufficient reproductive status prior to mating exposure is an effective management practice. This assures bulls of satisfactory reproductive potential at the start of the breeding season. With an understanding of the potential for changes in reproductive soundness during mating exposures provides insight towards management decisions that assure effective and efficient reproductive management.

Bull Breeding Soundness Evaluations (BBSE)

The mainstay for evaluation of the reproductive capability for bulls has been the bull breeding soundness evaluation (BBSE), as structured and refined through the American Society for Theriogenology (1983). The assessment addresses three of the four essential characteristics deemed necessary for bulls to impregnate cows. The principles and guidelines are thoroughly detailed in many publications (Barth, 1997; Chenoweth et al., 1994; Chenoweth, 2002). Needless to say, the evaluation of bulls prior to mating seasons proves as an economically sound practice (Chenoweth, 2002).

Limitations of the BBSE

1) Results are indicative of the present physical and reproductive status of the bull and diagnostically of the prior health and environmental effects upon the soundness of the bull. The results do not imply any conditional warranty or prognostication of reproductive performance.
2) The procedure identifies faults or weaknesses that would contribute to subfertility or infertility at that point in time. The system does not identify any conditional superiority in fertility.
3) Occasionally, the procedure is misapplied or not assessed in its entirety. Therefore, the interpretation of the reproductive potential may be over- or underestimated. Equally so, the expectations of producers toward reproductive outcomes may be erroneously interpreted as some guarantee of reproductive success. Human error in interpretation may play a factor.
4) The evaluation does not routinely assess any sexual behavior traits (libido and mating ability) or social adaptability of bulls within the mating environment.
5) Unless performed additionally, no mandate for testing for infertility diseases are required (Brucellosis, Trichomoniasis, Leptospirosis, BVDV, and other diseases).

Withstanding circumstances or insults that occur on a herd basis, generally it is expected and found 75% or more of any bull group or population will meet the requirements to be classified as satisfactory potential breeders. Diagnostically, the evaluation can be repeated at intervals to assess changes, both positive and negative, in reproductive soundness. In the case of yearling bull candidates, the breeding soundness evaluation assesses the advancement of pubertal development and sexual maturity (Barth, 1997). Bulls from 12 to 15 months of age that meet the threshold requirements of the BBSE are meeting selection parameters for earlier sexual development and maturity (Arteaga et al., 2001). Testicular development, as measured by scrotal circumference, is a highly desirable selection indicator for fertility in both sires and daughters of those sires (Brinks, 1972; Chenoweth et al., 1994). All in all, the BBSE, when properly performed

and interpreted provides a highly useful management tool and serves to reduce the risk of potential subfertility in herd bulls.

Beyond the Breeding Soundness Exam

To this point, we have generalized the importance of bull fertility, the essential characteristics required to assure reproductive capability, the known factors that contribute to subfertility or infertility, and given an overview of the primary management tool utilized to screen breeding bulls for breeding potential. The limitations of the bull breeding soundness evaluation have been presumed; however, further understanding by illustration can be made to the limitation of this test to predict each individual bull meets reproductive expectations equally during a mating period. Considering just the physical and reproductive characteristics evaluated with the BBSE, it is essential to understand the dynamics of the potential for changes in reproductive potential that can occur within a mating exposure period. The young bull, being immature, growing, and sexually inexperienced is a prime example to document the changes in reproductive capability that can occur during short time frames.

Yearling Bull Fertility Summary

Observing 74 yearling crossbred *Bos taurus* bulls during their virgin mating season of 2002 revealed dynamics of fertility and impacts on reproductive performance (Ellis, 2004; Ellis et al., 2005). Bulls were randomly placed in six multi-sire groups of 9-10 bulls per group. The bulls were rotationally exposed to natural mating for 14 days, rested for 14 days, and returned to mating exposure for either 14 or 21 day periods. Total mating exposure for the first three groups of bulls was 28 days and 35 days for the other three groups of bulls. During the first rotational mating period for each group, the bull-to-female ratio was approximately 1:20 (three cow herds of approximately 195 head). The entire mating season was 63 days in duration. Fourteen of the bulls were held in reserve for replacement use; however, they served as non-mating exposure controls as they were not used. Approximately three weeks prior to the beginning of the breeding season, a pre-breeding BBSE was performed with 59 of the 60 bulls used for mating and 8 of the 14 reserve bulls attaining satisfactory classification (90.5%). No group or breed differences were observed in age, physical or reproductive characteristics. Changes in physical and reproductive soundness were observed throughout the mating period and a post-breeding BBSE was performed within 3 days following completion of mating exposure (61 to 87 days following first BBSE).

The mating season experienced unusually hot and dry conditions, commencing just prior to and during several extended periods of the 63-day period. Overall, 37 of the 63 days had daily high temperatures from 90 to 100 degrees F and total precipitation was 6 inches below yearly averages. Forage conditions in pastures deteriorated and forced multiple pasture movements to sustain forage availability.

An unexpected high incidence of lameness and reproductive injuries were incurred during the mating season. Of the 60 bulls used for breeding, 52 were observed lame at least once and 14 were lame more than once. Ten bulls (17%) were removed from mating exposure due to severe injuries that limited mobility and breeding. Seven bulls (12%)

incurred prepucial or penile injuries with three bulls requiring early removal from mating. Overall, 23% of the yearling bulls did not complete their planned mating exposures due to injuries.

Summarizing the findings on the post-breeding soundness evaluation revealed marked changes in the bulls. Physically, the bulls lost over 170 lbs. of body weight (range 56 to 266 lbs.) with more than 60% of the loss occurring during the first 14-day mating period. Modest weight gains were made through the 14-day rest period for each group (30+ lbs).

Body condition scores declined from pre-breeding 6.1 to 4.6 at the conclusion of mating. The reserve bulls, without mating activity, gained approximately 60 lbs. during the same period. Reproductively, marked changes in scrotal circumference and semen quality were noted and differences were seen between the bulls exposed for mating and the reserve bulls. Scrotal circumference (SC) declined from 0 to 12.5% (4.6% mean) in the breeding bulls and increased 2.5% in the reserve bulls. Bulls with SC greater than 36cm at the start of the mating season had greater negative changes in SC. The SC declines were weakly associated with body weight losses and minimally associated with semen quality changes. Semen motility was not significantly changed between the pre- and post-breeding BBSE, however, spermatozoa motility was a significant factor in the unsatisfactory classification on the post-breeding BBSE. Spermatozoal morphology declined markedly on the post-breeding BBSE for nearly all bulls in the study. Normal spermatozoa percentage declined 7 to 32% for all bull groups. Group and breed differences in changes of normal spermatozoa were observed and strong association between normal morphology percent and incidence of injury was revealed. Abnormal spermatozoa classified as primary abnormal were higher in the bulls used for mating and those classified as secondary abnormal were higher in the reserve bulls. However, primary and secondary classified abnormal spermatozoa were increased in both groups.

Final classification for the bulls on the post-breeding BBSE revealed a significantly lower percentage of bulls achieving satisfactory classification (59%) compared to the first BBSE (90.5%). Of the 60 bulls with mating exposure, 40% were classified as unsatisfactory. Differences between groups, rotations, breeds, and herds were revealed. The bulls classified as unsatisfactory had a disproportionate level of injuries (81%) and removal rate (33%) than the bulls classified as satisfactory (58% injury rate and 8% removal rate). The bulls classified unsatisfactory demonstrated larger declines in scrotal circumference and declines in normal spermatozoa morphology and motility. Primary spermatozoal abnormalities that increased markedly included proximal protoplasmic droplets, head shape defects, acrosomal defects and nuclear defects (diadem craters). Table BBSE2 illustrates the changes in seminal traits.

Fertility Dynamics

Similar findings have been reported in young bulls in regard to physical and reproductive changes following induced stress conditions (Barth and Bowman, 1994; Meyerhoffer et al., 1985), seasonal changes from spring to fall in temperate and tropical regions (Barth and Waldner, 2002; Godfrey et al., 1987), following changes in environmental and nutrition conditions (Hansen, 1997), and following mating exposure or breeding activity (Makarechian et al., 1985). The conclusions from this study include:

1) Yearling bulls nutritionally and physically unconditioned to the breeding environment incurred physiological stress and body condition changes with concurrent declines in testicular mass and spermatozoal fertility.
2) Yearling bulls are susceptible to climatic (environmental) stressors that contribute to physical and reproductive changes reducing fertility potential at unpredictable levels. Spermatozoal changes revealed were associated with physiological stress, heat stress, and injury stress (Barth and Oko, 1989).
3) Virgin yearling bulls express juvenile social behaviors (aggressive mounting) in addition to expressed sexual behavior (libido) that culminates in a learned mating behavior. However, the learning curve is variable between bulls and mating efficiency tends to improve through time and experience. The inexperienced mating behavior contributes to increased physical depletion and increased risks of injury. This is supported from further details of the example study (unpublished).
4) The utilization of a pre-breeding BBSE assured the reproductive potential of the young bull; however, the changes in physical and reproductive characteristics during a mating season are an expression of the dynamics of fertility changes from day to day.

Reproductive Performance

Understanding the dynamics for changes in fertility of breeding bulls within a mating season allows for an understanding of the marked degrees of variation revealed in reproductive performances of bulls. This may be particularly prevalent in immature bulls that have continued growth and behavioral changes occurring as they advance towards sexual maturity. In the face of the marked changes in physical and reproductive soundness of the yearling beef bulls in the summarized study, herd pregnancy rates were very acceptable for the three herds, 92 to 95%. The assumption is sufficient bull numbers and sustained fertility was maintained throughout the mating season. When individual sire-offspring production was evaluated via genotyping of offspring, sires, and portions of the dams, highly variable levels of reproductive performance were revealed (unpublished to date). Individually, vast differences in calf output were recorded within herds. From the mean total calves sired per bull for all bulls exposed for mating (8.8 $\pm$1.0 calves; range 8.2 to 9.2 by herd), 40% of the bulls exceeded the mean. These 24 of the 60 bulls sired 73.3% of the offspring, ranging from 10 to 31 total calves sired. On the other end of the mean, 60% of the bulls (n=36) sired eight or less calves. This accounted for only 24.3% of the calf output. The range of production from these bulls was 0 (n=3) to 8 calves sired. Overall, the top 12 producing bulls (20%) sired 48% of the calves (range 17-31) and the lowest 12 producing bulls (20%) sired just 2.85% of the calves.

The association of declining physical and reproductive soundness with reproductive performance is demonstrated by differences in calf output by mating periods and total calf output per bull. Bulls were classified as either satisfactory or unsatisfactory potential breeding potential sires and calf output per category was assessed. The difference in calf output per sire during the first mating periods was not significantly different (7.4 vs. 5.0), although the unsatisfactory bulls had lower calf outputs. During the second mating period, a significant ($p<0.05$) difference in calf output between bull categories was revealed (3.6 vs. 1.4). This difference continued when total calf output was compared

between bulls classified as satisfactory and unsatisfactory at the post-breeding evaluation (10.5 vs. 6.1).

Table 1. Calves sired by bulls with satisfactory or unsatisfactory BBSE classification.

	Period 1 Calves	Period 2 Calves	Total Calves
Satisfactory	7.4 (1.1)	3.6 (0.7) *a*	10.5 (1.4) *a*
Range	0-27	0-16	0-31
Calf count	265	112	377
Unsatisfactory	5.0 (1.0)*a*	1.4 (0.4) *b*	6.1 (1.0) *b*
Range	0-18	0-5	0-18
Calf count	120	26	146
		$p<0.05$	$p<0.05$

More detailed information on calf output (calves sired) by mating period and totals are provided in the charts on a herd and group basis (Herd 1-3 Calf Output Charts).

This example of reproductive performance of yearling bulls is not intended to simplify the finding of vast variance in calf output between bulls to a single trait or characteristic. Most assuredly, variation in sexual behavior and social behavior are highly involved in the differences in reproductive performance. Furthermore, changes in breeding soundness involving physical, testicular and seminal changes are related to multi-factorial influences. Factors considered to have influenced bull fertility were environmental stressors, pre-breeding conditioning and management of the bulls, and behavioral inexperience and incompetent mating ability at the beginning of the mating exposure. Risk of injury or survival without injury was equally important in determining the maintenance of fertility.

The information and illustration does fortify the concept of the “BBSE and Beyond” in regards to the limitations of the BBSE in assuring successful reproductive performance. Fertility is most definitely a dynamic function and process that can be altered by many factors. The interaction of multiple factors may alter reproductive soundness of individual bulls within short periods of time. Predicting reproductive performance is challenging due to the complexity of reproductive function.

Table BBSE2: Reproductive characteristics: semen variables for post-breeding BBSE.

BSE Variables	BSE 2 Satisfactory	BSE 2 Unsatisfactory	BSE 2 UFB Bulls
n	36	21	57
MOT% BSE2	62.8 (2)[a]	40.4 (4)[b]	54.5 (2.5)
MOT% BSE1	59.0 (2)	59.0 (3)	59.4 (1.7)
MRPH% BSE2	80.6 (1) [a]	40.0 (5) [b]	66.2 (3.2)
MRPH% BSE1	83.3 (1)	78.7 (3)	81.8 (1.3)
PRM% BSE2	13.8 (1) [a]	43.4 (3.6) [b]	24.7 (2.4)
PRM% BSE1	12.1 (1)	16.6 (3.8)	13.5 (1.1)
SEC% BSE2	5.6 (1) [a]	16.8 (4) [b]	9.7 (1.6)
SEC% BSE1	4.7 (1)	4.6 (1)	4.7 (1)
Head defects %	4.0 (0.5) [a]	9.5 (2.0) [b]	6.0 (0.3)
Midpiece defects %	6.2 (0.7) [a]	11.3 (1.7) [b]	8.1 (0.4)
Tail defects %	1.1 (0.2)	0.5 (0.1)	0.8 (0.1)
Detached heads %	4.5 (0.6) [a]	16.3 (3.9) [b]	8.8 (0.5)
Prox. Droplets %	2.1 (0.3) [a]	10.8 (2.2) [b]	5.3 (0.2)
Acrosome defects %	0.6 (0.2)	2.0 (0.8)	1.1 (0.1)
Nuclear defects %	1.0 (0.5) [a]	9.8 (3.5) [b]	4.2 (0.5)

*Analysis of least square means and variances via ANOVA - single factor test
**Analysis of frequencies and proportions via Chi square; trend analysis, multiple comparisons
Columns with different letters are significantly different at $p < 0.05$

Herd 1: **Calf Outputs per bull, by period, total, cumulatively by group and within herd**

Post-Breeding BBSE results
NS=nonsatisfactory classification

Breed Period 1: Bull Group A		**GRP A**				**Period 3: GRP A**			**Grp Cum**	**Percent**	**Herd Cum**	**Percent**	**BSE 2**
Bull ID		Calves				Calves							
A-1	1083	5	7.25%	Lame		0	0.00%		5/92	5.43%	5/179	2.79%	NS
A-2	1106	1	1.45%			2	8.70%	Lame	3/92	3.26%	3/179	1.68%	Sat
A-3	1138	4	5.80%	Lame		6	26.09%	Lame	10/92	10.87%	10/179	5.59%	NS
A-4	1003	8	11.59%			3	13.04%		11/92	11.96%	11/179	6.15%	Sat
A-5	1051	2	2.90%			3	13.04%		5/92	5.43%	5/179	2.79%	NS
A-6	1147	5	7.25%			0	0.00%	Repro	5/92	5.43%	5/179	2.79%	Sat
A-7	1026	17	24.64%	***Lame***	***Out***	0	0.00%		17/92	18.48%	17/179	9.50%	NS
A-8	1019	11	15.94%	***Lame***	***Out***	0	0.00%		11/92	11.96%	11/179	6.15%	Sat
A-9	1127	16	23.19%			9	39.13%	Lame	25/92	27.47%	25/179	13.97%	Sat
Period Totals:		69	**38.50%**			23	**12.80%**		92		92/179	**51.40%**	
Herd (unk)		0				0			0		0	0.00	
Total		69/179	38.50%			23/179	12.80%		92		92/179	**51.40%**	

Breed Period 2: Bull Group D		**GRP D**				**Period 4: GRP D**			**Grp Cum**	**Percent**	**Herd Cum**	**Percent**	**BSE 2**
Bull ID		Calves				Calves	Percent						
D-0	1054	4	5.97%			0	0.00%		4/87	4.60%	4/179	2.23%	Sat
D-1	1055	1	1.49%			2	10.00%		3/87	3.45%	3/179	1.68%	Sat
D-2	1134	0	1.49%			1	5.00%		*1/87*	1.15%	1/179	0.56%	Sat
D-3	1024	11	16.42%	Lame		3	15.00%	Lame	14/87	16.09%	14/179	7.82%	Sat
D-4	1104	2	2.99%	Lame		0	0.00%	***Lame Out***	2/87	2.30%	2/179	1.12%	NS
D-5	1028	12	17.91%	Lame		2	10.00%	Lame	14/87	16.09%	14/179	7.82%	Sat
D-6	1119	14	20.90%	***Lame***	***Out***	0	0.00%		14/87	16.06%	14/179	7.82%	NS
D-7	1018	16	23.88%			7	35.00%		23/87	26.44%	23/179	12.85%	Sat
D-8	1007	4	5.97%			1	5.00%		5/87	5.75%	5/179	2.79%	Sat
D-9	1093	2	2.99%			0	0.00%		2/87	2.30%	2/179	1.12%	Sat
Period Totals:		66	**36.90%**			16	**8.90%**		82/87		82/179	**45.80%**	
Herd (unk)		0				3			3		3/179	**1.68%**	
Stray Bull 4632		1				1			2		2/179	**1.12%**	
Total		67/179	37.40%			20/179	11.17%		87		87/179	**48.60%**	

Herd 2: **Calf Outputs per bull, by period, total, cumulatively by group and within herd**

Post-Breeding BBSE results
NS=nonsatisfactory classification

Breed Period 1: Bull Group A		**GRP B**			**Period 3: GRP B**			**Grp Cum**	**Percent**	**Herd Cum**	**Percent**	**BSE 2**
Bull ID		Calves	Percent		Calves	Percent						
B0	1042	9	12.33%		3	10.34%		12/102	11.76%	12/174	6.90%	Sat
B1	1029	8	10.96%		0	0.00%		8/102	7.84%	8/174	4.60%	NS
B2	1053	11	15.07%		7	24.14%		18/102	17.65%	18/174	10.34%	Sat
B3	1107	3	4.11%	Lame	3	10.34%	Lame	6/102	5.88%	6/174	3.45%	NS
B4	1132	6	8.22%		1	3.45%		7/102	6.86%	7/174	4.02%	Sat
B5	1068	2	2.74%		2	6.90%		4/102	3.92%	4/174	2.30%	Sat
B6 **	1077	0	0.00%		0	0.00%	***Lame Out***	0/102	0.00%	0/174	0.00%	NS
B7	1039	12	16.44%		8	27.59%		20/102	19.61%	20/174	11.49%	Sat
B8	1006	6	8.22%		1	3.45%		7/102	6.86%	7/174	4.02%	Sat
B9	1081	15	20.55%	Lame	4	13.79%	Lame	19/102	18.63%	19/74	10.92%	Sat
Period Totals:		72	**41.40%**		29	**16.70%**		101		101/174	**58.00%**	
Herd (unk)		1			0			1		1/174	0.05	
Total		73	41.95%		29	16.70%		102		102/174	**58.60%**	

Breed Period 2: GRP E		**GRP E**			**Period 4: GRP E**			**Grp Cum**	**Percent**	**Herd Cum**	**Percent**	**BSE 2**
Bull ID		Calves	Percent		Calves	Percent						
E1	1010	3	6.82%		1	3.57%		4/72	5.56%	4/174	2.30%	NS
E2	1141	5	11.36%		3	10.71%		8/72	11.11%	8/174	4.60%	Sat
E3	1116	0	0.00%		1	3.57%		1/72	1.39%	1/174	0.57%	Sat
E4	1075	2	4.55%		0	0.00%		2/72	2.78%	2/174	1.15%	NS
E5	1129	18	40.91%	Lame	0	0.00%	Repro	18/72	25.00%	18/174	10.34%	Sat
E6	1040	6	13.64%	Lame	7	25.00%	Lame	13/72	18.06%	13/174	7.47%	Sat
E7	1071	3	6.82%		1	3.57%		4/72	5.56%	4/174	2.30%	NS
E8	1011	5	11.36%		13	46.43%		18/72	25.00%	18/174	10.34%	Sat
E9	1070	1	2.27%		2	7.14%		3/72	4.17%	3/174	1.72%	NS
Period Totals:		43	**24.70%**		28	**16.10%**		71/72		71/174	**40.80%**	
Herd (unk)		1			0			1		1/174	0.05	
Total		44	25.30%		28	16.10%		72		72/174	**41.40%**	

Herd 3: **Calf Outputs per bull, by period, total, cumulatively by group and within herd**

Post-Breeding BBSE results
NS=nonsatisfactory classification

Breed Period 1: Bull Group A		**GRP C**				**Period 3: GRP C**			**Grp Cum**	**Percent**	**Herd Cum**	**Percent**	**BSE 2**
Bull ID		Calves	Percent			Calves	Percent						
C0x	1112	5	4.85%			16	64.00%		21/128	16.41%	21/187	11.20%	Sat
C1	1036	17	16.50%			1	4.00%	Lame	18/128	14.06%	18/187	9.60%	**NS**
C2	1142	3	2.91%			1	4.00%		4/128	3.13%	4/187	2.10%	**NS**
C3	1124	5	4.85%	***Lame***	***Out***	0	0.00%		5/128	3.91%	5/187	2.70%	**NS**
C4	1090	29	28.16%	Lame		2	8.00%	Lame	31/128	24.22%	31/187	16.60%	Sat
C5	1058	3	2.91%			0	0.00%		3/128	2.34%	3/187	1.60%	Sat
C6	1091	5	4.85%	Lame		5	20.00%	Lame	10/128	7.81%	10/187	5.30%	**NS**
C7	1080	11	10.68%	***Lame***	***Out***	0	0.00%		11/128	8.59%	11/187	5.90%	**NS**
C7x	1041	2	1.94%			0	0.00%	Lame	2/128	1.56%	2/187	1.10%	**NS**
C8	1014	11	10.68%	***Repro***	***Out***	0	0.00%		11/128	8.59%	11/187	5.90%	Sat
C9	1117	7	6.80%	***Repro***	***Out***	0	0.00%		7/128	5.47%	7/187	3.70%	Sat
Period Totals:		98	**52.41%**			25	**13.37%**		123/128		123/187	**65.78%**	
Herd (unk)		5				0			5/128		5/187	0.03	
Total		103	55.08%			25	13.37%		128		128/187	**68.45%**	

Breed Period 2: GRP E		**GRP F**				**Period 4: GRP F**			**Grp Cum**	**Percent**	**Herd Cum**	**Percent**	**BSE 2**
Bull ID		Calves	Percent			Calves	Percent						
F0	1025	2	4.35%	Lame		3	23.08%		5/59	8.47%	5/187	2.67%	**NS**
F1	1130	2	4.35%	***Lame***	***Out***	0	0.00%		2/59	3.39%	2/187	1.07%	Sat
F2	1022	0	0.00%			0	0.00%		*0/59*	0.00%	0/187	0.00%	Sat
F3	1076	8	17.39%	Lame		2	15.38%		10/59	16.95%	10/187	5.35%	Sat
F4	1084	2	4.35%	***Lame***	***Out***	0	0.00%		2/59	3.39%	2/187	1.07%	**NS**
F4x	1135	2	4.35%			1	7.69%	Lame	3/59	5.08%	3/187	1.60%	**NS**
F5	1052	5	10.87%			0	0.00%	Lame	5/59	8.47%	5/187	2.67%	**NS**
F6	1114	1	2.17%			0	0.00%	Lame	*1/59*	1.69%	1/187	0.53%	Sat
F7	1059	3	6.52%			0	0.00%		3/59	5.08%	3/187	1.60%	Sat
F8	1038	0	0.00%			0	0.00%		*0/59*	0.00%	0/187	0.00%	**NS**
F9	1105	20	43.48%			7	53.85%		27/59	45.76%	27/187	14.44%	Sat
Period Totals:		45	**24.06%**			13	**7.00%**		58/59		58/187	**31.02%**	
Herd (unk)		1				0			1/59		1/187	0.53%	
Total		46	24.60%			13	7.00%		59		59/187	31.55%	

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