THE EFFECTS OF SEXUAL STIMULATION ON THE SEXUAL PERFORMANCE OF HEREFORD BULLS

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Summary

In the present study, 12 Hereford bulls approximately 22.5 mo of age were individually introduced to a restrained nonestrous stimulus female for 15 to 30 min under four treatment conditions: (1) without prior sexual stimulation and visually isolated from male conspecifics (control), (2) being watched by another male during matings, (3) after observing the copulatory activities of another male and (4) after being restrained in close proximity to a female. During sexual performance tests, an observer recorded the times at which the bulls exhibited ejaculations, mounts without ejaculation, mount attempts, mount intentions, head throws and Flehmen responses. The observer also recorded the percentage of time spent in proximity to the stimulus female and objectively rated the bulls for overall sexual performance and mating efficiency. Relative to the control treatment, the greatest improvement in sexual performance was noted when the bulls had observed the copulatory activities of conspecifics. Sexual performance was improved, albeit to a lesser degree, by being watched by another male and by restraint in the presence of the stimulus female. The advantages of sexual stimulation should be considered when breeding farm animals and when evaluating the sexual performance of males to be used in a breeding program. (Key Words: Bull, Cattle, Sexual Behavior, Sexual Stimulation.)

Introduction

Under natural breeding conditions, copulation by our common farm mammals is usually preceded by a number of premating ("courtship") behaviors often exhibited well in advance of the female's period of sexual receptivity (Sambraus, 1971; Price, 1984). These premating activities serve many functions including the sexual stimulation of both male and female participants.

When animals are selectively mated ("hand-bred") or when semen is collected for the purpose of artificial insemination, premating activities are largely bypassed in favor of gaining the desired number of completed copulations or ejaculations in the shortest period of time. Under such conditions, the male may not be sufficiently stimulated to reach his maximum potential of sexual performance unless the animal breeder can artificially create a more sexually stimulating environment.

Kerruish (1955) and Blockey (1981) have reported that the sexual performance of beef bulls was enhanced by allowing them to view other males engaged in copulatory behavior. However, they did not control for the singular effect of the female's presence (i.e., being restrained in the presence of a female conspecific). Likewise, it was not clear if the restrained spectator males were subsequently tested in the presence of other males. It is possible that the presence of a potential competitor can socially facilitate sexual performance. The following study was designed to test the effects of these conditions on bull sexual behavior.

Materials and Methods

Subjects were 12 sexually experienced Hereford beef bulls from the University of California, Davis experimental herd. At the start of the experiment the bulls were 22 to 23 mo of age and weighed approximately

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535 kg. Four ovariectomized heifers (similar in age to the bulls) were used as mounting stimuli during testing. Each bull was identified by ear tags and large numbers dyed (Nyanzol-D) onto each side and the buttocks.

Bulls and heifers were housed in adjacent enclosures separated by an alleyway 3 m in width. Subjects were maintained on a diet of chopped sorghum (IFN 2-04-485) during the study.

Three sides of the test arena were covered with plywood panels 2.5 m high to provide visual isolation between animals inside and outside the test area. An “L” shaped pen was constructed in one corner of the arena (see figure 1) to confine bulls allowed to observe the test male and(or) female before being tested themselves. This pen was made from portable metal panels that allowed good visibility between the spectator and animal(s) in the test arena. The service stanchion used to restrain the stimulus heifer was positioned approximately 2 m equidistant from both sides of the “L” shaped restraining pen (figure 1). The investigators were positioned approximately 20 m from the service stanchion.

The four treatment groups consisted of: (1) control (C) bulls that were tested without prior stimulation and in total visual isolation from other bulls, (2) watched (W) subjects consisting of bulls that were given no pretest sexual stimulation but were observed by another bull (spectator) while being tested, (3) spectator (S) bulls that were allowed to observe a bull and heifer mating for 15 to 30 min before being tested and (4) restrained (R) subjects that were confined in the restraining pen next to the heifer (no test bulls with the female) for 15 min before being admitted into the test arena. This last group served as a control for the S treatment, thus differentiating between the effect of watching conspecifics engage in sexual activity and just observing the lone, restrained heifer.

The test order was systematically scheduled so that on each test day, there were three bulls tested in each of the four treatments. Each animal was tested at a different time and in a different treatment group on successive test days. On each test day the order of testing was C followed by W, S and R, repeated three times. Bulls were tested twice each week for 6 wk with at least 2 d between trials. Each bull was given three tests under each treatment condition. Testing began each day at approximately 0600 h and continued until all subjects had been tested, about 1300 h. Testing was conducted during September and October.

All of the subjects had been previously exposed to restrained heifers in the test arena. Also, the bulls were habituated to the presence of nearby observers. Bulls were handled carefully to minimize excitement or stress before testing.

The four ovariectomized nonestrous heifers used as mounting stimuli were restrained in a metal, free-standing stanchion to which they had previously been habituated. Heifers were tranquilized just before testing and lubricating jelly was applied to the vulva of each female to prevent chaffing.

Tests began when the bull entered the test arena. Each bull was exposed to the heifer for a minimum of 15 min. If the subject had scored two ejaculations (E) in 15 min, it was removed from the arena. (An E was defined as a rapid forward and upward thrust of the bull, usually associated with one or both hind feet leaving the ground.) If two E had not been achieved, the bull was allowed to remain in contact with the heifer until two E were attained, or 30 min, whichever came first. Tested bulls were placed in an adjacent pasture and were not allowed to mix with untested bulls.

After a C bull was tested, an S bull was introduced into the L-shaped restraining pen. When it was secured a handler released a W bull into the test arena. When the W subject had either met the criterion or exhausted its time limit, it was removed from the pen and the S bull was then released into the arena to be tested. After the S bull was tested an R bull was placed in the restraining
pen for 15 min and then released into the arena with the heifer for testing.

During each test, the investigator recorded latencies for first mount (M; regardless of whether or not an ejaculation was achieved) and first E and the time at which each subsequent M and E occurred. Other sexual behaviors recorded were "head throws" (HT), defined as a rapid jerk of the head, horizontally and/or vertically in the direction of the female, with little or no movement of the animal's feet, mount intentions (MI), in which the bull raised its head and shifted its weight slightly to the rear as if it was about to mount but without lifting both front feet simultaneously off the ground, and mount attempts (MA), in which the bull's front feet both left the ground but did not become firmly positioned on the female's rump. Also recorded were the frequency and duration of "lip curl" or Flehmen (FL) responses (Estes, 1972). In addition, the observer recorded the time that the bull spent in sexual proximity to the heifer. A bull was considered in sexual proximity if it was within 1 m of the heifer and displayed sexual interest in her (i.e., the bull was attentive to her and not engaged in irrelevant behaviors such as rumination, et cetera).

The latency for each bull to attain two ejaculations or the total amount of time that the bull spent with the stimulus heifer, if the criterion was not achieved (30 min), was designated as the criterion latency (CL). The CL score was obtained by dividing the total number of minutes of testing by 15 (the minimum number of minutes required). A bull that achieved two E within 15 min received a CL score of 1.00; a bull reaching the criterion in 22.5 min obtained a CL score of 1.50.

The sexual performance of each bull was rated according to a subjective "libido rating" (LR) scale devised by Chenoweth et al. (1977). Because this rating system was designed for animal breeders, it is heavily weighted by the ejaculation frequency of the animal.

In addition, a mating efficiency score (MES) was devised to measure the relative proportion of each bull's total sexual performance represented by E (services). Traditionally, M/E has been used as a measure of mating efficiency (Wodzicka-Tomaszewskia et al., 1981). However, this formula only considers one component of the sexual behavior of the bull other than ejaculatory behavior, namely mounting. Clearly, other components of the bull's repertoire of sexual behaviors (e.g., MA, MI, HT) are also important to its time and energy budget. Hence, the formula \[ \frac{E}{M+MA+MI+HT} \] should be a more accurate measure of mating efficiency. If E was added to the denominator, \[ \frac{E}{E+M+MA+MI+HT} \], the formula would provide a crude estimate of the proportion of the male's total heterosexual responses that was spent in servicing available females. However, there are at least two problems with this formula.

First, the formula implies that any sexual component other than M culminating in E are inefficient (i.e., represent wasted time and energy). In a natural mating situation, sexual behaviors that do not culminate in E do not necessarily represent wasted time and energy. One could argue that the more efficient bull will first determine the sexual receptivity of a potential sex partner (by HT and MI) before it attempts to M.

The second problem relates to the fact that the various components of the sexual behavior of the bull are not necessarily equivalent from the standpoint of the animal's time and energy budget. Price, E. (unpublished data) has demonstrated that there are significant differences in the refractory periods that follow various sexual responses. Mount intentions and HT have the shortest refractory periods, E the longest, and M and MA are intermediate. Because the various sexual behaviors of the bull are not equivalent and because the frequencies of these behaviors are different in almost every test, it is not correct to merely summate the frequencies of the various behaviors in the denominator of the formula.

However, it may be possible to resolve these two problems, at least in part. First, the bulls used in this study had only had prior sexual experience with restrained females. Because every female they had ever encountered behaved like a sexually receptive female (i.e., remained immobile when mounted), they had not become conditioned to test the sexual receptivity of the cow before mounting.

The equivalency question could be at least partially resolved by weighting each sexual response according to the length of its refractory period. If the average refractory
period after a HT = 1.0 on a ratio scale, MI = 1.2, MA = 1.5, M = 1.9 and E = 4.3 (E. Price, unpublished data) then each sexual component in the formula could be multiplied by its respective weighting factor. The formula now reads:

\[
MES = \frac{E(4.3)}{E(4.3) + M(1.9) + MA(1.5) + MI(1.2) + HT(1.0)}
\]

The MES score will yield a number between 0 and 1. The more E a bull achieves relative to other sexual behaviors, the closer the MES score will be to 1. Conversely, the greater the number of HT, MI, MA and M relative to E, the smaller the MES value. A M without an E will reduce the MES score more than a MI.

The scores for the three tests for each animal in each treatment were averaged and analyzed using the one-way analysis of variance (ANOVA) for repeated measures (Winer, 1971). Data were transformed to logarithms when necessary to achieve homogeneity of variances. Tukey's test (Sokal and Rohlf, 1969) was used to determine the statistical significance of differences between the various treatment groups. To test for a time of day (testing) effect on sexual behavior, the mean sexual performance of bulls (treatments combined) in early morning, late morning and afternoon were compared using the one-way ANOVA for repeated measures.

Results

Treatment differences in the sexual performance of the experimental subjects are summarized in table 1. Latencies for the first M were longer under the C treatment than for the S (P<.01), R (P<.01) and W (P<.05) treatment conditions. In addition, bulls were slower to M under the W treatment than after serving as spectators (P<.01).

Latencies for the first E were longer when the bulls were unstimulated (C treatment) than for the S treatment (P<.01). Ejaculation latencies under the R and W treatments were also longer than for the S treatment (P<.05 and P<.10, respectively). The R and W treatments did not differ from the C treatment or from each other.

Treatment differences in time from the first E to the next M (postejaculatory interval) were not significant nor were treatment differences in the time between first and second E (interejaculatory interval).

Two or more E were recorded in the first 15 min in 46 of 144 tests (32%). If a bull achieved an E within the first minute of exposure to the stimulus heifer, a second E was likely obtained within the first 15 min (X² = 63.3, df = 1, P<.001), regardless of treatment condition.

Bulls achieved more E after serving as S than when serving as C (P<.01 for both the first 15 min of testing and total number of ejaculations). In the S treatment, bulls achieved two or more E in 27 of 36 tests (75%). In contrast, when tested under C conditions, bulls attained a second service in only 14 of 36 tests (39%). Ejaculation frequency for the bulls under R and W treatments did not differ significantly from the C treatment.

Serving as S before testing shortened the latency to achieve two E (criterion latency) relative to C (P<.01). The W and R treatments did not differ from either the C or S conditions for this variable.

Treatment differences in frequency of FL, HT and MI were not statistically significant. More MA were exhibited by bulls under the R treatment than when the C or S treatments were applied (P<.05 in both comparisons).

Treatment differences in the total number of M (not including those that culminated in E) were not significant. However, under the C treatment, the number of M exhibited in 15 min was significantly less than for the W (P<.05), R (P<.01) and S treatments (P<.01).

Treatment differences in the percentage of test time spent in sexual proximity were not significantly different.

Based on the libido rating systems devised by Chenoweth et al. (1977), bulls showed less libido when tested as C than when given the W (P<.05), R (P<.01) or S (P<.01) treatments. In addition, scores were lower under the W treatment than when the subjects served as S (P<.05).

Mating efficiency scores were somewhat higher for the S treatment than for the C condition (P<.10). All other comparisons for this variable were nonsignificant.

No significant time of day effects were observed.
TABLE 1. MEANS AND STANDARD DEVIATIONS OF SEXUAL BEHAVIOR SCORES OF BULLS TESTED UNDER FOUR SEXUAL STIMULATION TREATMENTS

<table>
<thead>
<tr>
<th>Variable</th>
<th>ANOVA treatment effect</th>
<th>Treatment</th>
<th>ANOVA treatment effect</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Control</td>
<td>Watched</td>
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<td></td>
<td></td>
<td>Restrained</td>
<td>Spectator</td>
</tr>
<tr>
<td>Latency first mount, s</td>
<td></td>
<td>235.2 b</td>
<td>110.0 c</td>
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<tr>
<td></td>
<td></td>
<td>262.2</td>
<td>176.3</td>
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<tr>
<td>Latency first ejac., s</td>
<td></td>
<td>827.8 b</td>
<td>607.2 b</td>
</tr>
<tr>
<td></td>
<td></td>
<td>474.8</td>
<td>487.6</td>
</tr>
<tr>
<td>Postejac. interval, s</td>
<td></td>
<td>471.2</td>
<td>391.8</td>
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<td></td>
<td></td>
<td>289.3</td>
<td>173.6</td>
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<tr>
<td>Interejac. interval, s</td>
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<td>853.1</td>
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<td></td>
<td></td>
<td>391.0</td>
<td>302.1</td>
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<td>Ejac. freq. (1st 15 min)</td>
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<td>.86 b</td>
<td>1.22 bc</td>
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<td>Ejac. freq. (total)</td>
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<td>1.20 b</td>
<td>1.61 bc</td>
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<td>.96</td>
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<td>Criterion latency, min + 15</td>
<td></td>
<td>1.71 b</td>
<td>1.54 bc</td>
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<td>.96</td>
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<td>Flehmen freq. (1st 15 min)</td>
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<td></td>
<td>1.81</td>
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<td>4.58</td>
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<td>3.93</td>
<td>2.41</td>
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<td>Mount intentions (1st 15 min)</td>
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<td>4.06</td>
<td>4.00</td>
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<td></td>
<td></td>
<td>2.91</td>
<td>2.72</td>
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<td>Mount attempts (1st 15 min)</td>
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<td>.11 b</td>
<td>.22 bc</td>
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<td>.16</td>
<td>.33</td>
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<tr>
<td>Mount w/o ejac. (1st 15 min)</td>
<td></td>
<td>3.03 b</td>
<td>4.58 c</td>
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<td>2.02</td>
<td>2.24</td>
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<tr>
<td>Mount w/o ejac. (total)</td>
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<td>4.68</td>
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<td>2.65</td>
<td>3.47</td>
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<td>Percentage time with female</td>
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<td>94.5</td>
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<td></td>
<td></td>
<td>12.2</td>
<td>2.0</td>
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<td>Libido rating f</td>
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<td>5.54 b</td>
<td>6.50 c</td>
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<td></td>
<td></td>
<td>1.53</td>
<td>1.47</td>
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<tr>
<td>Mating efficiency score</td>
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<td>.233</td>
</tr>
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<td></td>
<td></td>
<td>.106</td>
<td>.176</td>
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</table>

aPostejaculatory interval = time between an ejaculation and the next mount interaction. Interejaculatory interval = time between successive ejaculations. Criterion latency = time to attain two ejaculations (1 = within 15 min; 2 = did not reach criterion in 30 min).

b,c,dRow means with different superscripts differ (P<.05).

eNS = nonsignificant.

fChenoweth et al. (1977).

Discussion

Hale and Almquist (1960) demonstrated that the latencies of bulls to mount a conspecific and ejaculate into an artificial vagina could be reduced by the introduction of new stimulus animals (“teasers”) or by placing familiar stimulus animals in a new location. The results of the present study confirm previous reports (Kerruish, 1955; Blockey, 1981) that the sexual performance of bulls is enhanced by allowing them to view conspecifics engaged in copulatory behavior (S treatment). The present study also demonstrates that in the context of controlled mating (hand-breeding), sexual performance is improved, but to a lesser extent, by a bull being
restrained in close proximity to a stimulus female (R treatment) and by being watched by another male while engaged in sexual interactions with a stimulus female (W treatment). The fact that the S treatment condition was generally more effective than the R treatment suggests that the enhancement of sexual performance by the former treatment is due largely to viewing the sexual activities of a conspecific male rather than being restrained in the presence of a female. Likewise, the lesser impact of the W treatment on sexual performance indicates that the effectiveness of the S treatment in previous studies (Kerruish, 1955; Blockey, 1981) could not have been due solely to social facilitation resulting from the proximity of herdmates during the testing of S males.

As applied in this study, the S treatment permitted bulls to observe the sexual activities of other males, but they could also see the stimulus female and were not able to approach her. Considering that the latter condition (R treatment) had an effect of its own on sexual performance, it is possible that restraint and/or viewing the stimulus female contributed to the overall effectiveness of the S treatment [i.e., the effects of restraint and/or viewing the female were additive with the effects of observing the sexual behaviors of other males]. In a similar study with male dairy goats, Price et al. (1984) demonstrated that the effects of the S and W treatments on sexual performance were not additive. Goats given both S and W treatments performed no better than when they received the S treatment alone.

Watching conspecifics (male or female) engage in sexual activity may be analogous to the stimulation received by bulls in the field where they are able to observe cow-cow mounting in the sexually active group (Blockey, 1979) and the sexual activity of other males. Such visual stimulation may psychologically and physiologically "prime" the male for sexual activity.

Perception of a conspecific engaged in a particular activity often increases the observer's motivation to respond to the same or similar stimuli (social facilitation). Social facilitation of sexual behavior may be selected for in a natural mating system and may ultimately explain the evolution of the sexual stimulation phenomenon. Sexual stimulation may give bulls a competitive advantage in multi-male breeding groups. Bulls that are most readily aroused to engage in sexual activity may be most likely to locate and mate with estrous females. In addition, sexual stimulation may improve the quantity and quality of the ejaculate before copulation (Hale and Almquist, 1960; Almquist, 1973).

The effects of sexual stimulation on sexual performance might be mediated by rather rapid increases in systemic hormones (notably luteinizing hormone and testosterone) that could sensitize the animal to sexual stimuli (Katangale et al., 1971; Smith et al., 1973; Coquelin and Bronson, 1979; Graham and Desjardins, 1980).

Although sexual arousal is obviously facilitated by sexual stimulation, it is possible that sexual performance may also be enhanced by certain nonsexual stimuli that bring the animal to a state of general arousal or excitement (Kerruish, 1955).

The libido rating scale devised by Chenoweth et al. (1977) yielded treatment differences that corresponded closely with the overall results of the study. This finding was particularly interesting because the scale was applied to the data collected during the first 5 min of testing only. The fact that the rating scale was sensitive to the effects of sexual stimulation emphasizes the importance of controlling for this variable when testing the sexual performance of bulls to be used in breeding programs (Blockey, 1981). It should also be pointed out that the "Chenoweth Scale" confounds true measures of libido (sexual motivation) with performance variables (e.g., ejaculation rate). An animal with a high "serving capacity" will undoubtedly have a high libido, but the reverse is not necessarily true (Price, 1984). Poor sexual performance may result from factors totally unrelated to libido such as locomotor defects, genital abnormalities, etc. (Blockey, 1976).

When analyzing the data, it was noted that bulls paired with unmated stimulus females (i.e., females that had not previously been served that day) tended to achieve fewer E than bulls paired with mated females. Because a large proportion of the tests with previously unmated females were administered in the C treatment, the data for the number of E in 15 min were reanalyzed with these tests omitted. Although the F value for treatment effect was not as high as when
all the tests were included (3.94 vs. 4.68, respectively) the results were the same (S > C, P<.01).

Bulls tested under control conditions not only achieved fewer E but fewer M and MA as well (see table 1), demonstrating that the lack of sexual stimulation affected more than just their serving capacity. The lack of a highly significant difference in mating efficiency between unstimulated and stimulated bulls also suggests a general depression in sexual performance by subjects in the C treatment.

Although 15-min tests appeared to be long enough to distinguish between the effects of the various treatments, a second E was not attained in 55 tests that went the full 30 min. Because interejaculatory intervals could not be computed for these tests and postejaculatory intervals were not obtained in all cases, the treatment differences for these variables were artificially conservative.

Because bulls not attaining two E in 30 min were automatically given a criterion latency score of 2.0 (30 + 15 min), the treatment differences for that variable were also artificially conservative.

An effect of sexual stimulation has been reported in nonruminant species as well. Pickett et al. (1977) found that when stallions with low or abnormal sexual behavior were allowed to watch other stallions engage in copulatory behavior, they often were more likely to mount and service a mare.

It is concluded that the sexual performance of beef bulls can be enhanced in the context of controlled mating (hand-breeding) by sexual stimulation mediated through allowing bulls to observe the copulatory behavior of other males and, to a lesser extent, by being restrained in the presence of a female or by being watched by another male. The advantages of sexual stimulation should be considered when “hand-breeding” farm animals and when evaluating the sexual performance of males to be used in a breeding program.

**Literature Cited**


