

## Sexual behaviour of Zebu bulls in the humid tropics of Costa Rica: single versus multiple-sire groups

R. Molina<sup>a</sup>, I. Bolaños<sup>a</sup>, C.S. Galina<sup>b,\*</sup>,  
E. Pérez<sup>c</sup>, G. Paniagua<sup>c</sup>, S. Estrada<sup>c</sup>

<sup>a</sup> Escuela de Agronomía, Instituto Tecnológico de Costa Rica, sede San Carlos, Costa Rica

<sup>b</sup> Facultad de Medicina Veterinaria, Universidad Nacional Autónoma de México, México D.F. 04510, Mexico

<sup>c</sup> Escuela de Medicina Veterinaria, Universidad Nacional, Heredia, Costa Rica

Received 29 May 2000; received in revised form 26 July 2000; accepted 21 August 2000

### Abstract

This study compares the courtship and mounting behaviour of *Bos indicus* bulls in single- and multiple-sire groups in Costa Rica (latitude 10°25'N, longitude 84°32'W, annual precipitation of 3096 mm, temperature of 24°C and humidity of 85.3%). Four, 3–4 year-old Brahman bulls with previous sexual experience were used to sire a group of 120 multiparous cows (average of 128 days post-partum and a body condition score of 2.5) allocated to two groups of 60 each: (1) single-sire mating group (SSM) and (2) multiple-sire mating group of three bulls (MSM). Bulls were rotated among groups every 7 days for 28 days. The frequency, type and duration of sexual activities (mounting and mounting attempts) and courtship activities (smelling and licking genital area, butting, supporting the head over a female and the sign of Flehmen) were calculated for each mating group. Descriptive and non-parametric statistics (Wilcoxon, Mann-Whitney tests) were used to calculate differences between mating programmes.

Sexual activities tended to be more frequent in the SSM group than the MSM group (267 versus 124,  $P > 0.05$ ). Differences in the ratios of sexual to courtship activities between both groups were significant (1:3 in SSM and 1:6 in MSM,  $P > 0.05$ ). Pregnancy rate averages were 28 and 37%, respectively, ( $P > 0.05$ ). It is concluded that under these conditions multiple-sire mating and single-sire mating achieved similar pregnancy rates. © 2000 Elsevier Science B.V. All rights reserved.

**Keywords:** Mating systems; Fertility; Synchronisation

\* Corresponding author. Fax: +525-616-71-97.  
E-mail address: cgalina@servidor.unam.mx (C.S. Galina).

## 1. Introduction

Central American, meat-producing herds usually have low reproductive efficiency explained in part by inadequate management of sires selected for breeding programmes (Müller, 1994). Considering that bulls make up only 3–5% of a herd, their selection and use is one of the key aspects of cattle production using natural mating. When a cow fails to conceive for any reason, a calf is lost. When a bull fails, there is a potential loss of 25 to 50 calves for every 100 cows (Carrillo, 1988) which can be compensated for by the presence of other bulls. However, a dominant animal could prevent subordinate bulls from approaching receptive females, thus, stopping them from realising their full reproductive potential (Blockey and De, 1979).

The efficiency of a single bull serving a given group of cows under natural mating conditions can be determined by counting the number of pregnancies at the end of the mating season. This method cannot be applied, however, in multiple mating programmes where several bulls may serve the same cow, possibly masking the presence of sub-fertile (and even infertile) males. If this situation is not detected in time, it could lead to considerable economic losses. Thirty percent of bulls are reported as being unable to perform adequately under natural mating conditions (Blockey and De, 1979; Chenoweth, 1981). The number, selection and handling of bulls in the mating group is generally conducted by the breeder based on personal experience.

Little is known about the reproductive ability of *Bos indicus* bulls under field conditions (Galina and Arthur, 1991; Russell and Galina, 1987). There is evidence, however, to suggest that these breeds have particular reproductive behaviour patterns. Chenoweth and Osborne (1975) found that Zebu bulls are slower in responding to females in oestrus than *Bos taurus*. *Bos indicus* bulls also have lower scores in libido tests. Nonetheless, some individual Zebu bulls had similar or better sexual performance than the European breeds. This suggests the need to efficiently screen for poor libido, particularly in Zebu bulls. The objective of the present study is to compare the sexual behaviour of bulls in a single-sire as compared with multiple-sire mating programme. The effect of grouping bulls on individual performance was also studied.

## 2. Materials and methods

The research was conducted in the Bovine Production Unit of the Technological Institute of Costa Rica in San Carlos, Alajuela at latitude 10°25' N, longitude 84°32'W and 75 m above sea level. The area is classified as wet tropics, with an average annual precipitation of 3096 mm, temperature of 24°C and with humidity of 85.3%.

A total of 120 multiparous Zebu cows, averaging of 128 days post-partum, 390 kg body weight and body condition scores of 2.5 on a scale of 1 to 5 (Pullan, 1978) were used. Sixty four cows were used in the single-sire mating group (SSM) and 56 in the multiple-sire mating group (MSM). Twelve cows in each group were synchronised in batches of three animals at the start of each breeding period. Blood samples to determine ovarian activity were obtained from 70 animals twice a week, 8 weeks prior to the females being exposed to the bulls and for 4 weeks during exposure. A total of 34 cows were allo-

cated in the SSM and 36 in the MSM including four and eight cows in each group, respectively.

Blood sampling was scheduled for Tuesday and Friday (each week), at this time some synchronised cows had the implant placed while others had it withdrawn. Tuesday was the day of removing the bulls hence, manipulation was kept to a minimum, on average 4 h elapsed from the beginning to the end of this exercise. Samples for progesterone analysis were collected by tail venipuncture, immediately centrifuged and stored at  $-20^{\circ}\text{C}$  until assayed by solid-phase radio-immunoassay (Coat-A-Count, Diagnostic Products Corporation, USA) The intra- and inter-assay coefficient of variation were 3.2 and 11.4%, respectively. Females were randomly allocated to two mating systems: (1) single-sire (SSM) and (2) multiple sire, three bulls (MSM). Animals were nursing calves and were kept in two adjacent fields of approximately 10 ha each.

Bulls were rotated between the two groups of cows every 7 days for a period of 28 days. At the end of each week, the SSM bull was transferred to the MSM, and one in the MSM group, transferred to the SSM group. By the end of the experiment this procedure had been repeated three times, each bull thus, remaining 1 week in the SSM group and 3 weeks in the MSM, according to the following schedule:

Time period	SSM system	MSM system
	Bull	Bulls
1	A	B-C-D
2	B	A-C-D
3	C	A-B-D
4	D	A-B-C

Brahman bulls 3–4 years of age were utilised in the mating systems, each weighing more than 500 kg, with sexual experience and submitted to a breeding soundness evaluation exam. These bulls were together most of the time as a management practice even in the non-breeding season. In order to facilitate the assessment of bull courtship and mounting activities after each rotation of bulls, the two groups were observed continuously for 54 h following implant withdrawal in three cows previously synchronised. These animals were part of the group at the start of each time period. The cows were treated with an implant of 6 mg of Norgestomet (Synchromate-B, Meriel, Mexico) and a 3 mg intramuscular dose of 5 mg of estradiol valerate for 9 days.

Courtship and mounting behaviour were recorded in both experimental groups by two observers during 54 h. Activities were classified as either active or passive and further subdivided into the following categories: smelling and licking genital area, butting, supporting the head over a female and the sign of Flehmen (courtship activities) and mounting and mounting attempts (mounting activities) according to the methodology described by Orihuela et al. (1983). A rectal examination was performed on the cows at 35 days after the last mating period to determine pregnancy.

The frequency, type and duration of courtship and mounting activities were calculated for each mating group. Descriptive and non-parametric statistics (Wilcoxon, Mann-Whitney

tests), with a significance level of 5% were used to compare the number and types of actions shown by the bulls under the two mating systems.

### 3. Results

Similarities were found between the number and type of sexual activities performed by the bulls under the different mating systems. Courtship activities were the same ( $n = 796$ ) (Table 1). Sexual activities such as mounting and attempted mounting, tended to be more frequent in the SSM group (267 versus 124). Ratios between the percentage of mounting and courtship activities varied between groups and were 25:75 in SSM and 13:86 in MSM.

Table 1  
Sexual activities performed by Zebu bulls, depending on mating conditions<sup>a</sup>

Period	BULL	Type of activity							
		(a) Courtship					(b) Mounting		
		IOV	SLG	BUT	SHO	FLH	MA	MOU	Subtotals
Single-sire mating system									
I	D	51	84	37	0	31	104	10	317
II	C	71	142	23	14	12	73	9	344
III	B	44	45	23	6	48	49	7	222
IV	A	53	64	22	2	24	12	3	180
Subtotals		219 a	335 a	105 a	22 a	115 a	238 a	29 a	1063
Multiple-sire mating systems									
I	A	22	35	7	1	9	11	3	88
	B	8	35	6	1	22	4	0	76
	C	23	64	7	1	10	6	1	112
Subtotal		53	134	20	3	41	21	4	276
II	A	13	28	16	1	7	5	8	78
	B	0	8	0	0	6	0	0	14
	D	2	27	1	1	20	3	0	54
Subtotal		15	63	17	2	33	8	8	146
III	A	5	11	0	0	2	6	1	25
	C	40	64	5	6	16	12	5	148
	D	29	59	11	8	19	26	7	159
Subtotal		74	134	16	14	37	44	13	332
IV	B	7	10	4	0	14	5	0	40
	C	3	16	2	0	6	0	0	27
	D	11	32	12	1	22	18	3	99
Subtotal		21	58	18	1	42	23	3	166
Grand total		163 a	389 a	71 b	20 a	153 a	96 a	28 a	920

<sup>a</sup> IOV: interest over a certain female, FLH: Flehmen, SLG: sniff and/or lick genital area, MA: mounting attempts, BUT: butting as sign of sexual attraction, MOU: mount, SHO: supporting head over another animal and values with a different letter in the same column differ significantly ( $P < 0.05$ ).

Table 2

Relative distribution of sexual activities of the bulls during the four observation periods, under a multiple-sire mating system<sup>a,b</sup>

Period	Bull (grade%)				Subtotal
	A	B	C	D	
I	32 (88)	27 (76)	41 (112)	X* (317)	276
II	53 (78)	10 (14)	X* (344)	37 (54)	146
III	7 (25)	X* (222)	45 (148)	48 (159)	332
IV	X* (180)	24 (40)	16 (27)	60 (99)	166
Subtotal	21 (191)	14 (130)	31 (287)	34 (312)	(920)

<sup>a</sup> Figures in parenthesis include the amounts of activities for each bull during the corresponding period.

<sup>b</sup> X\* Under single mating system not included in the calculations.

Courtship activities, specifically smelling and licking the genital area (SLG) were the most frequent ( $P < 0.05$ ), 31.5 and 42.3%, respectively. However, mounting attempts (MA) was the sexual activity most frequently observed (22.4 and 10.3%, respectively). Comparing sexual activities in both mating groups, differences were not significant, with the exception of butting ( $P < 0.05$ ) (Table 1).

In spite of these similarities, distinctive sexual patterns were detected in each mating group. For example, in the MSM group bulls averaged 3.5 attempt mounts (MA) for every actual mount (MOU) while in the SSM group this figure was 8.3.

Table 2 shows that each bull in the MSM registered an average of  $76 \pm 46$  activities per observation period (54 h), whereas, in single-sire system, each bull performed an average of  $265 \pm 77$  activities. Therefore, bulls had 3.5 times more sexual actions when in SSM. Considerable variation was observed in the bulls under MSM depending on the combination of bulls in each period. However, as can be observed in Table 2, bull D was the most effective performer in each period (34% of the overall sexual activities). In contrast bull B averaged only 14%. The courtship behaviour of bulls in the MSM periods varied considerably between phases (Table 2).

Bull aggression is represented in Fig. 1. Head to head butting and butting on the side of the animal represented 75% of total aggressions recorded. Other actions such as avoidance, chasing, and threatening accounted for the remaining 25%. Bull A was the most aggressive and bull B the most passive.

In order to establish overall bull performance in the two systems, mounting and courtship activities in 17 cows showing oestrus in the SSM and 11 in the MSM were determined (Table 3). The average number of sexual activities received by the females in oestrus was 13.5 (SSM) and 8.4 (MSM) ( $P < 0.05$ ). The average duration of oestrous 8.4 h in SSM and 7.4 h in MSM group ( $P < 0.05$ ). The frequency of sexual activities was 2.0 and 1.1 per hour, respectively, ( $P < 0.03$ ). Oestrous response following SMB treatment ( $n = 12$ ) was observed in only four cows, (33%) in the SSM group and five (42%) in the MSM group.

Blood samples taken during the 8 weeks prior to the experiment, showed that 10 cows in the SSM and five in the MSM were already pregnant at the start of the experiment, thus, were excluded from the pregnancy calculations. From the remaining 105 cows, 18 cows had resumed ovarian activity in the MSM group and eight in the SSM. Fig. 2 depicts how

Bull identification	A	B	C	D
Number of aggression given (a)	36	4	15	25
Number of aggression received (b)	19	24	13	24
Aggression index [a/ a+b]	0,65	0,14	0,54	0,51

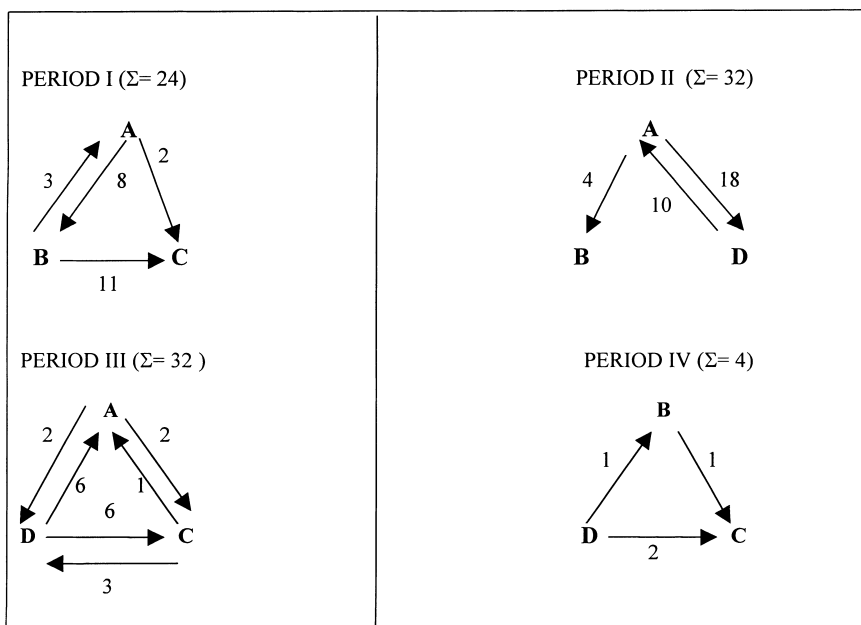


Fig. 1. Aggressive behaviour during the multiple-sire mating programme.

ovarian activity developed during bull exposure. In the SSM group, the average number of cows in oestrus per week was nine, whereas in the MSM the figure was 14. During the time the bulls were in the MSM system they were exposed to a significantly greater ( $P < 0.04$ ) number of cows that were expressing oestrus than during their time in the SSM group. In the SSM group, 15 out of 54 (28%) became pregnant, while in the MSM group 19 of the 51 (37%), the differences between the two groups were not significant.

#### 4. Discussion

Similar patterns were seen in the reproductive behaviour of the bulls in the present study. In both SSM and MSM groups, bulls spent more time in courtship than mounting activities

Table 3  
Amount of sexual actions received by the cows that showed oestrus behaviour depending on the type of mating system used<sup>a</sup>

Observation period	Animal	Received sexual activities (a)	Duration of oestrus (h) (b)	Activity per hour (a/b)
Single-sire mating system				
I	102/7	27	17	1.59
	332	25	11	2.27
	469/0 <sup>b</sup>	21	8	2.63
	46/9	29	4	7.25
II	389	9	2	4.50
	20/5	18	9	2.00
	336	9	10	0.90
	272	14	6	2.33
	112 <sup>b</sup>	15	17	0.88
	389/0 <sup>b</sup>	4	4	1.00
	8/5	17	5	3.40
III	276/0	13	18	0.72
	200/7	11	7	1.57
	2721	2	3	0.67
	311	2	2	1.00
	384/0 <sup>b</sup>	6	11	0.55
IV	523	7	10	0.70
	Average S.D. (±)	13.5 a 8.5	8.4 b 5.1	2.0 c 1.7
Multiple-sire mating system				
I	40 <sup>b</sup>	8	15	0.53
	1641	2	4	0.50
	2491 <sup>b</sup>	3	9	0.33
II	1112 <sup>b</sup>	4	7	0.57
	3/0	2	5	0.40
	1420	2	3	0.67
III	30	20	9	2.22
	382/9	25	8	3.13
	20/9	10	11	0.91
IV	266/7	4	5	0.80
	18/5 <sup>b</sup>	12	6	2.00
Average S.D. (±)		8.4 a 7.8	7.5 b 3.5	1.1 d 0.9

<sup>a</sup> Values with a different letter in the same column differ significantly ( $P < 0.05$ ).

<sup>b</sup> Cow treated with synchronate-B (SMB).

( $P < 0.05$ ). Not surprisingly, the most frequent courtship activity observed was licking and sniffing the genital area to determine if the cows are in oestrus and therefore, receptive (Chenoweth, 1983; Orihuela et al. (1983).

More activities were recorded for bulls in the SSM than MSM, 265 and 76, suggesting that limited individual activity is observed in a group situation, probably due to competition between bulls for receptive females. However, aggressions were minimal. As can be observed in Table 1, only 80 aggressions were recorded out of a total of 920 sexual actions.

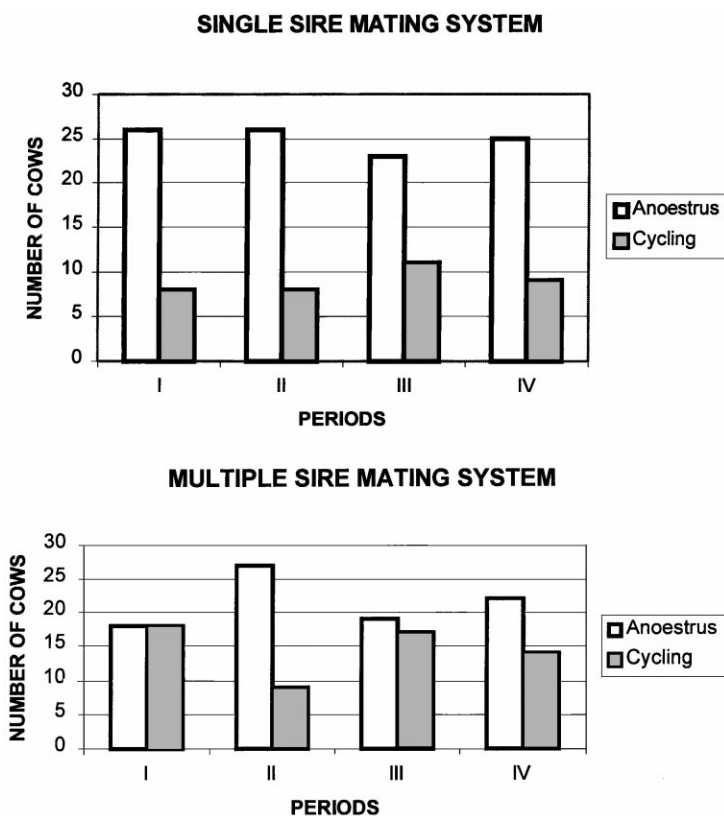


Fig. 2. Comparison of the number of cows in anoestrus or cycling (including synchronised cows), based on progesterone concentrations in blood samples obtained from 70 cows during the 4 weeks of the experiment according to the mating system used.

Previous observations point to differences in bull behaviour towards receptive females between grazing and other conditions (Fields, 1985). This is more evident in a group situation when bulls prevent each other from performing to their maximum potential. In fact, McCosker et al. (1989) found that 50% of bulls in multiple-sire mating programmes sired five or fewer calves per year.

The present results agree with previous data (Blockey and De, 1979) showing that under SSM conditions, more attempts to mount than effective mounts are observed. In the present report, a ratio of 8.3:1 (attempts to mount per effective mount) was observed in the MSM, compared with 3.5:1 in the SSM group. This result suggests that bulls first establish hierarchy before locating cows in oestrus.

Information available on the reproductive ability of Zebu bulls under an extensive system shows that they are slower in reacting to cows in oestrus than to *Bos taurus* bulls (Chenoweth and Osborne, 1975). Likewise, *Bos indicus* bulls spend less time mounting females, this in turn affecting fertility (Larsen et al., 1990). In the present study, sexual activities under

MSM conditions averaged 1.1 per hour while the cow remains in oestrus, whereas in the SSM the average was 2.0 activities ( $P < 0.03$ ). The scarcity of mounting behaviour is probably not the effect of intense competition between bulls, but rather due to the inspection of the cows prior to mounting. In any case, the frequency of mounting activity agrees with previous continuous observation studies (Orihuela et al., 1983; Landivar et al., 1985). Pregnancy rates in both mating systems averaged 32% confirming previous research that Zebu bulls are responsible for fewer pregnancies during the mating season than *Bos taurus* bulls (Larsen et al., 1990). Conflicting data are found in the literature on fertility differences in single- and multiple-sire systems. Blockey and De, (1979) and Mattner et al. (1974) found greater pregnancy rates in MSM while Rupp et al. (1977) and Farin et al. (1982) found no differences. This could be due to differences in courtship interactions hindering the capacity of the bulls to serve females.

The differences seen in pregnancy results must be carefully interpreted, as these could be related to the reproductive ability of the females rather than of the bulls themselves. The fact that not all cows with ovarian activity as revealed by progesterone measurements throughout the experiment, did not become pregnant, probably illustrates the failure of the females to be involved in a complete service or perhaps the inability of the bull to serve these females. Further research is necessary to explain why they fail to become pregnant in spite of showing progesterone concentrations indicative of luteal activity. In the present study, females were suckling, which may explain the small number of cows pregnant during the experiment. Bolaños et al. (1997) have shown that post-partum cows may initiate oestrous cycles but later undergo anoestrus. Under such conditions the bulls have little opportunity to express their full reproductive potentials. Future research should include progesterone monitoring of cows to determine whether or not they continue to express oestrus at regular intervals throughout the mating period. The limited number of females expressing oestrus created a bias favouring SSM. Results indicate the need, at least under tropical conditions, to review the bull to female ratio as this can possibly be decreased as not all cows will be expressing oestrus.

## Acknowledgements

The authors are grateful to Secretaria de Relaciones Exteriores de México and to the programme SAREC/Costa Rica for financial assistance. Thanks are expressed to Peter Chenoweth for constructive criticism.

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