Reduction of the bull:cow ratio in the Brazilian Pantanal[1]

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Abstract – This work was conducted to study alternatives for reduction of the bull:cow ratio in the Brazilian lowland and, therefore, lower the production costs for the local beef cattle industry. The ratios 1:10, 1:25, and 1:40 were used in native pastures with a mean stocking rate of 0.27 mature animal unit per hectare over two consecutive breeding seasons. Statistical analysis did not show any effect (P>0.05) of year (P = 0.2097), animal category (P = 0.0773), bull:cow ratio (0.8134) on reproductive performance. However, the pregnancy rate in a multiple bull system was higher (P = 0.0228) than in the individual bull system. An evaluation of the economic impact of this management system in the extensive Lowland herds showed that at the ratio of 1:10 the bulls were sub utilized.

Index terms: beef cattle, livestock management, production costs, animal production.

Redução da proporção touro:vaca no Pantanal brasileiro

Resumo – Este trabalho foi conduzido com o objetivo de estudar alternativas de redução da proporção touro:vaca no Pantanal e conseqüentemente reduzir os custos de produção da pecuária de corte regional. Utilizaram-se as proporções de 1:10, 1:25 e 1:40 em pastagens nativas com taxa de lotação média de 0,27 unidade de animal por hectare durante duas estações de monta consecutivas. A análise estatística dos dados não revelou efeito significativo quanto aos seguintes fatores: ano (P = 0,2097), categoria animal (P = 0,0773) e proporção touro:vaca (P = 0,8134). Entretanto, na variável tipo de acasalamento, o sistema múltiplo mostrou-se superior (P = 0,0228) ao individual. O impacto econômico desta prática de manejo no sistema de criação extensivo do Pantanal mostrou que ocorre subutilização de touros na região na proporção de 1:10.

Termos para indexação: gado de corte, manejo de gado, custo de produção, produção animal.

Introduction

Although the general recommendation for bull:cow ratio in Central Brazil is 1:25, farmers and researchers question the upkeep costs of the bulls under natural breeding conditions. In a three month breeding season, the cows generally become pregnant in the first month (Costa e Silva, 1994), therefore the bull has little reproductive use for the rest of the breeding season thereby increasing the cost of calf production. There are few studies in the literature which evaluate the bull:cow ratio using Zebu cattle under tropical conditions. Globalization of economy demands, however, reduction of production costs and increased productivity in order to reach new markets.

According to Radostits et al. (1994), in an average non-selected bull population, 20% to 40% of the animals may have low fertility due to inadequate semen quality and/or physical alterations inhibiting breeding and reducing libido. Fonseca (1989) agrees with the above, commenting that about 40% of the bulls in service are sub-fertile, presenting some

[1] Accepted for publication on July 10, 2002.

Supported by a grants from Embrapa, Conselho Estadual de Ciência e Tecnologia do Estado de Mato Grosso do Sul (CECITEC-SEPLAN) and from the Fundação da Universidade Federal do Mato Grosso do Sul (FUFMS).

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fertility problems during andrological exams. Gottschall & Mattos (1997) observed that the percentage of bulls considered inadequate for reproduction increased with age.

Crudeli et al. (1991) and Costa e Silva (1994) studied bull:cow ratios higher than those recommended at present for the Brazilian Southeast and Northeast. These authors obtained pregnancy rates of 90% and 92% after 120 and 90 day breeding seasons, respectively. Rupp et al. (1977) and Neville Junior et al. (1979) showed that there was no significant changes in pregnancy rates of European cattle when the bull:cow ratios varied from 1:15 to 1:60 on cultivated pastures. Costa e Silva et al. (1998) used bull:cow ratios of 1:40, 1:60, and 1:80 and obtained pregnancy rates of 71%, 66% and 66%, respectively, in Mato Grosso do Sul.

In Brazilian lowlands, beef cattle are produced extensively on native rangelands with low stocking rates of about 0.27 animal unit (AU)/ha (Cadavid Garcia, 1984). The selection of bulls is based on phenotype, body condition, and racial attributes, and frequently involves animals rejected by the surrounding farms, of low genetic merit (Rosa & Melo, 1995). The bull:cow ratio varies from 1:10 to 1:15, while other Brazilian areas use the ratio 1:25 (Costa e Silva, 1994). The low ratio causes a high investment in bulls, once natural breeding is the preferable method (Fonseca et al., 1991). There are few bulls available in the region, which come from surrounding regions at a price of US$ 600 per bull. Rosa & Melo (1995) estimated that the Brazilian lowland would need about 26,600 bulls/year, and only 25% (6,650) are produced locally.

The objective of the present study was to evaluate alternatives for reduction of the bull:cow ratio presently used (1:10) in the Brazilian lowland aimed at reducing production costs.

Material and Methods

Brazilian lowland comprises plains of approximately 140,000 km^2 and sub-humid type weather. The annual mean precipitation is 1,182 mm, concentrated (70%) from October to March. The main dry period includes July and August, with 6% of the total annual rainfall. Mean temperatures are about 25ºC, ranging from 20.7 to 28ºC. Mean yearly relative humidity is 82%, ranging from 75% to 86%. About 92% of the lowland plains have hydromorphic soils, mainly (70%) of low fertility, and the primary economic activity is beef farming (Cadavid Garcia, 1984; Amaral Filho, 1986; Soriano, 1999).

This study was carried out on the Nhumirim farm, owned by Embrapa-Centro de Pesquisa Agropecuária do Pantanal, in the sub-region of Nhecolândia, Corumbá, MS, Brazil. An andrological evaluation was carried out on all bulls, which involved a biometry test (Refsal & Mather, 1977), including physical and morphological semen characteristics (Fonseca et al., 1992). Body condition score and weight (Kilkenny, 1978), as well as a libido evaluation using an adaptation of Chenoweth method (Chenoweth, 1974) by Fonseca (1989), were also carried out to obtain a homogeneous sample of bulls for the treatments. All animals were weighed at the beginning (November) and end (February) of the two breeding seasons in the study (1994/95 and 1995/96). The same bulls were used for each treatment in both breeding seasons. The average bull age was eight years at the beginning of the experiment.

The bull:cow ratios were 1:25 (treatments A) and 1:40 (treatments B), in which, respectively, a single bull was used with a group of 25 cows and a single bull was used with a group of 40 cows and 1:10 (control, treatment C) and 1:25 (treatment D), in which five bulls for a group of 50 cows and two bulls for 50 cows were used, respectively.

The cows were distributed in the treatments at random. Cows used had approximately the same age, weight, body condition, breed, lactation status and reproductive performance at the beginning of the breeding season, to obtain a homogeneous sample of cows over the treatments.

Rectal palpation was carried out on each cow 60 days after the end of breeding season to estimate pregnancy rate. In the first breeding season (November/94 to February/95) no differences were observed between the cows as all were non-pregnant and showed good (average 4) body condition. In the second breeding season (November/95 to February/96), cows were evaluated for body condition, according to Kilkenny (1978), and scored 1 (very poor), 2 (poor), 3 (average), 4 (good) and 5 (excellent).

Pregnancy rates were evaluated (1994/95 and 1995/96) for females managed in four paddocks of different stocking rates (0.30, 0.25, 0.28, and 0.22 AU), in multiple or individual bull breeding assignments with a bull:cow ratio 1:40, 1:25 or 1:10, using two animal types (heifer and cow), and two breeds (Nelore or Pantaneira). Data were analyzed by PROC GENMOD from Statistical Analysis System (SAS Institute, 1985). The responseobtained from the pregnancy diagnosis (positive or negative) were binary, requiring an adjustment of the specific model (Collet, 1991). In this way, the model used was a logistic one as shown below:

$P_{ijklnmr} = [1 + \exp^{Y_{ijklnmr}}]^{-1}$,

where: $P_{ijklnmr}$ is the pregnancy proportion, and

$Y_{ijklnmr} = \mu + a_i + b_j + c_k + d_l + e_n + f_m + g_r + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + e_{ijklnmr}$,

where: μ is the overall mean; a_i is the effect of i^{th} body condition (i = 1, 2, 3, 4 and 5); b_j is the effect of j^{th} score from body condition at the end of the breeding season (j = 1, 2, 3, 4 and 5); c_k is the effect of the k^{th} bull:cow ratios (k = 1, 2 or 3); d_l is the effect of the l^{th} stocking rates (l = 1, 2, 3 or 4); e_n is the effect of the n^{th} animal breed (n = 1 or 2); f_m is the effect of the m^{th} animal type (m = 1 or 2); g_r is the effect of the r^{th} year (r = 1 and 2); b_s is the partial regression coefficients (s = 1, 2 or 3); X_1 is the weight gain during the breeding season; X_2 is the years of experiments; X_3 is the animal age; $e_{ijklnmr}$ is the random error associated with the n^{th} cell.

Interactions of practical interest (bull:cow ratio x year, bull:cow ratio x kind of breeding, bull:cow ratio x stocking rate and bull:cow ratio x animal type) were tested and were found not to be significant and for this reason were excluded from the model.

The economic analysis used the method suggested by Fonseca et al. (1991), and prices have been adjusted for inflation in American dollars at the time. The following mathematical model has been used:

X, Y and Z = n_1 x US$ A + [(n_2 x US$ A - n_2 x US$ B) x 5],

where: X, Y and Z are costs, cost of management; n_1 is the number of bulls needed for cows in the ratios X = 1:10, Y = 1:25 and Z = 1:40; US$ A is the cost of acquisition of each bull; n_2 is the number of bulls culled yearly, with a replacement rate of 20%; US$ B is the value received for culling of discharged bulls (around 12 @); 5 is the productive life of bulls, considering annual replacement rate of 20%.

Results and Discussion

There was no significant effect of year (P = 0.2097) for pregnancy rate, and means of 65% and 66% for years 1994 and 1995, respectively, were observed (Table 1). Also no significant effect (P = 0.8134) was observed for bull:cow ratio (Table 2) when pregnancy rates were 68%, 64% and 61%, respectively, for bull:cow ratios of 1:10, 1:25 and 1:40 over the two consecutive breeding seasons studied. According to Costa e Silva (1994), Fonseca et al. (1997) and Sereno & Costa e Silva (1998a, 1998b), the success of reducing the bull:cow ratio is linked to the andrological analysis of the bulls, preferably before the beginning of the breeding season.

Considering the large extension (140,000 km^2) and the extensive management conditions of beef cattle in the Brazilian lowland, the reduction of the bull:cow ratio should be gradual, starting at 1:25, and slowly reducing to 1:40. Farms that already use basic management procedures (breeding season from

Table 1. Live weights and standard deviations, at the beginning (November) and at the end (February) of 1994/95 and 1995/96 breeding seasons and pregnancy rates of cows submitted to different bull:cow ratios at the Brazilian lowland.

Bull:cow ratio	Live weight (kg)		Pregnancy rate (%)(1)
	November	February	
	1994/1995		
1:40	289 36	334 43	62a
1:25	282 45	347 48	65a
1:10	295 32	364 35	69a
	1995/1996		
1:40	307 36	335 38	60a
1:25	310 41	317 51	63a
1:10	316 31	351 33	67a

(1)Means followed by the same letter are not different by Tukey test at 5% probability.

Table 2. Variance analysis of pregnancy rate in a Brazilian lowland herd, at the 1995/96 breeding season.

Source(1)	Levels	DF	ChiSquare	P Value
Intercept		1	1.5313	0.2159
Body condition at beginning of season	1	1	0.0000	0.9997
	2	1	15.6548	0.0001
	3	1	25.9369	0.0001
	4	1	2.9356	0.0866
	5	-	-	-
Body condition at the end of season	1	1	0.0000	0.9999
	2	1	0.5288	0.4671
	3	1	1.3113	0.2522
	4	1	2.1334	0.1441
	5	-	-	-
Bull:cow ratio	1:10	1	0.0557	0.8134
	1:25	1	0.0513	0.8208
	1:40	-	-	-
Stocking rate (UA/ha)	0.30	1	0.0387	0.8441
	0.25	1	2.1051	0.1468
	0.28	1	0.1891	0.6637
	0.22	-	-	-
Animal breed	1	1	3.1102	0.0778
	2	0	-	-
Animal type	0	1	3.1208	0.0773
	1	-	-	-
Kind of breeding	I	1	5.1836	0.0228
	M	-	-	-
Weight gain (kg)	1994/95	1	1.6663	0.1968
Weight gain (kg)	1995/96	1	1.5736	0.2097
Animal age	-	1	0.0264	0.8710

(1)Animal breed 1: Nelore and 2: Pantaneira; animal type 0: heifers and 1: cow; kind of breeding group I: individual and M: multiple.

November to March, weaning at 6-7 months of age, stocking rates adjusted to pasture type, annual selection and culling of animals, annual andrological exam for bulls) could adopt the 1:40 bull:cow ratio immediately.

Probably the farmers in the Lowland region adopted empirically the 1:10 bull:cow ratio some time ago, due to the large pasture size of native pastures and to the lack of knowledge on the importance of andrological exams on bulls and female reproductive evaluations. This may have been coupled with a lack of qualified professionals to carry out these exams. At present time there are qualified professionals in the region who can carry out these techniques at reasonable prices (between US$ 2 and 6/andrological exam). The final price depends on the number of bulls examined and/or the number of days this professional stays on the property. The use of periodic reproductive examinations of this type would have considerable impact on reproductive indices.

Rupp et al. (1977) suggested that intensification of the management program, which reduces the breeding season to less than 50 days, might increase the pressure on bulls, exceeding their work limits in the natural breeding system. Pineda et al. (1997) suggested that the maximum number of cows for bulls of high reproductive performance is 80 for a short breeding season; higher numbers could be limiting fertilizing capacity, at least during the first weeks of the breeding season.

There was a significant difference ($P = 0.0228$) between the individual and multiple bull breeding systems, where using more than one bull, the pregnancy rate was higher. These data are particularly important for regions of extensive management, where large pasture areas with more than one bull are used. Rupp et al. (1977) showed that oestrus detection was equally good using bull:cow ratios of 1:25, 1:44 and 1:60, indicating that the number of bulls/paddock did not affect the ability of bulls to identify cows in oestrus. In single bull breeding systems, the number of heifers identified by the bull increased with the number actually in oestrus, whereas in multiple bull breeding systems, the number of oestrus' marked was related to the number of sexually active females. This also shows the benefit of multiple bull systems.

According to Pineda (1996), the utilization of a bull:cow ratio of 1:50, and artificial insemination programs, using semen of tested bulls in the multiplying herds, would reduce the need of young tested bulls per year by more than 50%, allowing increased investments in animals of superior genetic merit.

There was a significant differences ($P = 0.001$) in body condition scores at the beginning of the second breeding season (November 1995 to February 1996) (Table 2). Cows that showed excellent body condition at the beginning of the second breeding season were single cows that failed in the first breeding season. However, this difference ($P = 0.4671$) disappeared at the end of the second breeding season. This suggests that the cows which had poor body condition at the beginning of the breeding season showed improvement in this trait during the breeding season. There was no significant difference ($P = 0.1968$) in weight gain between treatments during both breeding seasons and therefore no difference in final weight of cows among treatments.

There was no significant effect in pregnancy rate ($P = 0.0773$) due to animal type, age ($P = 0.8710$) or breed ($P = 0.0778$) for the different treatments. Also, there was no significant effect ($P = 0.8441$) between stocking rates in this study, suggesting that, for the Brazilian lowland extensive conditions, a stocking rate similar to that used here (0.30 to 0.22 AU/ha) is appropriate for achieving acceptable pregnancy rates.

Economic evaluation

Considering a 1,000 cow farm, of mostly Nelore cattle, typical of the Brazilian lowlands, of mostly Nelore cattle, under usual conditions, 100 bulls are needed to obtain a 1:10 bull:cow ratio. According to the results obtained in this work, it is possible to reduce the ratio to 1:25 initially, corresponding to 40 bulls for the same number of cows (40% of the bulls), or further reducing the number of bulls, using a bull:cow ratio of 1:40, thereby demanding 25 bulls (25% of the present number). Considering the annual replacement rate of 20%, it is possible to estimate the production costs of the two management systems, using different bull:cow ratios.

For traditional management system (X) and bull:cow ratio of 1:10 (control), production cost would be: X = 100 x US$ 600 + [(20 x US$ 600 - 20 x US$ 252) x 5]; for proposed management system (Y) and bull: cow ratio of 1:25, production cost would be: Y = 40 x US$ 600 + [(8 x US$ 600 - 8 x US$ 252) x 5]; and for future management system (Z) and bull:cow ratio of 1:40, production cost would be: Z = 25 x US$ 600 + [5 x US$ 600 - 5 x US$ 252) x 5]. This calculation brought about the following results: X = 94,800 American dollars; Y = 37,920 American dollars and Z = 23,700 American dollars.

In this way, it would be possible to reduce the costs of the two management systems: X = US$ 94,800 during 5 years or 18,960/year; X-Y = US$ 56,880 during 5 years or US$ 11,376/year, and X-Z = US$ 71,100 during 5 years or US$ 14,220/year.

The economic projection was based on technical studies carried out in the beef cattle producing regions, to evaluate the impact of reducing the bull:cow ratio in the extensive production system used in the Brazilian lowland (Table 3).

Considering Brazilian's lowland weaning rate of 40% relative to the number of cows (Cadavid Garcia, 1981), the reduction in the total cost per calf born in each management systems would be:
X = 18,960 ÷ (1,000 cows x 40%) = US$ 47.40 per born calf/present cost;
X-Y = 11,376 ÷ (1,000 cows x 40%) = US$ 28.44 per born calf and
X-Z = 14,220 ÷ (1,000 cows x 40%) = US$ 35.55 per born calf.

The final calf cost, in an extensive management system, includes the following items: medical, feeding, labour, maternal, sire and land investment, buildings and other installations and depreciation as well as other costs. For simplification, as this is a complex value to calculate, microeconomic theory was used and the value included in the equation was the sale value of the calves. The sum of the nine components above used was US$ 100.00. The product sale value is exactly equal to its total production cost (perfect concurrent theory as stated above, Table 3).

Passing the bull:cow relation from 1:10 to 1:25, a reduction of 28.88% is reached in the mean cost of total calf production. If a 1:40 ratio is used this reduction may reach 35.55%.

Fonseca et al. (1991) observed total cost reduction of calf production of 15% or US$ 14.6/calf born, when increasing the bull:cow ratio from 1:25 to 1:40. Nevertheless, it should be noted that the savings observed above may be greater, as the model used (Fonseca et al., 1991) to determine costs did not take into consideration other inevitable expenses with bulls such as feeding, medication, unnecessary land use, risk of accident or death, depreciation and interest on invested capital.

Cadavid Garcia (1985) estimated that the Brazilian lowland had a cattle population of 3.8 million animals, of which 42% were reproductive females, and using natural breeding, with a bull:cow ratio of 1:12. Rosa & Melo (1995) estimated the annual need for bulls in the Brazilian lowland as 26,600 bulls/year, considering a mean rate of bull replacement of five years. Considering the above data, the mean price of a bull in the area (US$ 520.00, for a 500 kg animal) and the bull:cow ratio of 1:10, the cost with bull acquisition in this region would be about US$ 13,832,000.00 (26,600 bulls x US$ 520.00) per year. Using the same criteria, it is possible to estimate the cost of bull acquisition for different bull:cow ratios (Table 4). It is worth considering that

Table 3. Portion of final cost of calf, attributed to the bull, in three different bull:cow ratios.

Bull:cow ratio	Part of total calf cost originated in bull investment (Value US$/calf)	Percentage of final calf cost (%)
One bull to 10 cows (1:10)	47.40	47.40
One bull to 25 cows (1:25)	18.97	18.97
One bull to 40 cows (1:40)	11.85	11.86

Table 4. Estimates of cost reduction with the acquisition of Nelore bulls in the Brazilian lowland, considering different bull cow ratios (bull = US$ 520.00).

Bull:cow ratio	Annual need for bulls	Investment needed/year (US$)
1:10	31,920	16,598,400
1:25	12,768	6,639,360
1:40	7,980	4,149,600
1:50	6,384	3,196,680
1:60	5,320	2,766,400

the prices vary with the genetic merit of the bulls. The lowest value (US$ 520.00), obtained from local farmers, was used to avoid over-estimating the value paid for the bull. Based on the present findings, it was estimated that a reduction in bull:cow ratio from 1:10 to 1:25 and 1:40 would result in economy of about US$ 9.95 and US$ 12.45 million/year, respectively, due to reduction in acquisition of bulls. However, the farmer may also consider other gains, with the incorporation of this technology, such as cull value of bulls and feed costs.

Conclusion

1. It is possible to reduce bull:cow ratio in the lowland region without negatively influencing the fertility rate of the herd.

2. An andrological analysis on the bull semen and the duration of the breeding season are fundamental for the establishment of the new bull:cow ratio.

3. The incorporation of these recommendations in the extensive production system used in the lowlands may generate an economy of 28.88%, if moved from 1:10 to 1:25 bull:cow ratio, or 35.55%, if changed to a 1:40 ratio.

Acknowledgements

To Drs. Maria Luiza F. Nicodemo and Concepta McManus Pimentel for English translation and review.

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