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Research Article

Protein-Energy Supplementation for Different Categories of Animals in Beef Cattle on Natural and Cultivated Pastures of the Brazilian Pantanal

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Abstract

The goal of this study was to evaluate the effect of protein-energy supplementation during the dry period on the performance of different categories of beef cattle in different management systems of natural and cultivated pastures in the Brazilian Pantanal. Different categories of animals (weaned calves, heifers, primiparous and multiparous cows) were stratified by weight and distributed in one of the following feeding treatments: T1 - natural pasture (grazed), with liquid supplementation (control); T2 - natural pasture (deferred grazing), with liquid supplementation; T3 - cultivated pasture (deferred grazing), with liquid supplementation, from June to September 2006. A continuous stocking method was adopted (0.3, 0.6 and 0.6 of Animal Unit per hectare (AU/ha) for T1, T2 and T3, respectively). Forage availability and quality, supplement intake by livestock, animal performance and ingestive behavior were evaluated over two periods, totaling 90 days of evaluation. Analysis of variance showed differences between initial weight and finished weight in each period between different feeding treatments and animal categories. Animal weight gains were observed during the initial period (mid-season drought), when 440 to 2.800 kg DM forage/ha was available, while weight losses were observed in the final period (late-season drought) when 580 to 800 kg DM forage/ha was available. In the late-season drought, T3 allowed less weight loss among the categories. Primiparous and multiparous cows lost more weight and these higher losses may be related to the higher demand for dry matter intake these categories require. Considering forage offer as the limiting factor during the second period, we concluded that protein-energy supplementation is viable only when the stocking rate is adjusted according to availability of forage.

Keywords: Calf rearing phase; Deferred grazing; Forage offer; Grazing behavior

Introduction

One of the main challenges to achieving sustainability in beef cattle production in tropical rangeland is to promote the correct management of pastures and to define appropriate feeding supplementation strategies for specific or natural pasture grazing systems.

The Pantanal is the largest tropical continental wetland area of the world composed of heterogeneous landscape of seasonally flooded grassland, savannah and forests. The existence of large natural pasture areas favored cattle ranching with low-input feed. However, the availability and quality of native pastures depend on the proportion of the existing landscapes (spatial variation), as well as the climatic conditions (temporal variation), especially the distribution of rainfall intensity during the year [1]. As in the other tropical regions, the Pantanal presents a highlighted seasonality in the quantity and quality of pastures during the year, with periods of food restriction in the drought but, depending on the location of the ranch and the intensity of the rainfall, food restriction may also occur during the flooding period [2].

In traditional extensive beef cattle production systems, little attention has been given to animal nutrition during calving, conception and weaning periods. To meet the most demanding animal categories, one of the management strategies adopted by ranchers has been the replacement of low quality native forages by exotic forages, especially those of the genus *Urochloa* and species of African origin [3], which are usually deferred for use in the dry season.

Among pasture management practices, deferral of pastures during or at the end of the rainy season may be a strategy to increase forage availability for the dry season. This practice was recommended for pasture with stoloniferous and decumbent growth habits [4]. Among native forage species, *Mesosetum chaseae* is an alternative grass to exotic species for storing forage in the field for the dry season [5]. In general, deferred pastures have poorer quality, which is a limiting factor for animal performance, and it is therefore necessary to provide supplementary feed [6].

This study aims to evaluate the effect of the liquid protein/energy supplementation on the performance of different categories of beef cattle grazed on natural pastures (deferred or not) and exotic pasture

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Table 1: Landscape unit area, total area and available pasture area for the three feeding management treatments.

Landscapes	T1 - natural pasture not deferred with liquid supplementation	T2 - deferred natural pasture with liquid supplementation	T3 - deferred exotic/native pasture with liquid supplementation
Woodland (ha)	32.21	0.06	9.97
Savanna (ha)	59.84	11.41	31.49
Flooding open grassland/*Urochloa* spp. (ha)	79.95	40.55	33.99
Wetland (ha)	8.69	0.39	5.42
Water bodies perennial water bodies (ha)	2.44	0.01	2.05
Total area (ha)	183.12	52.42	82.93
Available pasture* (ha)	88.64	40.94	67.53

*Grazing areas.

Table 2: Analysis of variance for weight difference of periods 1 and 2[1] in grazing beef cattle submitted to different feeding management systems in the Pantanal.

Source of variation	DF	Mean square		F value		P value	
		DP1	DP2	DP1	DP2	DP1	DP2
Categories (C)	3	4263.5	1821.6	32.7	25.3	0.0001**	0.0001**
Treatments (T)	2	2591.4	331.8	18.8	4.6	0.0001**	0.0111*
CxT	6	147.9	39.4	1.1	0.6	0.3807^{ns}	0.7731^{ns}

**P(<0.01); *P(<0.05); ns: not significant (P>0.05).

Period 1 = 07/06/2006 to 21/07/2006 (DP1 = difference between weight at end of first period and initial weight); Period2 = 22/07/2006 to 6/09/2006 (DP2 = difference between weight at the end of the second period and end of the first).

(deferred) during the dry season in the Brazilian Pantanal.

Methodology

The study was conducted at Nhumirim ranch (18°59'0"S, 56°39'0"W), a research station located in the Nhecolândia sub-region of the Brazilian Pantanal, from June to September 2006.

The experiment comprised three feeding treatments (three management units), four animal categories (multiparous cows, primiparous cows, yearling heifers and weaned calves) and two periods (mid- and late-season drought).This work was performed following the ethical standards required by Brazilian legislation.

The feeding management treatments were: T1 = natural pasture dominated by *Mesosetum chasae* without deferred with liquid supplementation; T2 = deferred natural pasture dominated by *M. chasae* with liquid supplementation; and T3 = deferred exotic/ native pasture dominated by *Urochloa humidicola* with liquid supplementation. In T2 and T3 the pastures were deferred in the end of January 2006 with deferral period of four months.

The pastures were mapped using CBERS satellite images according to Rodela et al. [7]. The main landscape units Figure 1 were classified according to their degree of flooding: woodland (non-inundated area), savanna (non-inundated area) and flooded open grassland/*Urochloa* spp. (may be flooded for up to six months), wet grassland (perennial) and water bodies (perennial). These landscapes types are characteristic of the Nhecolândia sub-region Photo 1.

At the beginning of June 2006, 224 Nellore cattle of different categories (weaned calves - n = 82, yearling heifers - n = 48, primiparous cows - n = 62 and multiparous cows - n = 32) were grouped by weight and distributed into the three feeding management treatments (T1, T2, T3). Available pasture constituted the main areas used to graze by cattle in each feeding management treatment Table 1.

Cattle were randomly divided into the three treatments as a function of category, body condition score and weight. The grazing system adopted was continuous stocking with fixed stocking rate estimated as a function of the total area of the management unit, which is the method usually adopted in the region. The stocking rate was expressed as Animal Unit/ha (AU/ha). In T1, the traditional stocking rate used in the region (0.3AU/ha) was adopted, totaling 60 AU; and in T2 and T3 (deferred pastures), the stocking rate was doubled by adopting 0.6AU/ha, considering the total area of the management unit, totaling 35 and 54 AU for T2 and T3, respectively. Each AU corresponded to a 350kg "Pantaneira" cow according to Santos et al. [8].

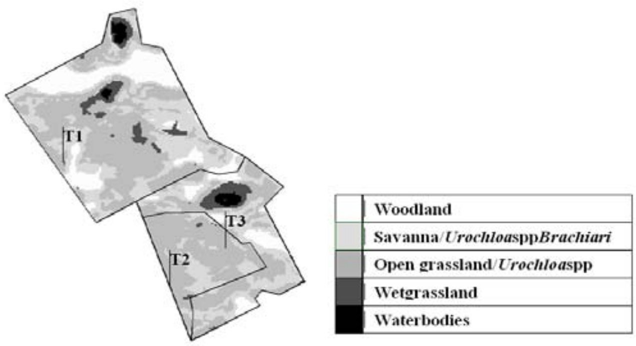

Figure 1: Thematic map of the pastures classified in relation to their degree of flooding and landscape (Brazilian Pantanal).

Each management unit (Treatment) was equipped with two covered troughs to supply liquid supplementation, at two heights (the lower for calves), about 50m from each other. Liquid supplementation (Anipro do Brasil, Campo Grande, MS, Brazil) consisted of 25% crude protein (3.6% non-protein nitrogen), 50% Total Digestible Nutrients (TDN) and 938mg/kg macrominerals and 200mg/kg vitamins.

Liquid supplement offered followed the manufacturer's recommendations and it was based on an estimated daily intake of 0.1% body weight and was provided so that the trough was replenished every three days. The calculations of intake were made from the difference between the weight of supplement supplied and the weight left over in the trough. The animals were weighed at the commencement of the study, 45 days (period 1 - mid-season drought) and 90 days after commencement (period 2 - late-season drought), for a total of two experimental periods and three measures. Experimental animals were identified by colored numbers on their side.

Measures of time spent grazing, ruminating, displacement; leisure and consuming supplement were performed by direct visual observation. In July (period 1) and September 2006 (period 2), the animals present in each feeding treatment were followed from 0600 to 1800 (12 h) for three consecutive days of each treatment in period 1 and once in period 2. Continuous grazing time, rumination time, trough time, movement and rest times were all sampled visually. Within this behavioral analysis, two shifts were considered: morning (0600 to 1200) and afternoon (1201 to 1800), considering the behavior of the herd as a whole, where each activity was noted when it was performed by more than 50% of the animals. The individual behavior of the supplement use in the trough during the day was also observed using scan sampling, which consisted of noting every minute the number of animals that had their heads inside the trough (consuming the supplement).

With these records, it was possible to estimate the time spent in the trough per animal (minutes/day/animal), considering both shifts (morning and afternoon). To evaluate the bite rate (bites/minute) and search time (time in minutes searching for grazing sites), in June 2006, a focal animal from each category (cow - multiparous or primiparous, heifer and calf) was selected for each treatment. Every 10 minutes, one animal category was observed and its bites counted using a chronometer and its time searching for another grazing site evaluated. The registration was made by two observers, one of whom made the visual recording of the bite rate (number of bites/min) according to Forbes [9] and the other the daily grazing time (grazing with head position down).

Available forage mass was estimated in each treatment on the main grazing sites according to Santos et al. [1], using $10\times0.25m^2$ square quadrats, randomly allocated before the beginning of the experiment (June 2006) and at the end of the experiment in August 2006. Samples simulating the grazing habit were collected from each treatment to evaluate the quality of the diet selected by cattle. These samples were dried in a forced air circulation oven at 55-60ºC for 72 hours for subsequent dry matter determination and bromatological analysis. Crude Protein (CP) was determined by 6.25×total N from the Kjeldahl method adapted by Galvani and Gaertner [10], Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF) and lignin by the sequential method, according to Goering and Van Soest [11]. *In Vitro* Organic Matter Digestibility (IVOMD) was determined by technique described by Tilley and Terry [12]. Following the calculation of Total Digestible Nutrients (TDN) = 83.79 - 0.4171 x NDF [13], the TDN:CP ratio for the different pastures was estimated.

Herbage Allowance (HA) was determined above ground level in each sampling period, considering the stocking rate per total area (usually adopted) and available pasture area Table 1. For the calculation of the available pasture area, only open grassland and wetland were considered, removing from the calculation the forested and savanna areas of the T1 and T2. Savanna areas of T3 that were replaced with *Urochloa* spp. were considered in the calculation. Herbage allowance did not take forage accumulation into account because there is a low growth of pastures in the region during the dry season. HA was calculated as the ratio of estimated forage mass in each 45-day period to the fixed stocking rate for total and available area, as follows: HA = (available forage mass x 100 x 1ha)/(45 days x stocking rate).

The animals were divided into four categories (MC: Multiparous Cows; PC: Primiparous Cows; YH: Yearling Heifers; C: Calves) to constitute the sample units within each treatment (management unit). Data were analyzed in both periods, using the differences between animal weights (weight at end of period - weight at beginning of period) as response variables. With these variables the following linear model was adjusted:

$$y_{ij} = \mu + \alpha_i + \beta_j + \alpha\beta_{ij} + \varepsilon_{ij} \quad i = 1,2,3 \quad j = 1,2,3,4 \qquad (1)$$

where *yij*: Response variables, μ: General average, α_i: Effect of the feeding treatment i, β_j: Effect of the animal category j, $\alpha\beta_{ij}$: Effect of the interaction feeding treatment i and animal category j; and ε_{ij}: Experimental error with normal distribution with zero mean and constant variance.

Individual behavior was evaluated by trough time (minutes/day) and supplement intake by the total herd, using the same previous model, where the response variables were trough time and average supplement intake by the herd, respectively. All analyzes were performed using SAS [14]. In the univariate analysis of individual behavior, the difference in the trough time between the two periods was considered as a response. Subsequently, a bivariate analysis was performed and a non-significant correlation of 0.11 was found.

The same model (1) with bivariate response was used, where the y response was defined by intake (minutes/day in the trough) in both periods and the effects of feeding treatment, category and interaction were considered bivariate vectors. The experimental error component presents bivariate normal distribution with null mean vector and a constant variance-covariance matrix for each combination of treatment and animal categories.

Results and Discussion

In the analysis of variance for the initial and final weight difference for the different categories of animals (weaned calves, yearling heifers, primiparous cows and multiparous cows) submitted to three feeding management treatments during two periods there was no significant interaction between categories and treatment for both periods evaluated (P>0.05; Table 2).

During mid-season drought (Period 1), the mean weight differences from the end of the period to the beginning are all positive, indicating significant weight gain for all categories and treatments evaluated. However, in late-season drought (Period 2) all averages were negative, indicating weight reduction during Period 2 Table 3.

It was observed that animals in the most demanding categories (multiparous and primiparous cows) in terms of dry matter intake, lost more weight in the late-season drought period (Period 2). It is

Table 3: Cattle weight (kg/animal) differences according to feeding treatments and animal categories.

	Period 1 - mid-season drought						
	FeedingTreatments[3]			Animal Categories[4]			
	T1	T2	T3	MC	PC	YH	C
Weight difference[1]	22.0	26.5	33.9	32.9	33.9	27.1	15.9
	Period 2 - late-season drought						
	FeedingTreatments			Animal Categories			
	T1	T2	T3	MC	PC	YH	C
Weight difference[2]	-7.5	-8.9	-4.4	-13.9	-10.2	-2.5	-1.2

[1]Weight difference from end of period 1 to start of experiment; [2]Weight difference from end of period 2 to end of period 1; [3]T1 = natural pasture with dominance of *M. chasae* without deferred with liquid supplementation; T2 = deferred natural pasture with dominance of *M. chasae* with liquid supplementation and T3 = deferred exotic/native pasture with dominance of *Urochloa humidicola* with liquid supplementation.; [4]MC: Multiparous Cows; PC: Primiparous Cows; YH: Yearling Heifers; C: Calves.

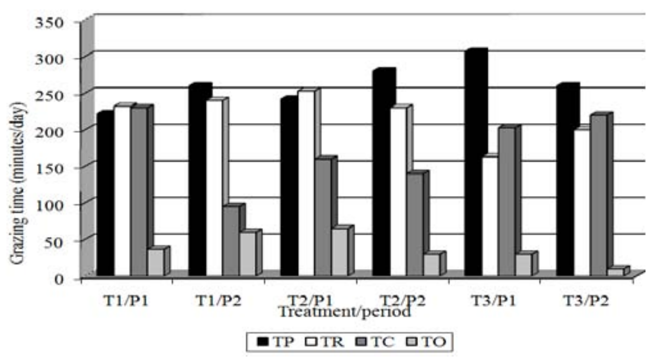

Figure 2: Grazing Time (TP); Rumination Time (TR); Trough Time (TC) and Other activities Time (TO) in minutes from 0600 to 1800 h in beef cattle in Period 1 (P1) and Period 2 (P2), 2006. T1: Non-deferred natural pasture dominated by *M. chasae* with liquid supplementation; T2: Deferred natural pasture dominated by *M. chasae* with liquid supplementation; T3: Deferred exotic/native pasture dominated by *U. humidicola* with liquid supplementation.

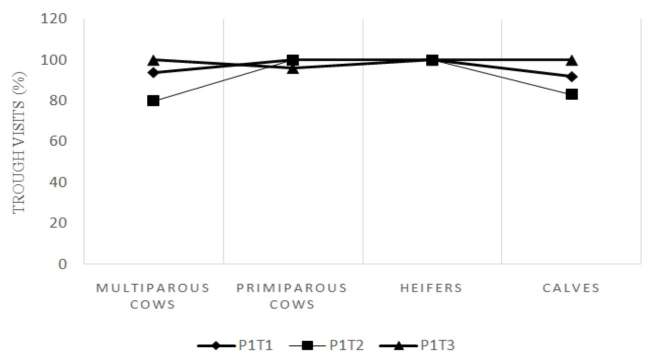

Figure 3: Percentage of visits to the trough at least once during three consecutive days individual animals in different categories and feeding treatments, in June 2006 (mid-season drought period = P1). (T1 = non-deferred natural pasture dominated by *M. chasae* with liquid supplementation; T2 = deferred natural pasture dominated by *M. chasae* with liquid supplementation; T3 = deferred exotic/native pasture dominated by *U. humidicola* with liquid supplementation).

assumed that one of the limiting factors of weight gain during the late-season drought period was the lower forage supply in all treatments, mainly in T1 and T2 Table 4, associated with decreased quality of available pasture Table 5. Table 6 shows the means and standard deviation of the weights of the different categories of animals in the different periods of the experiment.

Table 4: Forage Mass (FM, kg DM/ha), *herbage Allowance* by Total area (HAT) and available pasture (HAA) in different feeding treatments during period 1 (June) and period 2 (August) in 2006.

Treatment	Period 1			Period 2		
	FM	HAT	HAA	FM	HAT	HAA
T1	440.00	9.3%	4.0%	580.00	12.2%	5.3%
T2	1.900.00	20.1%	15.1%	450.00	4.8%	3.6%
T3	2.800.00	29.6%	25.4%	880.00	9.3%	8.0%

T1 = non-deferred natural pasture dominated by *M. chasae* with liquid supplementation; T2 = deferred natural pasture dominated by *M. chasae* with liquid supplementation and T3 = deferred exotic/native pasture dominated by *U. humidicola* with liquid supplementation.

Photo: Aerial view of the Nhecolândia sub-region, Pantanal.

There were forage mass reductions of 76.3% and 68.6% for T2 and T3, respectively, in the late-season drought period compared to the mid-season drought period, both of these being deferred grazing treatments. The greatest animal weight loss occurred in T2, whose herbage allowance (total and available) was low, with values around 4%. Neves et al. [15] evaluated four fixed herbage allowances (4%, 8%, 12% and 16%) and three variable herbage allowances (8-12%; 12-8% and 16-12%) during the year on the performance of primiparous cows grazing native pastures in the south of Brazil and found that a HA of 4% should not be adopted due to the poor performance and death of cattle submitted to this treatment. The other HA studied provided satisfactory reproductive performance for 28-month-old heifers. Similarly, Soares et al. [16] evaluated different combinations of HA on two years old steers and verified that HA between 8% and 12% during the winter (dry period) provide positive weight gains. Therefore, the majority of the HA available during the late-season drought period in the present study were below the values considered adequate. If the HA had been adjusted for the 90-day grazing period (duration of the experiment), preferably using the proportion of landscapes used for grazing in the calculation, it is assumed that the performance results would be better. According to Nabinger [17], the maximum animal consumption occurs when forage availability is between 10% and 13% of their live weight in dry matter (HA).Therefore, the deferred cultivated pastures presented HA values of 8% in late-season drought period, values that were close to those considered adequate, but there was no satisfactory animal performance in any treatment.

Table 5: Mean values for Crude Protein (CP), Acid Detergent Fiber (ADF), Lignin (LIG), Neutral Detergent Fiber (NDF), IVDMD (*in vitro* dry matter digestibility) and ratio TDN[1]:CP for total and selective pasture of different feeding treatments[2] and periods[3] in Brazilian Pantanal.

	CP (%)		ADF (%)		LIG (%)		NDF (%)		IVDMD (%)		TDN:CP	
	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2
T1 total	5.8	4.9	37.8	34.1	8.4	5.8	73.2	73.2	58.0	58.2	9.4	11.2
T1 sel.	11.0	7.8	35.9	29.9	4.0	4.8	66.3	66.3	71.0	62.7	5.3	7.5
T2 total	3.7	3.6	33.9	34.2	4.1	6.0	71.5	71.5	60.1	56.8	14.8	15.2
T2 sel.	6.1	4.1	32.5	33.2	3.2	3.8	66.2	66.2	65.8	58.6	8.9	13.2
T3 total	3.3	3.0	37.0	41.0	3.9	7.6	72.9	72.9	-	-	15.4	16.9
T3 sel.	5.3	4.6	32.5	35.9	-	-	68.1	68.1	-	-	9.8	11.3

[1]Total Digestible Nutrient (TDN) = 83.79-(0.4171xFDN%); [2]Treatments (T1 = non-deferred natural pasture dominated by *M. chasae* with liquid supplementation; T2 = deferred natural pasture dominated by *M. chasae* with liquid supplementation and T3 = deferred exotic/native pasture dominated by *U. humidicola* with liquid supplementation; Total = total pasture available in the area; sel. = pasture selected by animals); [3]Period 1 (P1) = 07/06/2006 to 21/07/2006; Period 2 (P2) = 22/07/2006 to 6/09/2006.

Table 6: Average Body Weight (BW) and Body Condition Score (BCS) for cattle of different categories according to time of year and type of pasture in the Pantanal.

	T1				T2				T3			
	MC	PC	YH	C	MC	PC	NS	B	MC	PC	YH	C
Start												
BW	350.0	274.0	211.0	146.0	330.0	299.0	211.0	147.0	368.0	274.0	205.0	146.0
BCS	5.5	5.5	5.0	5.0	4.0	5.5	5.0	5.0	5.0	5.0	5.0	5.0
End P1												
BW	383.0	304.0	229.0	153.0	333.0	331.0	243.0	163.0	407.0	317.0	234.0	170.0
BCS	6.0	6.0	5.0	5.0	4.0	6,0	5.5	5.5	5.5	5.5	5.5	5.5
End P2												
BW	366.0	294.0	227.0	155.0	343.0	318.0	239.0	161.0	397.0	311.0	236.0	168.0
BCS	5.5	5.5	5.0	5.0	4.0	6.0	5.5	5.5	5.0	5.5	5.5	5.5

MC: Multiparous Cows; PC: Primiparous Cows; YH: Yearling Heifers; C: Calves

Comparing the types of forage samples collected (total and selective), those that simulated grazing (selected by animals) presented higher nutritional value (higher CP content and lower ADF, LIG and NDF contents, higher IVOMD coefficient and lower TDN:CP ratio) Table 4. Regarding the periods, it can be observed that in the mid-season drought period the quality of forages was higher than in the late-season drought period, results justified by the maturation of the dominant tropical forages during the end of the drought and lower possibility of diet selection.

In T1, where continuous grazing management was used, the pasture supply was relatively low and remained similar during both experimental periods. Total pasture availability increased in the second period, probably due to the accumulation of grazed and ungrazed dead matter with low nutritional value Table 4. However, this increase in availability was insufficient to prevent weight loss of animals as it was unable to meet the maintenance needs of the animals. T1 animals did not lose weight in the first period Table 3, probably because the animals selected the best quality diet in terms of CP Table 5. However, due to the low forage supply, these animals had the lowest performance in the first period compared to the other treatments Table 3. Catto et al. [18] evaluated the use of a similar liquid protein/energy supplement for calving beef cows grazing on native pastures in the same sub-region under continuous grazing management compared to native pastures supplemented only with mineral salt and protein/energy supplement at the end of pregnancy and early lactation, finding no effect on pregnancy rate and weight gain. These results indicate that the positive animal response to net supplementation in terms of weight gain and fertility is dependent upon adequate availability of pasture dry matter.

In general, natural pastures used for grazing had low lawn height; the bite size of the animals was reduced, which consequently affected the intake rate, which in turn is the product of bite size, bite weight, and grazing time. Bite size is the main determinant of intake and other variables are compensatory [19]. However, several studies have not indicated evidence of the compensation function. It was observed in this study Figure 2, that the average grazing time of the herd in T1 (deferred native pasture) was below the other treatments, which probably led to lower than desired consumption, with consequent greater weight loss. According to Erlinger et al. [19], there are animals that maximize the bite size and minimize grazing time, consequently reducing grazing energy expenditure, a feature that should be considered in a selection program. For T1 (non-deferred native pasture) and in July mid-season drought period (Period 1), the longest trough time was observed Figure 2. This fact may be due to the exploratory behavior of the animals, given that the average intake of supplement was lower in T1 than the other treatments and did not differ between periods Table 7.

As a rule, supplement consumption is not uniform across animals and categories. It was observed in the present study that most animal categories visited the trough in the treatments at least once over three

Table 7: Analysis of variance of time spent at the trough of different categories of beef cattle in the mid-season drought (P1) and late-season drought (P2) periods.

Source of variation	DF	Mean square		F value		P value	
		P1	P2	P1	P2	P1	P2
Categories (C)	3	5.44	61.49	0.77	5.17	0.5136ns	0.0018**
Treatment (T)	2	74.11	103.57	10.44	8.7	0.0001**	0.0002**
CxT	6	31.19	11.18	4.39	0.94	0.0003**	0.4673ns

**: (P<0.01); *: (P<0.05); ns: not significant
Mid-season drought period (P1) = 07/06/2006 to 21/07/2006
Late-season drought period (P2) = 22/07/2006 to 6/09/2006

Table 8: Liquid supplement intake (g/day/AU) by cattle as a function of different periods[1] and treatments.

	T1: Natural pasture (non-deferred)	T2: Natural pasture (deferred)	T3: Exotic pasture (deferred)
Mid-season drought period (Period 1)	401.0±101.0^{bA}	738.0±316.0^{aA}	805.0±136.0^{aA}
Late-season drought period (Period 2)	397.0±87.0^{bA}	591.0± 54.0^{aB}	666.0±115.0^{aB}

Means followed by different *lowercase letters*in *rows* and uppercase *letters* in *columns differ* by the *Tukey test* (P ≤ 0.05). [1]Period 1 = 07/06/2006 to 21/07/2006; Period 2 = 22/07/2006 to 6/09/2006.

consecutive days of observation Figure 3. It was also found that the use of two close troughs in the same management unit probably led to a better distribution of consumption among the animal categories, reducing the effects of dominance and competition. According Bowman and Sowell [20], high competition generally increases the proportion of animals that do not consume the supplement, while low competition provides variation in supplement intake.

Figure 3 shows that the frequency of visits to the trough of multiparous cows and calves was lower in the deferred native pasture (T2) than those kept in the deferred cultivated pasture (T3). The time spent at the trough by the animals was evaluated by univariate analysis of the individual time spent at the trough in mid-season drought and late-season drought periods Table 7. There was significant interaction between treatment and animal categories in Period 1 (P<0.01), evidencing that the difference depends on nutritional management and animal category.

Bivariate analysis showed that the analyses of the two periods are independent; therefore, the analysis of variance was performed for each period separately Table 7. In this analysis, the interaction between treatment and categories was significant only for mid-season drought period (Period 1; P<0.01). For late-season drought period (Period 2), significant differences were observed for animal category and feeding treatment (P<0.01), but not their interaction (P>0.05). Earley et al. [21] observed cows and calves in pasture, verifying that they spent 46% and 16% of their time, respectively, consuming supplements and significantly affecting the time spent for consumption

All animal categories spent a longer time in the trough during T2 (deferred natural pasture during the late-season drought period). In T2, analysis of variance on the consumption of supplement of the total herd was significant for feeding treatment and animal categories (P<0.001), but there was no significant interaction between feeding treatment and animal categories (P>0.05).

The supplement intake by animal unit as a function of the treatment and period Table 8 was reduced in the late-season drought period for T2 and T3 (treatments with deferred pastures), both of which had higher supplement intakes than T1 (non-deferred pasture treatment) (P<0.05). This fact is probably related to the decrease in forage supply in the second period, which was not observed in T1 where native pasture was not deferred. Rezende et al. [22] evaluated the effect of supplements based on Non-Protein Nitrogen (NPN) on the consumption of protein supplements of grazing cattle during two periods with dry matter constant and observed that it was also constant in both periods.

The use of supplementation in pasture can produce two effects (additive and substitution), being mainly determined by the quality of the forage (Euclides and Medeiros). The T2 and T3 treatments (deferred native and cultivated pastures) presented very low crude protein content in this experiment. Although the selected diet had relatively higher levels, it was below 6-7% in the late-season drought period, a minimum level that, according to Minson [23], is required by rumen microorganisms for effective fermentation. The TDN:CP ratio can be used as an indicator of adequacy of the amount of Nitrogen (N) in the diet. According to Moore et al. [24], when the ratio is greater than 7 (signifying an N deficiency in relation to energy in the diet) forage intake increases, but when the ratio is less than 7 (signifying an adequate N content in the diet) forage intake decreases. It was observed in this work that the deferred native and cultivated pastures had selected diets with ratios above 10 in both periods Table 5. The TDN:CP values closest to the appropriate were obtained for T1 (native pasture under traditional management) Table 5. Generally, when the supplementation is combined with low quality pastures, as in the case of deferred pastures where consumption is low, the effect of supplementation is usually additive or synergistic, since the amounts ingested are small and corrections of deficiencies render the highest [25]. In this study, the grazing time was longer in T2 and T3 (deferred pastures) compared to T1. However, the average time in all treatments was lower Figure 2 than that observed by Santos et al. [26] in a study with cattle grazing native pastures without supplementation in the same region of the Brazilian Pantanal, which was approximately 400 minutes daily considering at the same time of year as the present study. This reduction may have been compensated in the treatment with deferred pasture treatments by increasing trough and rumination times once idleness or other activities remained low. In the treatment with deferred native pasture (T3), where there was less availability of DM and pasture supply, the animals increased grazing time and reduced other activities even with more energy and losing more weight Table 6, Figure 2.

It was evidenced in this study that although the pastures were deferred, the stocking rate adopted was above the recommended in terms of Dry Mass (DM) of available pasture, preventing the animals had from an adequate supplement intake across the entire experimental period, mainly those in the treatment with deferred native pasture (T3). As the animals were gaining weight in the first experimental period (mid-season drought), protein-energy supplementation probably stimulated the highest dry matter intake of native and cultivated pastures. Even though there was no accumulation rate of DM measured during the study period, it would still be considered appropriate to reduce the stocking rate to maintain the same forage supply during the late-season drought period. As this did not occur, there was a reduction in the performance of the animals in the late-season drought period in all feeding treatments, regardless of animal category.

Conclusion and Recommendations

These results indicate that cattle reared on pastures during the dry season in the Brazilian Pantanal, supplemented with non-protein nitrogen in liquid form is only feasible when the stocking rate is adjusted so that the available forage supply and quality are sufficient for the animals to gain weight. The use of liquid non-protein nitrogen supplement combined with deferred exotic pasture at the end of the wet season in the Brazilian Pantanal can favor beef cattle performance during the dry season. It can be concluded that in a continuous grazing system (non-deferred) on natural pastures of the Brazilian Pantanal, when there is low herbage allowance, protein-energy supplementation is not justified, especially when the selected diet has a high protein content.

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