



## Performance of steers supplemented with mineral mixtures in the State of Mato Grosso

Euclides Reuter de Oliveira<sup>1</sup>, Paulo César de Aguiar Paiva<sup>2</sup>, José Libêncio Babilônia<sup>3</sup>, Andréa Maria de Araújo Gabriel<sup>1</sup>, Flávio Pinto Monção<sup>4\*</sup> and Felipe de Almeida Nascimento<sup>1</sup>

<sup>1</sup>Faculdade de Ciências Agrárias, Universidade Federal da Grande Dourados, Dourados, Mato Grosso do Sul, Brazil. <sup>2</sup>Departamento de Zootecnia, Universidade Federal de Lavras, Lavras, Minas Gerais, Brazil. <sup>3</sup>Centro Federal de Educação Tecnológica de Mato Grosso, Cuiabá, Mato Grosso, Brazil. <sup>4</sup>Programa de Pós-graduação em Zootecnia, Universidade Estadual Paulista "Júlio de Mesquita Filho", Via de Acesso Prof. Paulo Donato Castellane, s/n, 14884-900, Jaboticabal, São Paulo, Brazil. \*Author for correspondence. E-mail: moncaomoncao@yahoo.com.br

**ABSTRACT.** The present study evaluated the effects of supplements on the productive performance and economical parameters of beef steers on pastures during the dry season. Twenty-four castrated steers with average age and weight of eighteen months and 269 kg, respectively, were evaluated in the following treatments: pasture without minerals (P); pasture and mineral salt (PMS) and pasture and mineral salt plus urea (PMSU). The chemical composition showed low contents of crude protein and high values of neutral and acid detergent fiber for forages sampled in the form of complete collection compared with the grazing simulation technique. The supplementation with mineral salt plus urea led to a higher average daily gain ( $p < 0.05$ ) than the animals on pasture without mineral. However, when the average daily gain was expressed per metabolic weight, the supplementation with mineral salt plus urea was superior ( $p < 0.05$ ). The supplementation of animals on pasture proved economically profitable, and the use of mineral salt with urea in the dry season enables a better performance at viable costs.

**Keywords:** cattle, economic evaluation, production, urea.

## Desempenho de novilhos suplementados com misturas minerais na região de Mato Grosso

**RESUMO.** O presente experimento foi conduzido com o objetivo de avaliar o efeito de suplementações sobre o desempenho produtivo e parâmetros econômicos de novilhos de corte, em fase de recria, manejados em pastagens durante a época da seca. Foram utilizados 24 novilhos castrados, com idade e peso médios de 18 meses e de 269 kg, respectivamente. Foram avaliados os seguintes tratamentos: pastagem sem minerais (P); pastagem e sal mineralizado (PSM) e pastagem e sal mineralizado mais ureia (PSMU). A composição bromatológica caracterizou-se por baixos conteúdos de proteína bruta e altos valores de fibra em detergente neutro e fibra em detergente ácido para forragens amostradas na forma de coleta completa comparada com a técnica de simulação de pastejo. Os animais sob os tratamentos com suplementação mineralizada mais ureia apresentaram ganhos de peso diários médios superiores ( $p < 0,05$ ) ao daquele submetido apenas à pastagem. No entanto, quando o peso médio foi expresso em peso metabólico apenas o tratamento com ureia apresentou superioridade nos dados ( $p < 0,05$ ). A suplementação de animais em pastejo mostrou-se uma técnica economicamente rentável, sendo que a utilização de sal mineralizado com ureia no período seco possibilita melhor desempenho a custos viáveis.

**Palavras-chave:** bovinos, avaliação econômica, produção, ureia.

### Introduction

The beef cattle production in Brazil is being prompted to efficiently and continuously produce good quality and low cost meat throughout the year. With the economic globalization and the emergence of new markets, major changes occurred in several segments of agribusiness (FREITAS et al., 2011).

In this context arises the need to verify not only alternative and innovative technologies that are consistent with the new requirements, but also to reassess some technologies compatible with this

modern vision, because the livestock farming tends to be a business sector, moving away the extractive model and approaching to the total intensification (MURTA et al., 2008).

These systems have to be competitive, sustainable and capable of producing animals for slaughter before 42 months of age which is the national average (EUCLIDES et al., 1990).

According to Koenig et al. (2013) the growing phase brings together a large group of bovine animals, followed by the suckling and finishing phases and is a very important period for animals in

terms of nutritional requirement. Moreover, the growing phase retains cattle for a long period (between 12 and 36 months), so as to constitute 58.3% of the production cycle, followed by the suckling (16.7%) and finishing (25.0%) phases, possibly due to the low nutritional value of pastures to which these animals are subjected to. Since the herd is composed of large number of animals and the duration of the growing phase is prolonged, there is a negative contribution of this phase to the efficiency of the production process as a whole.

The supply and quality of pastures are influenced by the species, cultivar, chemical and physical properties of soil, climatic conditions, physiological age and by the management to which it is subjected to. The best efficiency of utilization of forage can only be achieved by understanding the interaction of these factors (SILVA et al., 2009).

One of the strategies to overcome the shortage of forage in the dry season is the deferment of grazing, preventing the access of animals to certain areas in the rainy season, allowing accumulating material for use in the dry season (SANTOS et al., 2010). With an increase in forage availability per animal, selective grazing is allowed, and the quality of the ingested material becomes superior to that of previously available material (VALENTE et al., 2011). In this sense, the animal does not undergo food restriction, grazes selectively and gets maximum forage intake, since consumption is influenced by supply - availability - and by the quality of forage (GOMIDE et al., 2001).

In the dry season, grasslands in general, are mature and contain low levels of nutrients, especially protein and the presence of nitrogenous elements in the rumen (rumen degradable protein (RDP)), which is probably the nutrient with the highest priority to meet the normal growth of rumen microorganisms (FIGUEIREDO et al., 2008). The use of urea can be an alternative to meet the protein requirements of cattle and at the same time reduce the cost of this nutrient.

Associated with this protein source for a better use of pasture, Sales et al. (2008) suggests the use of mineral mixture, which consists of formulations that provide macro- and microminerals, which can be added of urea, growth promoters, vitamins, among others. As a result, increased ruminal microbial growth and fermentation efficiency directly affect the increased digestibility, consumption of forage and animal performance, at affordable costs to the cattle breeder.

Given the above, this study aimed to verify the effects of mineral supplements on the production and economic parameters of beef steers in the growing phase, managed on pasture during the dry season.

## Material and methods

The experiment was conducted on the facilities of the Federal Agrotechnical School of Cuiabá, State of Mato Grosso, Brazil, between July and November 2001.

The experimental area was composed of three paddocks of ten hectares each, made up of signal grass (*Brachiaria decumbens* Stapf), palisade grass (*Brachiaria brizantha* Hochst. Stapf) and Tanzania grass (*Panicum maximum* Jacq), equipped with covered feeder and drinker. For the pasture deferment, it was previously grazed, fertilized and later fenced in April 2001.

Two alternatives of supplementation (PSM and PSMU) were evaluated, compared to a control group maintained exclusively on pasture (P). The treatments were: P - only pasture; PSM - pasture + mineral salt and PSMU - + pasture + mineral salt + urea. The percentage compositions are listed in Table 1.

**Table 1.** Percentage composition of the experimental treatments.

Ingredients	Treatment		
	P	PSM	PSMU
Urea	0	0	10.0
Sulfur	0	0	1.0
Common salt	0	0	40.4
Mineral mixture*	0	0	48.6
Complete mineral salt**	0	100	0
Total	0	100.0	100.0

\*P - only pasture; PSM - pasture + mineral salt and PSMU - pasture + mineral salt + urea. \*\*Assurance levels: in g kg<sup>-1</sup> (Calcium - 150; Phosphorus - 88; Sulfur - 30; Magnesium - 9.2) and in mg kg<sup>-1</sup> (Zinc - 5,500; Manganese - 1,500; Copper - 1,400; Cobalt - 80; Iodine - 150; Selenium - 30).

Twenty-four castrated steers, ½ Caracu + ½ Nellore, with average age and weight of 18 months and 269 kg, respectively, underwent 40 days of adaptation to the facilities, management and supplementation and during the experimental period (72 days). Animals were weighed every 14 days, after 12 hours of complete fasting, in order to evaluate the weight gain coinciding with the rotation of treatments between paddocks to eliminate possible variations due to this source. At the beginning of the experiment, an ivermectin based product (1%) was applied for controlling endo and ectoparasites.

During the experimental period, tick and horn flies infestations were controlled. Climatic data of the study period are shown in Table 2.

**Table 2.** Mean values of temperature, rainfall and relative humidity during the experimental period<sup>1</sup>.

Date	Temperature (°C)			R	RU
	air	max.	min.	(mm)	(%)
July 21 - 31	21.60	27.40	16.10	3.40	69.33
August 1 - 31	25.37	30.80	18.00	52.20	43.67
September 1 - 30	25.28	30.07	19.73	45.20	60.56
October 1 - 31	24.73	29.70	20.00	56.00	72.00
November 1 - 10	24.17	29.00	19.90	85.60	80.67

<sup>1</sup>Main Climatological Station of São Vicente da Serra - Mato Grosso State. R - rainfall and RU - relative humidity.

The average consumption of the supplements was calculated from the difference between the initial weight and remains in the trough considering the number of animals and the days of supplementation, which ranged around three days.

Experimental data were analyzed using the randomized block design with three treatments and eight replications, and means were compared by the Scott-Knott test, at 5% significance level. The initial weight of the animals was the variable used for blocking. Statistical analysis was performed using the System of Analysis of Variance for Balanced Data (SISVAR), according to Ferreira (2011).

The studied forages were collected for analysis and for availability by two ways: A - by the hand plucking technique according to Johnson (1978) from fifty samples from each paddock. B - by the complete collection of the forage through cuts on the entire available mass in the grassland by cutting at 10 cm from the ground using a square frame (0.5 x 0.5 m), at 15 randomly selected areas within each paddock. After cutting, the material was weighed and mixed. A composite sample of each paddock was withdrawn, oven-dried at 65°C for 72 hours, weighed and ground for subsequent laboratory analysis of dry matter (DM) according to the methodology described by AOAC (1990), neutral detergent fiber (NDF) and acid detergent fiber (ADF) according to Van Soest et al. (1991). With the determination of DM, we calculated the availability of dry matter ha<sup>-1</sup>. However, the evaluations refer only to collections made at the end of the experiment, due to the loss of the other experimental cuts for a serious problem in the greenhouse.

The concentration of urea N in the blood was studied in blood samples collected at the end of the experimental period. We collected through jugular vein puncture, at 18:00 hours, the blood from six animals of each treatment, randomly chosen. The samples were centrifuged at 3,000 rpm for 20 minutes, removing an aliquot of 3 mL of the supernatant. Plasma urea was determined by colorimetric chemical method employing a commercial kit (Doles). The experiment was a completely randomized design with six replications and means were compared by the Scott-Knott test ( $p < 0.05$ ). Data analysis was performed using the System of Analysis of Variance for Balanced Data (SISVAR), according to Ferreira (2011).

The assessment of economic parameters was based on revenues and additional costs compared to the control (P). For best viewing results, we applied a sensitivity analysis, due to variations in the values of supplements and sale of animals. All quotations used were taken in the region and in the period of

execution of this experiment. The following formulas characterize each of the analyzed items:

$$\text{TMP} = (\text{ADA}_T - \text{ADG}_C) \times 72 \text{ days}$$

$$\text{CE} = (\text{TMP} \times 50) / 100$$

$$\text{TR} = (\text{CE} / 15) \times 42.50$$

$$\text{RIC} = (\text{TR} - \text{TE}) / \text{TE}$$

$$\text{CAP} = (\text{TE} \times 15) / \text{CE}$$

in which:

TMP = Total meat production;

ADA<sub>T</sub> = Average daily gain of the treatment analyzed;

ADG<sub>C</sub> = Average daily gain of the control treatment;

CE = Carcass equivalent;

TR = Total Revenue;

RCI = Return on invested capital;

TE = Total expenditure;

CAP = Cost per arroba produced.

## Results and discussion

Given the management of fertilization and deferment of grazing, started in April, the mean availability of dry matter 2,723 kg DM ha<sup>-1</sup> at the end of the experimental period is adequate, allowing the selection of forage by cattle throughout the experimental period, considering a continuous system. Teixeira et al. (2011) studied the nitrogen application strategy in late summer and noted that it promotes a greater dry matter yield of total forage and of leaf blade in the upper canopy strata, and improves forage quality. The monitoring of the forage quality in vertical strata may suggest different management as the deferred pasture is used, since the use of the deferred pasture is commonly performed in the dry season under continuous stocking.

In agreement with Casagrande et al. (2010) herbage allowance of 4% BW day<sup>-1</sup> promotes lower elongation of stems and tends to reduce losses due to senescence. Stem elongation and tiller density are the morphogenetic and structural variables most affected by intensity and succession of grazing (defoliation) and environmental conditions have the greatest influence on morphogenetic and structural characteristics compared with management actions such as the manipulation of forage supply.

Along with this context, Reis et al. (2009) found values of forage availability similar to the present study, which was considered as a minimum so there is no decrease in the bite size and cattle have no difficulty meeting their consumption, i.e. to ensure maximum selection and intake of forage. Thus, the amount of dry matter available allowed animals to select the material to be consumed.

The chemical composition (Table 3) showed low contents of crude protein (CP) and high values of neutral detergent fiber (NDF) and acid detergent fiber (ADF) for forages sampled in the form of complete collection. The higher values of CP and lower values of NDF and ADF obtained in the hand plucking samples (Table 3) confirm the selection ability of the cattle to graze on paddock with high availability of DM, so the quality of the ingested material is higher than that sampled by the entire material. The results for chemical composition can be explained by the maintenance of forage quality when preceded by deferment of grazing and by rainfall during the experimental period, expressed in Table 2. For Euclides et al. (1990) fenced pastures at this time have a reasonable accumulation of forage associated with higher CP content in leaves and stems during the period of use. Santos et al. (2010) stated that the structural characteristics of the deferred pasture are associated with its nutritional value and that management actions that result in reduced mass of dead stems and of the number of reproductive and dead tillers in the deferred pasture, contribute to improve its structure and nutritional value.

**Table 3.** Chemical composition of the forage per paddock in two forms of collection.

Nutrients (%)	Paddocks						Mean
	1	2	3	4	5	6	
	Complete collection of forage						
NDF <sup>1</sup>	88.18	90.42	88.42	88.30	84.07	89.38	88.13
ADF <sup>1</sup>	58.23	58.58	58.67	54.79	53.92	53.12	56.22
CP <sup>1</sup>	4.34	3.92	4.71	4.72	4.71	4.73	4.52
	Collection by hand plucking						
NDF <sup>1</sup>	79.49	80.12	80.26	81.84	74.74	81.90	79.73
ADF <sup>1</sup>	45.56	43.90	45.46	46.43	47.51	47.02	45.98
CP <sup>1</sup>	7.06	8.95	11.12	9.68	9.65	8.92	9.23

\*NDF- neutral detergent fiber; ADF- acid detergent fiber and CP- crude protein. <sup>1</sup> dry matter basis.

Complementing the procedure with the pastures, according to Koster et al. (1997) using urea in place of ruminally degradable true protein does not affect the intake of forage of low to medium quality when the supplementary N is provided in sufficient quantities to maximize the intake of digestible organic matter in contrast, the use of urea at high levels decrease the digestion and thus the intake of digestible organic matter. In agreement with Vasconcelos et al. (2009) there is a clear reduction in voluntary intake, as the level of urea is added in the supplementation above 14.0%. This was exemplified by the study of Koster et al. (1997), in which due to the rapid rate of hydrolysis, the concentrations of ruminal ammonia nitrogen increase with increasing levels of urea.

Hunter and Siebert (1987) showed that the requirements of these nutrients to achieve

maximum forage intake with average protein content can be met with nitrogen and rumen degradable carbohydrates. Detmann et al. (2011) argued that protein supplementation improves the aspects related to the dynamics of degradation of neutral detergent fiber of low-quality forage. The balance of the supplement, in order to provide a third of the crude protein from true protein and two thirds from non-protein nitrogen, optimizes degradation and microbial growth on neutral detergent fiber. Similar to the present study, according to Figueiras et al. (2010) when evaluated grazing animals supplemented with nitrogenous compounds during the dry season in amounts that raise the CP content of the diet to levels close to 9%, and detected the optimization of the use of low-quality forage for grazing cattle.

The animals in the treatments with mineral supplementation (PSM) and supplemented with 10% urea (PSMU) had higher average daily weight gains ( $p < 0.05$ ) than those only on pasture (P), however, when the average weight was expressed as metabolic weight only the treatment with 10.0% urea (PSMU) was superior ( $p < 0.05$ ) (Table 4).

**Table 4.** Dry matter intake of supplements (DMIS), weight gain (WG), average total weight (ATW) and coefficient of variation (CV%) of the experimental treatments.

Variables	Treatments			CV (%)
	P	PSM	PSMU	
	Consumption of the supplements			
kg day <sup>-1</sup>	-	0.10	0.09	-
DMIS % BW	-	0.05	0.04	-
g DW kg <sup>0.75</sup>	-	1.65	1.45	-
WG	0.488b	0.627a	0.690a	21.20
ATW (kg <sup>0.75</sup> )	71.33b	72.60b	75.86a	3.06

\*P - only pasture; PSM - pasture + mineral salt; PSMU - pasture + mineral salt + urea; WG- weight gain; PMT- average total weight - expressed in metabolic weight and CV%- coefficient of variation. \* Means followed by the same letter in the row are not significantly different by the Scott Knott test at 5% probability.

The lower performance of the other treatments (P and PSM) may have been due to the imbalance between nitrogen and energy for fiber digester-microorganisms. In this situation, the poor availability of degradable protein combined with easily fermentable energy from the forage were not enough for an efficient synthesis of microbial protein to equate to urea supplementation.

Canesin et al. (2009) verified daily gains in nellore steers maintained on pastures of *Brachiaria brizantha* Hochst Stapf, in the dry season and supplemented with mineral mixture + urea at 670 g animal day<sup>-1</sup>, when supplementation was provided daily, and at 90 g animal day<sup>-1</sup>, when the supplement was provided every three days during the month of July. These results were lower than the present experiment possibly due to the low nutritional value of the forage that showed ADF content above 62%

associated with the supplement used, which probably did not meet the requirements of energy and protein for proper microbial growth and suitable fermentation activity.

Oliveira et al. (2004) investigated mineral supplementation and noted that the weight gain is closely related to the intake of DM, effective degradability, apparent digestibility and feed conversion and other specific factors of pastoral environments (MINSON, 1990), confirming the responses obtained for the analyzed variables. The availability of quality forage allowed weight gain (Table 4) even for animals that received no mineral supplementation, opposing most studies performed in this period as that of Moreira et al. (2003) who examined the supplementation of protein and mineral for beef cattle. Nevertheless, similar results were registered by Fernandes et al. (2010) by supplementing cattle with mineral salt, urea and/or other sources, on pasture of *Brachiaria brizantha* cv. Marandu during the dry season, with rotation of animals on pastures, detected positive responses in all treatments for the performance, assuring the great importance given to the quantity and quality of forage.

Freitas et al. (2011) evaluated the performance of Nellore steers, ½ Nellore + ½ Red Angus and crossbred Holstein maintained on *Brachiaria brizantha* cv. Marandu supplemented with urea (0.6% body weight) and observed daily weight gain of 610, 790 and 730g animal<sup>-1</sup>, respectively. These results are close to those observed in this study with minor variations that can be explained by differences in genetic group, where F1 crossbred animals ½ Nellore + ½ Red Angus are the earliest, and by the chemical composition of pastures.

#### Urea-N

The levels of urea in the blood (LUB), milk (LUM), saliva, endometrial fluid and urine can be assessed by nitrogen content, which represents 46.6% of the molecule. The content of urea nitrogen (urea-N) present in the bloodstream can be measured in plasma fractions such as plasma urea nitrogen (PUN) or serum and, most often, these acronyms refer generically to blood urea content (OLIVEIRA et al., 2004) as presented in Table 5.

There was a difference in levels of blood urea-N between treatments (Table 5). There was an increase ( $p < 0.05$ ) in the concentration of urea-N in the blood of animals in the PSM and PSMU treatments, indicating the highest protein content, derived from the forage and from the urea added in the supplementation, which seems in this case to have increased the efficiency of utilization of ammonia in

the rumen. In this way, Koscheck et al. (2013) suggested that ruminal ammonia content greater than 6 to 15 mg dL<sup>-1</sup> are required to maximize the degradation of organic matter in the rumen of production animals, which is in agreement with the average value of 12.90 in this study.

**Table 5.** Mean concentrations of urea-N in the blood of animals subjected to different treatments and coefficient of variation (CV%).

Treatments	Urea-N (mg dL <sup>-1</sup> )*
P	11.87 <sup>b</sup>
PSM	13.34 <sup>a</sup>
PSMU	13.51 <sup>a</sup>
CV (%)	11.50

\*P – only pasture; PSM – pasture + mineral salt; PSMU – pasture + mineral salt + urea. \*Means followed by the same letter in the column are not statistically different by the Scott Knott test ( $p > 0.05$ ).

The concentration of plasma urea has been used as an indicator of protein metabolism and is directly related to dietary protein levels and energy: protein ratio of food (FERREIRA et al., 2009). In this context, Gonzáles (2000) recommended values below 15 mg dL<sup>-1</sup> for concentration of blood urea.

Paula et al. (2009) evaluated the urea polymer and livestock urea as sources of soluble nitrogen in the rumen: ruminal and plasma parameters, and obtained mean levels of plasma urea at 12.52%. These results are consistent with those obtained herein.

Lucci et al. (2006) studied the increases in crude protein as protein equivalents by adding livestock urea in the treatments, for cattle, and detected a direct relationship with increasing levels of plasma urea nitrogen in the animals, which was consistent with the highest levels of urea in treatments, thus being a good indicator of the nitrogen content used in feeding or at least, in terms of nitrogen as equivalent in protein degraded in the rumen according to the feed.

According to Hvelplund (1991), nitrogen metabolism in the rumen can be divided into two processes. The first is the degradation of dietary protein, mediated by the proteolytic activity of rumen microorganisms, the second is the synthesis of microbial protein (P<sub>mic</sub>) in the rumen from the energy available during the fermentation of carbohydrates. In relation to the treatments evaluated in this study, forage quality and concentrations of NH<sub>3</sub> derived from the treatment with urea could be made compatible with the protein and energy available of the forage. Harmeyer and Martens (1980) surveyed the metabolism of urea in small ruminants and noticed that the blood urea concentration is directly related to the amount of protein and energy: protein ratio of the diet.

Rennó et al. (2000) found values between 18.03 and 11.63 plasma urea-N (LUP, mg dL<sup>-1</sup>), which

showed a linear decreasing trend as a function of the level of concentrate in the feed. The values found in the present study are similar to those reported by these authors, changing only the types of supplementation, which seems to agree with Lima et al. (2013) who observed that the fractional excretion of urea is variable, allowing greater retention of urea at low intakes and increased excretion at high intakes of N.

Moreover, Paula et al. (2009) evaluated ruminal and plasma parameters in ruminants receiving or not sources of non-protein nitrogen and registered similar values to those of our study. They detected the importance of using sources of non-protein nitrogen in the evaluated parameters.

Given the importance of that described, Mendonça et al. (2004) drew comparisons of urea concentration between plasma and milk of bovine with different protein and energy diets, and verified that urea-N in plasma is effective in detecting the animal protein metabolism.

The mean values of total meat production (TMP), total revenue (TR), total expenditure (TE), return on invested capital (RIC), cost per arroba produced (CAP) and total revenue: total expenditure are listed in Table 6.

**Table 6.** Mean values of total meat production (TMP), total revenue (TR), total expenditure (TE), return on invested capital (RIC), cost per arroba produced (CAP) and total revenue: total expenditure (TR/TE) according to treatments.

Treatments	Values					
	TMP (kg)	TR (R\$)	TE (R\$)	RIC (% month)	CAP (R\$)	TR/TE
PSM	15.82	22.41	26.06	-0.14	49.43	0.86
PSMU	22.60	32.02	25.57	+0.25	33.95	1.25

\*PSM – pasture + mineral salt; PSMU – pasture + mineral salt + urea; TMP – total meat production; TR – total revenue; TE – total expenditure; RIC – return on invested capital; CAP – cost per arroba produced and TR/TE – total revenue: total expenditure.

In Table 6, the treatment with urea showed a proper ratio of total revenue/total expenditure (TR/TE), representing a 25% return. Fernandes et al. (2010) studied the effect of supplementation on performance of beef cattle, and observed biological and economic responses similar to those obtained in this trial. The authors concluded that the animals exhibited gain weight superior to that of the control, and although the costs have been higher, the revenue outweighed the difference.

Therefore, the viability of any technology should be assessed from an economic perspective, in order to achieve a positive cost/benefit ratio. Using this technology animals are sold in a more favorable period, obtaining a price premium in addition to stimulating production included in the system.

## Conclusion

Supplementation of grazing animals is a cost-effective technique, and the use of urea plus mineral salt in the dry season provides a better performance at viable costs.

## Acknowledgements

To the Research Foundation of the State of Mato Grosso for the financial support.

## References

- AOAC-Association of Official Analytical Chemists. **Official Methods of the Association of Official Analytical Chemists**. 15th ed. Washington, D.C.: AOAC, 1990.
- CANESIN, R. C.; BERCHIELLI, T. T.; REIS, R. A.; REY, F. S. B.; RESENDE, K. T.; TEIXEIRA, I. A. M. A. Desempenho de bovinos em pastejo submetidos a duas frequências de suplementação no período da seca. **Acta Scientiarum. Animal Sciences**, v. 31, n. 4, p. 417-423, 2009.
- CASAGRANDE, D. R.; RUGGIERI, A. C.; JANUSCKIEWICZ, E. R.; GOMIDE, J. A.; REIS, R. A.; VALENTE, A. L. S. Características morfológicas e estruturais do capim-marandu manejado sob pastejo intermitente com diferentes ofertas de forragem. **Revista Brasileira de Zootecnia**, v. 39, n. 10, p. 2108-2115, 2010.
- DETMANN, E.; QUEIROZ, A. C.; ZORZI, K.; MANTOVANI, H. C.; BAYÃO, G. F. V.; GOMES, M. P. C. Degradação *in vitro* da fibra em detergente neutro de forragem tropical de baixa qualidade em função da suplementação com proteína verdadeira e/ou nitrogênio não-proteico. **Revista Brasileira de Zootecnia**, v. 40, n. 6, p. 1272-1279, 2011.
- EUCLIDES, V. P. B.; VALLE, C. B.; SILVA, J. M.; VIEIRA, A. Avaliação de forrageiras tropicais para produção de feno-em-pé. **Pesquisa Agropecuária Brasileira**, v. 25, n. 1, p. 393-407, 1990.
- FERNANDES, L. O.; REIS, R. A.; PAES, J. M. V. Efeito da suplementação no desempenho de bovinos de corte em pastagem de *Brachiaria brizantha* cv. Marandu. **Ciência e Agrotecnologia**, v. 34, n. 1, p. 240-248, 2010.
- FERREIRA, D. F. SISVAR: A computer statistical analysis system. **Ciência e Agrotecnologia**, v. 35, n. 6, p. 1039-1042, 2011.
- FERREIRA, M. A.; SILVA, R. R.; RAMOS, A. O.; VÉRAS, A. S. C.; MELO, A. A. S.; GUIMARÃES, A. V. Síntese de proteína microbiana e concentrações de ureia em vacas alimentadas com dietas à base de palma forrageira e diferentes volumosos. **Revista Brasileira de Zootecnia**, v. 38, n. 1, p. 159-165, 2009.
- FIGUEIRAS, J. F.; DETMANN, E.; PAULINO, M. F.; VALENTE, T. N. P.; VALADARES FILHO, S. C.; LAZZARINI, I. Intake and digestibility in cattle under grazing supplemented with nitrogenous compounds during dry season. **Revista Brasileira de Zootecnia**, v. 39, n. 6, p. 1303-1312, 2010.

- FIGUEIREDO, D. M.; PAULINO, M. F.; DETMANN, E.; SOUZA, M. G.; COUTO, V. R. M.; SALES, M. F. L. Estratégias de suplementação para antecipação da idade à puberdade para novilhas de corte em pastagem tropical. **Acta Scientiarum. Animal Sciences**, v. 30, n. 4, p. 415-423, 2008.
- FREITAS, D.; FREGADOLLI, F. L.; BERTIPAGLIA, L. M. A.; MELO, G. M. P.; REIS, R. A.; BERCHIELLI, T. T. Suplementação da dieta de novilhos de três grupos genéticos em pastagem de *Brachiaria brizantha* cv. Marandu. **Acta Scientiarum. Animal Sciences**, v. 33, n. 4, p. 417-425, 2011.
- GOMIDE, J. A.; WENDLING, I. J.; BRAS, S. P.; QUADROS, H. B. Consumo e produção de leite de vacas mestiças em pastagem de *Brachiaria decumbens* manejada sob duas ofertas diárias de forragem. **Revista Brasileira de Zootecnia**, v. 30, n. 4, p. 1194-1199, 2001.
- GONZÁLES, F. H. D. Uso do perfil metabólico para determinar o *status* nutricional em gado de leite. In: GONZÁLES, F. H. D. (Ed.). **Perfil metabólico em ruminantes: seu uso em nutrição e doenças nutricionais**. Porto Alegre: Félix H. D. Gonzáles, 2000. p. 31-51.
- HARMEYER, J.; MARTENS, H. Aspects of urea metabolism with reference to the goat. **Journal of Dairy Science**, v. 63, n. 10, p. 1707-1728, 1980.
- HUNTER, R. A.; SIEBERT, B. D. The effect of supplementation of rumen degradable protein and formaldehyde treated casein on the intake of low nitrogen roughages by *Bos Taurus* and *Bos indicus* steers at different stages of maturity. **Australian Journal of Agricultural Research**, v. 38, n. 1, p. 209-218, 1987.
- HVELPLUND, T. Volatile fatty acids and protein production in the rumen. In: JOUANY, J. P. (Ed.). **Rumen microbial metabolism and ruminant digestion**. Paris: INRA, 1991. p. 165-178.
- JOHNSON, A. D. Sample preparation and chemical analysis of vegetation. In: MANETJE, L. T. (Ed.). **Measurement of grassland vegetation and animal production**. Aberystwyth: Commonwealth Agricultural Bureaux, 1978. p. 96-102.
- KOENIG, K. M.; MCGINN, S. M.; BEAUCHEMIN, K. A. Ammonia emissions and performance of backgrounding and finishing beef feedlot cattle fed barley-based diets varying in dietary crude protein concentration and rumen degradability. **Journal of Animal Science**, v. 91, n. 5, p. 2278-2294, 2013.
- KOSCHECK, J. F. W.; ZERVOUDAKIS, J. T.; ZERVOUDAKIS, L. K. H.; CABRAL, L. S.; OLIVEIRA, A. A.; BENATTI, J. M. B.; CARVALHO, D. M. G.; SILVA, R. P. Total digestible nutrient levels in supplements for finishing steers in the rainy season: nutritional characteristics and microbial efficiency. **Revista Brasileira de Zootecnia**, v. 42, n. 11, p. 798-805, 2013.
- KOSTER, H. H.; COCHRAN, R. C.; TITGEMEYER, E. C.; VANZANT, E. S.; NAGARAJA, T. G.; KREIKEMEIER, K. K.; JEAN, G. S. Effect of increasing proportion of supplemental nitrogen from urea on intake and utilization of low-quality, tall grass-prairie forage by beef steers. **Journal of Animal Science**, v. 75, n. 1, p. 393-1399, 1997.
- LIMA, H. L.; GOES, R. H. T. B.; OLIVEIRA, E. R.; GRESSLER, M. G. M.; BRABES, K. C. S.; GABRIEL, A. M. A. Nitrogenous compounds balance and microbial protein synthesis in steers supplemented with sunflower crushed in partial replacement of soybean meal. **Acta Scientiarum. Animal Sciences**, v. 35, n. 3, p. 281-288, 2013.
- LUCCI, C. S.; VALVASORI, E.; PEIXOTO JUNIOR, K.; FONTOLAN, V. Concentrações de nitrogênio na dieta, no sangue e no leite de vacas lactantes no período pós-parto. **Revista da Sociedade Brasileira de Zootecnia**, v. 35, n. 1, p. 258-263, 2006.
- MENDONÇA, S. S.; CAMPOS, J. M. S.; VALADARES FILHO, S. C.; VALADARES, R. F. D.; SOARES, C. A.; LANA, R. P.; QUEIROS, A. C.; ASSIS, A. J.; PEREIRA, M. L. A. Balanço de compostos nitrogenados, produção de proteína microbiana e concentração plasmática de ureia em vacas leiteiras alimentadas com dietas à base de cana-de-açúcar. **Revista Brasileira de Zootecnia**, v. 33, n. 2, p. 493-503, 2004.
- MINSON D, J. **Forage in ruminant nutrition**. San Diego: Academic Press, 1990.
- MOREIRA, F. B.; PRADO, I. N.; CECATO, U.; WADA, F. Y.; NASCIMENTO, W. G.; SOUZA, N. E. Suplementação com sal mineral proteinado para bovinos de corte, em crescimento e terminação, mantidos em pastagem de grama estrela roxa (*Cynodon plectostachyris* Pilger), no Inverno. **Revista Brasileira de Zootecnia**, v. 32, n. 2, p. 449-455, 2003.
- MURTA, R. M.; SILVA, F. F.; OLIVEIRA, A. R. S.; SANTOS, L. X. Resultados brasileiros em confinamentos: Revisão de literatura. **PUBVET**, v. 2, n. 9, p. 1-20, 2008.
- OLIVEIRA, E. R.; PAIVA, P. C. A.; BABILÔNIA, J. L.; BANYS, V. L.; PÉREZ, J. R. O.; MUNIZ, J. A.; TOSETTO, E. M. Degradabilidade *in situ* da matéria seca, proteína bruta e fibra em detergente neutro, de diferentes gramíneas, em novilhos suplementados com mistura múltipla. **Ciência e Agrotecnologia**, v. 28, n. 2, p. 425-430, 2004.
- PAULA, A. A. G.; FERREIRA, R. N.; ORSINE, G. F.; GUIMARÃES, L. O.; OLIVEIRA, E. R. Ureia polímero e ureia pecuária como fontes de nitrogênio solúvel no rúmen: parâmetros ruminal e plasmático. **Ciência Animal Brasileira**, v. 10, n. 1, p. 1-8, 2009.
- REIS, R. A.; RUGGIERI, A. C.; CASAGRANDE, D. R.; PÁSCOA, A. G. Suplementação da dieta de bovinos de corte como estratégia do manejo das pastagens. **Revista Brasileira de Zootecnia**, v. 38, n. 1, p. 147-159, 2009. (supl. especial).
- RENNÓ, L. N.; VALADARES, R. F. D.; CAMPOS FILHO, S. V.; LEÃO, M. I.; SILVA, J. F. C.; CECON, P. R.; GONÇALVES, L. C.; DIAS, H. L. C.; LINHARES, R. S. Concentração plasmática de ureia e excreções de ureia e creatinina em novilhos. **Revista Brasileira de Zootecnia**, v. 29, n. 4, p. 1235-1243, 2000.
- SALES, M. F. L.; PAULINO, M. F.; PORTO, M. O.; VALADARES FILHO, S. C.; ACEDO, T. S.; COUTO,

- V. R. M. Níveis de energia em suplementos múltiplos para terminação de novilhos em pastagem de capim-braquiária no período de transição águas-seca. **Revista Brasileira de Zootecnia**, v. 37, n. 1, p. 724-733, 2008.
- SANTOS, M. E. R.; FONSECA, D. M.; BALBINO, E. M.; SILVA, S. P.; MONNERAT, J. P. I. S.; GOMES, V. M. Características estruturais de perfilhos vegetativos e reprodutivos em pastos diferidos de capim-braquiária. **Ciência Animal Brasileira**, v. 11, n. 3, p. 492-502, 2010.
- SILVA, F. F.; SÁ, J. F.; SCHIO, A. R.; ÍTAVO, L. C. V.; SILVA, R. R.; MATEUS, R. G. Suplementação a pasto: disponibilidade e qualidade x níveis de suplementação x desempenho. **Revista Brasileira de Zootecnia**, v. 38, n. 1, p. 371-389, 2009.
- TEIXEIRA, F. A.; BONOMO, P.; PIRES, A. J. V.; SILVA, F. F.; ROSA, R. C. C.; NASCIMENTO, P. V. N. Diferimento de pastos de *Brachiaria decumbens* adubados com nitrogênio no início e no final do período das águas. **Revista Brasileira de Zootecnia**, v. 40, n. 7, p. 1480-1488, 2011.
- VALENTE, T. N. P.; LIMA, E. S.; HENRIQUES, L. T.; MACHADO NETO, O. R.; GOMES, D. I.; SAMPAIO, C. B.; CARLI COSTA, V. A. C. Anatomia de plantas forrageiras e a disponibilidade de nutrientes para ruminantes: revisão. **Veterinária e Zootecnia**, v. 18, n. 3, p. 347-358, 2011.
- VAN SOEST, P. J.; ROBERTSON, J. B.; LEWIS, B. A. Methods for dietary fiber, neutral detergent fiber, and nonstarch polysaccharides in relation to animal nutrition. **Journal of Dairy Science**, v. 74, n. 10, p. 3583-3597, 1991.
- VASCONCELOS, J. T.; COLE, N. A.; MCBRIDE, K. W.; GUEYE, A.; GALYEAN, M. L.; RICHARDSON, C. R.; GREENE, L. W. Effects of dietary crude protein and supplemental urea levels on nitrogen and phosphorus utilization by feedlot cattle. **Journal of Animal Science**, v. 87, n. 1, p. 1174-1183, 2009.

Received on November 28, 2013.

Accepted on January 23, 2014.

License information: This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.