Ciência Animal Brasileira

Ciência Animal Brasileira

DOI: 10.1590/1809-6891v21e-43578



# Pasture structure and production of supplemented cattle in deferred signalgrass pasture

## Estrutura do pasto e produção de bovinos suplementados em pastagens diferidas com capim braquiária

Anselmo de Deus Santos[1] , Dilermando Miranda da Fonseca[2] , Braulio Maia de Lana Sousa[3] , Manoel Eduardo Rozalino Santos[4*] , Angélica Nunes de Carvalho[4]

[1]Escola Agrotécnica Federal de São Cristóvão, São Cristóvão, SE, Brazil.
[2]Departamento de Zootecnia, Universidade Federal de Viçosa, Viçosa, MG, Brazil.
[3]Departamento de Zootecnia, Universidade Federal de Sergipe, São Cristóvão, SE, Brazil.
[4]Faculdade de Medicina Veterinária, Universidade Federal de Uberlândia, Uberlândia, MG, Brazil.
*Correspondent – manoel.rozalino@ufu.br

Section: Animal Production

Received
October 4, 2016.
Accepted
September 10, 2019.
Published
5 de fevereiro de 2020

www.revistas.ufg.br/vet
visit the website to get the how to cite in the article page

**Abstract**:
The effects of supplement doses (0, 1, 2 and 3 kg ha$^{-1}$ day$^{-1}$) and grazing periods (1, 28, 59, 89 and 103 days) on the *B. decumbens* cv. Basilisk structure and cattle production in deferred pastures were evaluated. The design was a randomised complete block design with two replications. The sward height and the total forage and stem masses decreased with grazing period. The crude protein (8.12%) and *in vitro* organic matter digestibility (52.74%) were not affected by grazing period. The fibre content in neutral and acid detergent increased linearly with the grazing period. The average daily gain of cattle ranged from 0.419 to 1.019 kg animal$^{-1}$ day$^{-1}$; the stocking rate ranged from 2.7 to 3.9 animal unit ha$^{-1}$; and the average gain per area ranged from 2.7 to 7.9 kg ha$^{-1}$ day$^{-1}$, with the maximum values obtained with the highest dose of concentrate. Concentrate supplementation increases cattle production in deferred pastures. During the use of deferred pasture in winter there are decreases in the quantity and quality of forage, as well as limitations in its structure.
**Keywords:** *Brachiaria decumbens*; Ecophysiology; Grazing management

**Resumo**:
Foram avaliados os efeitos de doses de suplemento (0, 1, 2 e 3 kg animal$^{-1}$ dia$^{-1}$) e períodos de pastejos (1, 28, 59, 89 e 103 dias) sobre a estrutura da *Brachiaria decumbens* cv. Basilisk e a produção de bovinos em pastagens diferidas. O delineamento foi em blocos casualizados com duas repetições. A altura do pasto e as massas de forragem total e de colmo diminuíram com o período de pastejo. A proteína bruta (8,12%) e a digestibilidade *in vitro* da matéria orgânica (52,74%) não foram influenciadas pelo período de pastejo. Os teores de fibras em detergente neutro e ácido aumentaram linearmente com o período de pastejo. O ganho médio diário dos bovinos variou de 0,419 a 1,019 kg animal$^{-1}$ dia$^{-1}$; a taxa de lotação variou de 2,7 a 3,9 UA ha$^{-1}$; e o ganho médio por área variou de 2,7 a 7,9 kg ha$^{-1}$ dia$^{-1}$, sendo os maiores valores

obtidos com a dose mais alta de concentrado. A suplementação com concentrado aumenta a produção de bovinos em pastagens diferidas. Durante a utilização do pasto diferido no inverno há decréscimos na quantidade e na qualidade da forragem, bem como limitação em sua estrutura.
**Palavras-chave:** *Brachiaria decumbens*; Ecofisiologia; Manejo do pastejo

## Introduction

Although pastures are an important source of food in Brazil, seasonal forage production results in limited animal performance throughout the year. Therefore, it is essential to provide forage during the scarcity period, through cutting grass, hay, silage and deferred pasture, among others. Of these options, deferred pasture is interesting because of the practicality of execution and relatively lower cost.

In deferred pastures, cattle express moderate performance or maintain body weight. However, higher animal performance can be obtained when adequate deferral actions are associated with supplementation[1]. Supplementation can be used to correct forage nutritional deficiencies, increase pasture support capacity, enhance weight gain, reduce slaughter age, assist in pasture management and provide additives or growth promoters[2].

To increase the efficiency of concentrated supplementation, forage availability and deferred pasture structure should not limit animal consumption[1]. These conditions can be obtained by proper pasture management before the deferment period. In this sense, it is recommended that *Brachiaria decumbens* cv. Basilisk pastures should be deferred in April[3], with an initial height of 20 cm[4], for use in early July. These conditions would ensure the formation of the most adequate pasture structure, both in quantity and quality.

It is also noteworthy that forage availability decreases and the canopy structure becomes limited during the grazing period, due to the phenological alteration of the plants and the effect of grazing itself[5]. These changes in deferred pasture structure in the grazing period affect ingestive behaviour and consequently, animal performance. In this sense, understanding of the plant–animal interface during the grazing period, under conditions of concentrate supplementation, may help in the recommendation of more efficient management practices in deferred pastures. Thus, this work proposed to evaluate the structural characteristics and nutritional value of the pasture, as well as the performance of supplemented animals in deferred pastures with *Brachiaria decumbens* cv. Basilisk.

## Material and methods

This work was conducted from January to October 2011, in an area of the Department of Animal Science of the Federal University of Viçosa, Viçosa, MG (20º 45' south latitude, 42º 51' west longitude and 651 m altitude). The climate of Viçosa[6] is Cwa type, subtropical, with mild and dry winters and rainy summers. The average annual temperature is 19 ºC and the average annual rainfall is 1,340 mm. Climatic data from the experimental period were recorded at the Federal University of Viçosa Meteorological Station, located 500 m from the experimental area (Figure 1).

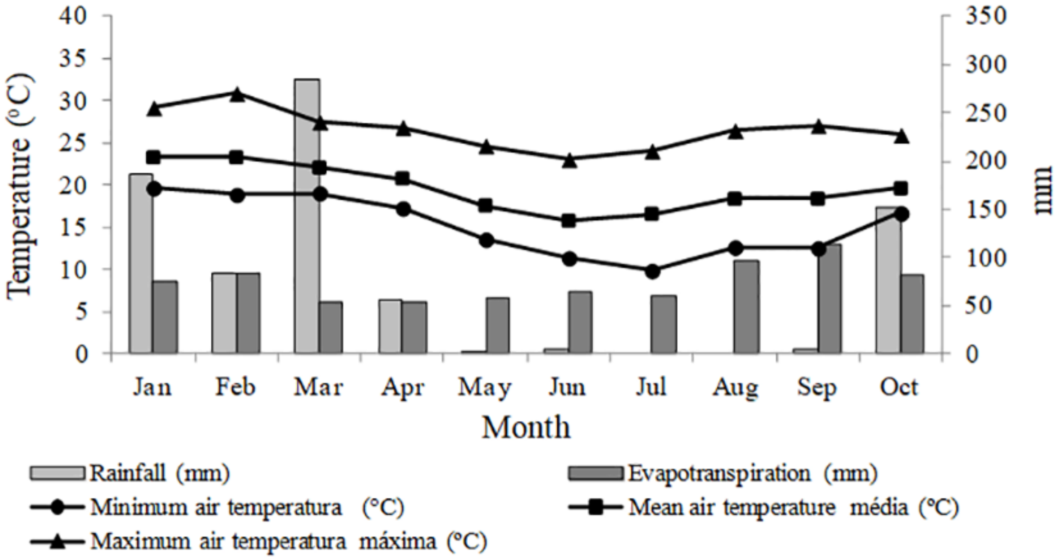


**Figure 1 -** Average mean, minimum and maximum air temperature, total rainfall and total monthly evapotranspiration on the experimental site from January to October 2011.

The experimental area used was an area of pasture with *Brachiaria decumbens* Stapf. cv. Basilisk (signalgrass) established in 1997 and subdivided into eight paddocks (experimental units), with an area ranging from 0.25 to 0.39 ha. The soil of the experimental area was classified as red–yellow latosol, of clay texture and with medium wavy relief(7).

In January 2011, prior to the implementation of the experiment, soil samples were taken from a 0–20 cm deep layer to analyse the fertility level in each experimental unit. According to the results of the chemical analysis, the soil presented, on average, the following characteristics: pH in $H_2O$: 5.00; P (Mehlich$^{-1}$): 4.00 mg dm$^{-3}$ and K: 106.80 mg dm$^{-3}$; $Ca_2^+$: 1.67 cmolc dm$^{-3}$; $Mg_2^+$: 0.52 cmolc dm$^{-3}$; $Al_3^+$: 0.30 cmolc dm$^{-3}$ (1 mol KCl L$^{-1}$); base saturation: 30.5%. Based on the results of the analysis of the soil samples, 150 kg ha$^{-1}$ of the formulated 20-05-20 (N-$P_2O_5$-$K_2O$), divided into three applications, was applied in January, February and March 2011(8). From January to April 2011, the pastures were managed with continuous stocking of cattle and a variable stocking rate, to maintain the average height at 20 cm(9). In April 2011, the pastures were deferred, with an initial height of 20 cm(4,10), remaining deferred until July 2011, when the grazing period began.

Four doses of concentrated supplement were evaluated (0, 1, 2 and 3 kg animal$^{-1}$

day$^{-1}$, which corresponded to 0, 0.45, 0.86 and 1.34% of the average body weight of the animals, respectively and provided to the animals throughout the period of deferred pasture use (07/04/2011 to 10/15/2011). Additionally, the structural characteristics of the deferred pastures were evaluated on five days during the grazing period: 07/04/2011, 07/31/2011, 08/31/2011, 09/30/2011 and 10/15/2011. These consisted of the 1$^{st}$, 28$^{th}$, 59$^{th}$, 89$^{th}$ and 103$^{th}$ days of the grazing period, respectively. The experimental design was a randomised complete block with two replications. The criterion for determining the blocks was the relief of the experimental area.

During the use of the deferred pastures (07/04/2011 to 10/15/2011), the signalgrass was managed in continuous stocking with an initial fixed stocking rate of 2.2 animal units (AU) ha$^{-1}$, keeping two animals per paddock. The AU corresponded to 450 kg of animal body weight. Sixteen Holstein x Zebu crossbred steers, non-castrated, with an average initial weight of 190 kg were used. These animals remained in the eight paddocks during the 103 days of the grazing period, during which there was no adjustment of the stocking rate in the paddocks. The ingredient compositions of the supplements were: 1 kg animal$^{-1}$ day$^{-1}$ (68% cornmeal, 19% soybean meal, 10% mineral salt and 3% urea); 2 kg animal$^{-1}$ day$^{-1}$ (73% cornmeal, 19% soybean meal, 5% mineral salt and 3% urea); and 3 kg animal$^{-1}$ day$^{-1}$ (74.7% cornmeal, 19% soybean meal, 3.3% mineral salt and 3% urea). The cattle began to receive supplementation seven days before the beginning of grazing for adaptation. They also received mineral salt ad libitum.

All evaluations of deferred pastures occurred on the 1$^{st}$, 28$^{th}$, 59$^{th}$, 89$^{th}$ and 103$^{th}$ days of the grazing period. Pasture and extended plant heights were measured at 50 points per paddock, followed up by a zigzag walk. For pasture height measurements, a graded ruler was used, considering the distance between the ground level and the forage leaf horizon in the pasture. The extended plant height was measured by extending the tillers vertically and noting the distance between the ground level and the apex of the tillers. The falling index was estimated by the quotient between the extended plant height and the pasture height[4].

Forage mass was estimated at three sites representative of the average pasture height per experimental unit. At each sampling site, the tillers contained within a 0.40 m side (0.16 m$^2$) rebar frame were harvested at ground level. In the laboratory, the samples were weighed and subdivided into two subsamples. One of these was weighed, wrapped in a paper bag and placed in a 65 °C forced air oven for 72 h, when it was reweighed. The other subsample was manually separated into live leaf blade, live stem, dead leaf blade and dead stem. Subsequently, each component was weighed and dried in a forced air oven at 65 °C for 72 h and reweighed. It was thus possible to estimate live forage (live leaf blade + live stem), dead forage (dead leaf blade + dead stem) and total forage mass (sum of all morphological components of available forage), expressed in kg ha$^{-1}$ of dry matter (DM). The volumetric density of available forage and morphological components (kg cm$^{-1}$ ha$^{-1}$ of DM) were estimated by dividing the forage and its morphological component masses, respectively, by pasture height.

Tiller population density was estimated at three sites representative of the average pasture height per experimental unit. At each location, the tillers within a 0.25 m (0.0625 m²) rebar frame were measured.

A grazing simulation method was used to collect herbage samples in areas where the animal was grazing. A single properly trained evaluator collected the samples, observing the forage intake of all animals present in the experimental area. Subsequently, the samples were separated into live leaf blade, live stem and dead forage. These components were dried in a forced air oven at 65 ºC for 72 h and reweighed. These samples were also evaluated for dry mass, crude protein, neutral detergent and acid fibres, cellulose, lignin and silica[11].

Daily, the amounts of supplement provided in each paddock, as well as the leftovers from the previous day, were weighed. Thus, the absolute intake of supplement (kg $animal^{-1}$ $day^{-1}$) was obtained by the difference between the daily supplement supplied and the respective leftovers from the previous day, divided by the number of animals (two) per experimental unit. The relative intake of supplement, as a percentage of animal body weight, was calculated by dividing the daily amount of supplement consumed by the average animal weight and then multiplied by 100. The average daily weight gain per animal was calculated by the weight difference of the animals, with fasting before 12h, at the beginning and at the end of the experiment. The average daily weight gain per unit area (kg $ha^{-1}$ $day^{-1}$) was calculated by the ratio between the accumulated weight gain of the animals in each paddock throughout the grazing period, by the respective area of the experimental unit. The result was divided by the evaluation period (103 days). The final stocking rate (AU $ha^{-1}$) was calculated on the day of the final weighing by dividing the sum of the body weight of the animals in each paddock by the respective paddock area. For each paddock, forage offerings were calculated during the grazing period by dividing the forage mass (kg $ha^{-1}$) by the animal weight (kg $ha^{-1}$) in each paddock.

Data analyses were performed using the System for Statistical Analysis – SAEG, version 8.1. The characteristics of animal productivity, measured only at the beginning and end of the experimental period, were subjected to analysis of variance and subsequently, regression, whose largest response surface model as a function of treatment means was: Ŷi = β0 + β1Si + β2Si2 + ei, where Ŷi = response variable; Si = supplement level; β0, β1, and β2 = parameters to be estimated; and ei = experimental error. For the other characteristics, measured on the 1st, 28th, 59th, 89th and 103th days of the grazing period, the variance analysis was performed and subsequently, the regression analysis, whose largest response surface model as a function of treatment mean was: Ŷi = β0 + β1Si + β2Si2 + β3Pi + β4Pi2 + β5SiPi + ei, where Ŷi = response variable; Si = supplement level; Pi = grazing period; β0, β1, β2, β3, β4 and β5 = parameters to be estimated; and ei = experimental error.

The fit level of the models was evaluated by the coefficient of determination and the significance of the regression coefficients, tested by the Tukey test, based on the variance analysis residues. The coefficients of variation for plot (supplement level) and subplot (grazing period) were calculated for each response variable. Analyses were performed at the 10% level of significance.

## Results and discussion

Pasture height and plant extended height were influenced (P < 0.10) quadratically by the supplementation level and negatively and linearly by the grazing period. There was a reduction in pasture height and plant extended height when animals were supplemented with 1 kg animal$^{-1}$ day$^{-1}$, with a subsequent increase in values of these variables with levels of 2 and 3 kg animal$^{-1}$ day$^{-1}$ (Table 1).

**Table 1 –** Pasture height (PH), plant extended height (PEH) and falling index (FI) of signalgrass deferred as a function of concentrate supplement level (S) and grazing periods (P)

| Variable | Equation | $R^2$ | $CV^a$ (%) | $CV^b$ (%) |
|---|---|---|---|---|
| PH (cm) | $\hat{Y} = 39.48 - 3.9150{*}S + 1.0750{*}S^2 - 0.2115{*}P$ | 0.90 | 56.09 | 5.90 |
| PEH (cm) | $\hat{Y} = 50.24 - 5.5540{*}S + 1.8440{*}S^2 - 0.2321{*}P$ | 0.83 | 55.98 | 6.69 |
| FI | $\hat{Y} = 1.21 + 0.006722{*}P - 0.00004979{*}P^2 + 0.0005297{*}SP$ | 0.81 | 26.44 | 5.85 |

[a]Coefficient of variation for the level of supplement factor; [b]Coefficient of variation for grazing period factor; * Significant by the Tukey test (P<0.10).

There was an interaction (P < 0.10) between supplement level and grazing period for falling index (Table 1). This response can be best understood by analysing the extreme levels of the grazing period (1 and 103 days) of the secondary factor at each primary factor level (supplement level) (Figure 2). On the first day of grazing, the pasture tipping index decreased in pastures managed with 1 kg animal$^{-1}$ day$^{-1}$ of supplement, increasing with higher supplement levels. On the last day of grazing, the falling index was higher with the increase in supplement level.

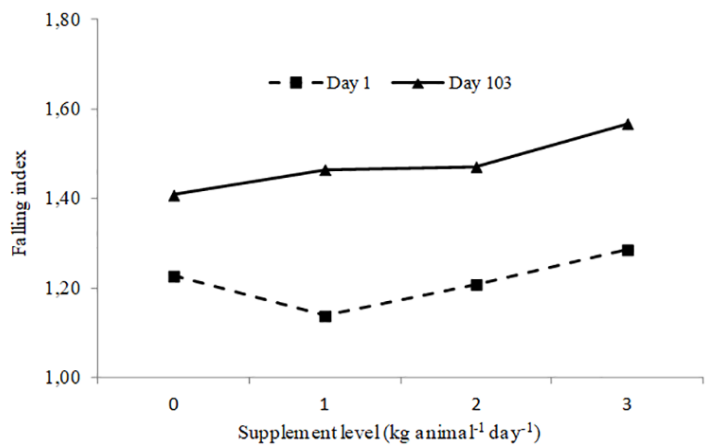


**Figure 2 –** Falling index of signalgrass deferred and used by cattle that received four supplement levels, on the 1st and 103rd days of grazing period.

During the use of deferred pasture in winter, plant growth is stalled or reduced considerably due to environmental conditions limiting growth, such as low light, temperature and rainfall (Figure 1). Therefore, the forage consumed by the animal is not compensated by grass growth, which results in a decrease in pasture and extended plant heights (Table 1). In addition, the grazing animal possibly increases the trampling of the grass, increasing plant falling (Figure 2).

Regarding supplementation, the provision of 1 kg animal$^{-1}$ day$^{-1}$ may have corrected some forage nutrient deficiency[(2)], stimulating forage intake and reducing pasture and extended plant heights (Table 1) and the falling index (Figure 1) in relation to pasture without supplementation. When supplementation levels were 2 and 3 kg animal$^{-1}$ day$^{-1}$, the pasture intake may have been replaced by supplementation, which would justify the increase in pasture and plant extended heights, as well as in the falling index. The substitutive effect refers to the maintenance of the total energy intake level, through the increase in supplement intake and decrease in pasture forage intake[(2)].

Total forage and living stem mass decreased ($P < 0.10$) linearly with the grazing period. Live leaf blade mass and live leaf blade volumetric density were quadratically influenced ($P < 0.10$) by supplementation and by grazing period, respectively (Table 2). The dead leaf blade masses (1,071 kg ha$^{-1}$ DM) and dead stem (1,870 kg ha$^{-1}$ DM), the total forage density (275.8 kg ha$^{-1}$ cm$^{-1}$) of the stem (103.3 kg ha$^{-1}$ cm$^{-1}$), dead leaf blade (48.3 kg ha$^{-1}$ cm$^{-1}$) and dead stem (96.6 kg ha$^{-1}$ cm$^{-1}$) and the ratios of live leaf blade/live stem (0.30) and live mass/dead mass (1.39) were not influenced ($P > 0.10$) by the factors studied. Live tiller population density increased linearly ($P < 0.10$) with supplement level and decreased ($P < 0.10$) with grazing period (Table 2).

**Table 2 -** Structural characteristics of deferred signalgrass pasture as a function of concentrate supplements (S) and grazing period (P)

| Variable | Equation | $R^2$ | CV[a] (%) | CV[b] (%) |
|---|---|---|---|---|
| TFM (kg ha$^{-1}$) | $\hat{Y}$= 9,114.8 – 48.7895*P | 0.49 | | 21.50 |
| LLBM (kg ha$^{-1}$) | $\hat{Y}$ = 2,773,0 – 320.765*S + 104.109*S$^2$ – 56.5370*P + 0.314937*P$^2$ | 0.90 | 26.01 | 21.76 |
| LSM (kg ha$^{-1}$) | $\hat{Y}$= 4.110,5 – 28.4882*P | 0.63 | | 33.85 |
| VDLLB (kg ha$^{-1}$ cm$^{-1}$) | $\hat{Y}$ = 74.60 - 1.20159*P + 0.0053124*P$^2$ | 0.87 | | 20.18 |
| TPD (tiller m$^{-2}$) | $\hat{Y}$= 1,521.05 + 74.9332*S – 5.83774*P | 0.60 | 45.85 | 21.63 |

TFM: Total forage mass; LLBM: Live leaf blade mass; LSM: Live stem mass; VDLLB: Volumetric density of live leaf blade; TPD: Tiller Population Density. [a] Coefficient of variation for the level of supplement factor; [b] Coefficient of variation for grazing period factor; * Significant by the Tukey test ($P<0.10$).

The decrease in live leaf blade mass at the 1.0 kg animal$^{-1}$ day$^{-1}$ level is consistent with the reduction in pasture and plant extended heights (Table 1), reinforcing the possible stimulation of pasture forage intake through supplementation. From 2 kg animal$^{-1}$ day$^{-1}$, increases in live leaf blade mass, as well as pasture and plant extended heights and tiller population density may be related to the replacement of forage intake by supplementation. The concentrated supplement is more digestible and readily available for animal consumption compared to pasture. Thus, the intake of pasture is replaced by supplementation(2).

The quadratic influence of grazing period on mass and volumetric density of live leaf blade can be attributed to the adverse climate during winter, which reduced the values of these characteristics, with a subsequent increase at the end of the grazing period, due to better environmental conditions in October, notably temperature and rainfall (Figure 1), which indicate the beginning of pasture regrowth.

The reduction in total forage, live stem and live leaf blade masses, as well as the tiller population density during the grazing period (Table 2) is a result of the consumption of pasture by cattle. Grazing cattle preferentially consume live leaf(12,13), as it has better nutritional value(14), lower shear strength(15) and is easily accessible in the upper canopy stratum(16). This justifies the reduction of live leaf blade mass during the grazing period (Table 2). In turn, the stem is considered a physical limitation to the forage intake by the animals, since they can reduce the bit depth(17). Despite this, there was a decrease in live stem mass with the grazing period. Thus, this situation cannot be generalised to any grass and pasture management condition, because in the case of signalgrass, which has thin and flexible stems when green, there may be ingestion of these by animals during winter, when live leaf mass reduces in pasture. In addition, it is possible that some tillers died during the grazing period, which would also justify the reduction of live stem mass during this period.

The percentage of dead stem decreased linearly ($P < 0.10$) with the supplement level and increased linearly ($P > 0.10$) with the grazing period. The percentage of live leaf blade was quadratically influenced ($P < 0.10$) by the grazing period. The percentage of live stem decreased ($P < 0.10$) linearly with the grazing period, while the percentage of dead leaf blade varied ($P < 0.10$) quadratically with the supplement level and grazing period (Table 3).

The linear reduction of the live stem percentage and the quadratic response in the live leaf blade, as well as the linear increase of the dead stem and dead leaf blade percentages with the grazing period (Table 3), coincide with the reduction of the pasture height (Table 1), total forage masses, live leaf blade and live stem (Table 2) throughout the grazing period. As discussed earlier, when the animal consumes the deferred pasture, there is a greater selection of green forage, reducing the number of live leaf and stem and increasing the number of dead blades and stem. In addition, the use of deferred pastures in the Southeast region of Brazil occurs in winter, when there are climatic limitations to pasture growth, mainly due to low temperature, photoperiod and soil moisture (Figure 1), among others. Thus, the senescence and death processes of the plant are higher in this season(18), which also contributes to increasing the percentages of leaf blade and stem deaths in the pastures. However, the onset of favourable climatic conditions (October) resulted in a stimulus for signalgrass regrowth, which led to a small reduction in the percentage of dead leaf blade and an increase in the percentage of live leaf blade during this period.

**Table 3 -** Morphological composition of deferred signalgrass pasture as a function of concentrate supplement (S) and grazing period (P)

| Variable | Equation | $R^2$ | CV[a] (%) | CV[b] (%) |
|---|---|---|---|---|
| LS | $\hat{Y}$= 31.59 – 0.66722*P + 0.00393*$P^2$ | 0.93 | 43.39 | 18.62 |
| DLB | $\hat{Y}$= 46.34 – 0.161774*P | 0.55 | 29.70 | 22.46 |
| DS | $\hat{Y}$= 12.23 – 4.29825*S + 1.39325*$S^2$ + 0.37265*P + 0.00322*$P^2$ | 0.47 | 26.12 | 15.83 |
| LLB | $\hat{Y}$= 15.06 – 1.8040*S + 0.381112*P | 0.83 | 75.81 | 22.13 |

LS: Percentage of live stem; DLB: Percentage of dead leaf blade: DS: Percentage of dead stem; LLB: Percentage of live leaf blade; [a]Coefficient of variation for the supplement level factor; [b]Coefficient of variation for grazing period factor; * Significant by the Tukey test (P<0.10).

Regarding supplementation, pastures with levels of 0, 1, 2 and 3 kg animal$^{-1}$ day$^{-1}$ concentrate showed, on average, 18.66, 14.85, 16.10 and 17.85%, respectively of dead leaf blade. As previously discussed, the reduction in the percentage of dead leaf blade at the level of 1 kg animal$^{-1}$ day$^{-1}$ may be related to a stimulation of pasture consumption. The percentage of dead leaf blade increasing from 2 kg animal$^{-1}$ day$^{-1}$ could be related to the replacement of pasture intake.

The percentage of live leaf blade of the simulated grazing sample increased linearly ($P < 0.10$) with the supplement dose and was quadratically influenced by the grazing period (Table 4). The increased availability of food through supplementation may have allowed the animal to select a higher quality diet, normally composed of more leaves. During the grazing period, the signalgrass used on days 1, 28, 59, 89 and 103, after deferral, presented, on average, 73.8, 39.7, 23.6, 11.9 and 36.4% of live leaf blade, respectively, certainly in response to the selection of this component by the animal, associated with reduced or no regrowth during winter. In October (favourable climate for regrowth), there was a greater participation of live leaves in the pasture and apparent forage consumption by cattle.

The percentage of dead forage in simulated grazing presented a quadratic response with the grazing period ($P < 0.10$) (Table 4). Probably, with the scarcity of live leaf blade during the winter grazing period, the animals started to consume more dead forage. At the end of the grazing period, in October, the beginning of pasture regrowth increased the availability of live leaf blade, which was consumed more, replacing dead forage. The percentage of live stem in simulated grazing (17.66%) was not affected ($P > 0.10$) by the evaluated factors.

**Table 4 -** Morphological composition of hand plucked herbage samples in deferred signalgrass pasture as a function of supplement doses (S) and grazing period (P)

| Variable | Equation | $R^2$ | CV[a] (%) | CV[b] (%) |
|---|---|---|---|---|
| LLB (%) | $\hat{Y} = 72.07 - 1.665{*}P + 0.0118{*}P^2 + 2.881{*}S$ | 0.73 | 30.41 | 17.03 |
| FD (%) | $\hat{Y} = 10.02 + 1.339{*}P - 0.0087{*}P^2$ | 0.50 | 34.42 | 12.08 |

LLB: Percentage of live leaf blade; FD: Percentage of dead forage; [a]Coefficient of variation for the supplement level factor; [b]Coefficient of variation for grazing period factor; *Significant by the Tukey test (P<0.10).

The live leaf blade percentage (37.08%) in the simulated grazing sample was much higher than that found in the pasture average (12.15%). Otherwise, the percentage of dead forage (16.86%) was lower in the simulated grazing sample in relation to the pasture average. These results highlight the ability of the grazing animal to select a higher quality diet in relation to the available pasture average.

Organic matter content (92.67%), crude protein (8.12%) and *in vitro* digestibility of organic matter (52.74%) were not influenced (P > 0.10) by grazing period and supplement level. On the other hand, neutral detergent fibre, acid detergent fibre, lignin, cellulose and silica contents increased linearly (P < 0.10) with grazing period (Table 5). The structural characteristics of the pasture became unfavourable during the grazing period (Tables 3, 4 and 5), which led to worsening of the nutritive value of the hand plucked herbage samples (Table 5).

**Table 5 -** Nutritional value of hand plucked herbage samples in deferred signalgrass pastures as a function of grazing period (P)

| Variável | Equation | $R^2$ | CV[a] (%) | CV[b] (%) |
|---|---|---|---|---|
| NDF | $\hat{Y} = 69.91 + 0.06412{*}P$ | 0.63 | 2.58 | 2.70 |
| ADF | $\hat{Y} = 31.13 + 0.0789{*}P$ | 0.51 | 8.52 | 7.45 |
| LIG | $\hat{Y} = 3.33 + 0.0239{*}P$ | 0.54 | 15.57 | 9.27 |
| CEL | $\hat{Y} = 20.89 + 0.05884{*}P$ | 0.54 | 12.28 | 7.41 |
| SIL | $\hat{Y} = 1.14 + 0.02217{*}P$ | 0.55 | 26.59 | 26.31 |

NDF: Neutral Detergent Fibre; ADF: Acid Detergent Fibre; LIG: Lignin; CEL: Cellulose; SIL: Silica; [a]Coefficient of variation for the supplement level factor; [b]Coefficient of variation for grazing period factor; *Significant by the Tukey test (P<0.10).

The structural characteristics of deferred pasture may make it less predisposing to animal consumption and performance during grazing. This fact was verified by the reduction of the forage and live leaf blade masses (Table 1) and the number of tillers (Table 2) and increase in dead forage mass (Table 2), which may have reduced the nutritive value of the pasture. This reduction in the nutritive value of the pasture was proven, for example, by the increase in acid detergent fibre and lignin contents (Table 5) in the pasture over the pasture period. During the grazing period, two processes contributed to the decrease of the nutritive value of the pasture: the senescence and the preferential intake of live leaf by the cattle.

Average daily gain (ADG), stocking rate (SR), livestock production by area (LPA), relative supplement intake (RSI) and absolute supplement intake increased linearly ($P < 0.10$) with supplement doses (Table 6). The ADG ranged from 0.419 to 1.019 kg animal$^{-1}$ day$^{-1}$; SR ranged from 2.7 to 3.9 AU ha$^{-1}$; LPA ranged from 2.7 to 7.9 kg ha$^{-1}$ day$^{-1}$ and RSI ranged from 0.022 to 2.915%. Already the forage offer (OFFER) decreased ($P < 010$) linearly with supplement doses. Forage offer is the relationship between forage mass and animal weight. Therefore, animals that received a higher amount of supplementation presented higher performance and consequently, higher final weight, which may justify the reduction in forage offer. During the dry season, signalgrass paddocks in which animals had access to supplementation presented higher carrying capacity than those in which animals did not consume supplementation[19].

**Table 6 -** Animal performance, supplement intake and forage offer of deferred signalgrass pastures as a function of concentrate supplement (S)

| Item | Equation | $R^2$ | CV (%) |
|---|---|---|---|
| ADG (kg animal$^{-1}$ dia$^{-1}$) | $\hat{Y} = 0.419 + 0.2002^{*}S$ | 0.94 | 5.85 |
| SR (UA ha$^{-1}$) | $\hat{Y} = 2.733 + 0.42075^{*}S$ | 0.98 | 9.48 |
| LPA (kg ha$^{-1}$) | $\hat{Y} = 2.720 + 1.7216^{*}S$ | 0.97 | 7.26 |
| RSI (kg animal$^{-1}$ dia$^{-1}$) | $\hat{Y} = 0.022 + 0.96450^{*}S$ | 0.99 | 3.93 |
| ASI (kg animal$^{-1}$ dia$^{-1}$) | $\hat{Y} = 0.054 + 0.40925^{*}S$ | 0.97 | 4.58 |
| OFFER (% of body weight) | $\hat{Y} = 18.905 - 2.83325^{*}S$ | 0.04 | 17.58 |

ADG: Average daily gain; SR: Stocking rate; LPA: livestock production by area; RSI: relative supplement intake; ASI: Absolut supplement intake; OFFER: Offer the forage; CV: Coefficient of variation; *Significant by the Tukey test (P<0.10).

The animal performance results, mainly from the non-supplemented pasture, exceeded expectations, because if, during the dry season, average daily gains of null or moderate animals are expected, it is possible that the appropriate management of the deferred pasture, characterised by a short period of time deferral (90 days) and low height (20 cm) at the beginning of the deferment period, have enabled this level of performance. Fortes (2013)[20], working with *Brachiaria brizantha* cv. Piatã deferred in February in Tocantins, also observed high performance of crossbred steers (0.287 kg animal$^{-1}$ day$^{-1}$) from June to August.

These results contradict the claim that deferred pastures result always in null or modest animal performance. Therefore, this concept should not be generalised, since management actions adopted in deferred pasture have a major effect on the nutritional value and structure of the pasture. Thus, appropriate management actions can and should be performed to improve plant and animal productivity in deferred pastures[1].

## Conclusions

Supplementation with concentrate increases cattle production in deferred pastures. During the period of use of deferred pastures, in winter, there is a decrease in the amount of forage, as well as limitations in the structure of the pasture and the quality of the forage grazed by cattle.

**Authors' note:** this article is derived from the Master's Thesis in Animal Science by the Universidade Federal de Viçosa of the first author.

## References

1. Shio AR, Veloso CM, Silva FF, Ítavo LCV, Mateus RG, Silva RR. Ofertas de forragem para novilhas nelore suplementadas no período de seca e transi¬ção seca/águas. Acta Scientiarum. Animal Sciences. 2011. (33)1: 9-17. Available from: http://periodicos.uem.br/ojs/index.php/ActaSciAnimSci/article/view/9112. Portuguese.

2. Reis RA, Ruggieri AC, Oliveira AA, Azenha MV, Casagrande DR. Suplementação como estratégia de produção de carne de qualidade em pastagens tropicais. Revista Brasileira de Saúde e Produção Animal. 2012. (13)1: 642-655. Available from: http://revistas.ufba.br/index.php/rbspa/article/viewArticle/2615. Potuguese.

3. Santos MER, Fonseca DMF, Balbino EM, Monnerat JPIS, Silva SP. Caracterização de perfilhos em pastos de capim-braquiária diferidos e adubados com nitrogênio. Revista Brasileira de Zootecnia [on-line version]. 2009a; 38(4): 643-649. Available from: http://dx.doi.org/10.1590/S1516-35982009000400008. Portuguese.

4. Santos MER, Fonseca DM, Euclides VPB, Nascimento Júnior D, Queiróz AC, Ribeiro Júnior JI. Características estruturais e índice de tombamento de *Brachiaria decumbens* cv. Basilisk em pastagens diferidas. Revista Brasileira de Zootecnia. 2009b. (38)4: 626-634. Available from: http://www.scielo.br/pdf/rbz/v38n4/06.pdf. Portuguese.

5. Silva CS, Montagner DB, Euclides VPB, Queiroz CA, Andrade RAS. Steer performance on deferred pastures of Brachiaria brizantha and *Brachiaria decumbens*. Ciência Rural. 2016. (46)1: 1998-2004. Available from: http://dx.doi.org/10.1590/0103-8478cr20151525.

6. Kopen W. Climatologia. Buenos Aires, Argentina: Gráfica Pan-Americana, 1948.

7. EMBRAPA. Sistema brasileiro de classificação de solos. 2nd ed. Rio de Janeiro: Embrapa Solos; 2006; 306p. Portuguese.

8. Cantarutti RB, Martins CE, Carvalho MM, Fonseca DM, Arruda ML, Vilela H, Oliveira FTT. Pastagens. In: Ribeiro AC, Guimarães PTG, Alvarez VVH. Comissão de Fertilidade do Solo do Estado de Minas Gerais. Recomendação para o uso de corretivos e fertilizantes em Minas Gerais. Viçosa - 5a Aproximação. 1999. p. 332 - 341.

9. Santos MER, Santos AD, Fonseca DM, Sousa BML, Gomes VM, Chaves. Cattle production supplemented on signal grass pastures during the rainy season. Acta Scientiarum [On-line version]. 2016; 38(4): p.53-60. Available from: http://dx.doi.org/10.4025/actascianimsci.v38i1.29104. English.

10. Santos MER, Fonseca DM, Euclides VPB, Júnior JIV, Nascimento Júnior D, Moreira LM. Produção de bovinos em pastagens de capim-braquiária diferidas. Revista Brasileira de Zootecnia [On-line version]. 2009c; 38(4): p. 635-642. Available from: http://dx.doi.org/10.1590/S1516-35982009000400007. Portuguese.

11. Silva DJ, Queiroz AC. Análise de alimentos: métodos químicos e biológicos. 3rd ed. Viçosa: UFV, 2006. 235p.

12. Da Silva SC, Nascimento Júnior D. Avanços na pesquisa com plantas forrageiras tropicais em pastagens: características morfofisiológicas e manejo do pastejo. Revista Brasileira de Zootecnia [On-line version]. 2007; 36(Suplemento 0): p.121-138. Available from: http://dx.doi.org/10.1590/S1516-35982007001000014. Portuguese.

13. Trindade JK, Silva SC, Júnior SJS, Giacomini AA, Zeferino CV, Guarda VDM, Carvalho PCF. Composição morfológica da forragem consumida por bovinos de corte durante o rebaixamento do capim-marandu submetido a estratégias de pastejo rotativo. Pesquisa Agropecuária Brasileira [On-line version]. 2007; 42(6): p. 883-890. Available from: http://dx.doi.org/10.1590/S0100-204X2007000600016. Portuguese.

14. Santos MER, Fonseca DM, Balbino EM, Silva SP, Monnerat JPIS. Valor nutritivo de perfilhos e componentes morfológicos em pastos de capim Braquiária diferidos e adubados com nitrogênio. Revista Brasileira de Zootecnia [On-line version]. 2010; 39(9): p.1919-1927. Available from: http://dx.doi.org/10.1590/S1516-35982010000900009. Portuguese.

15. Nave RLG, Pedreira CGS, Pedreira BC. Nutritive value and physical characteristics of Xaraes palisadegrass as affected by grazing strategy. South African Journal of Animal Science. 2010; 40: 285-293.

16. Souza DOC, Fernandes WB, Silva GF, Santos MERS, Silva SP. A roçada do capim-marandu alto no fim do inverno melhora a estrutura do pasto no início do verão. Enciclopédia Biosfera. 2015; 11(21): 12-22.

17. Benvenutti MA, Gordon IJ, Poppi DP. The effects of stem density of tropical swards and age of grazing cattle on their foraging behavior. Grass and Forage Science. 2008; 63: 1–8.

18. Paula CCL, Euclides VPB, Lempp B, Barbosa RA, Montangner DB, Carloto MN. Acúmulo de forragem, características morfogênicas e estruturais do capim-marandu sob alturas de pastejo. Ciência Rural [Online]. 2012; 42: 2059-2065. Available from: http://www.scielo.br/pdf/cr/2012nahead/a30412cr5188.pdf. Portuguese.

19. Euclides VPM, Filho KE, Arruda ZJ, Figueiredo GR. Desempenho de novilhos em pastagens de *Brachiaria decumbens* submetidos a diferentes regimes alimentares. Revista Brasileira de Zootecnia. 1998; 27(2): 246-252.

20. Fortes AC. Métodos de lotação e suplementação em pastagens diferidas de capim-piatã para recria de gado de corte no período seco no norte do estado do Tocantins. Rio de Janeiro. Dissertação [Mestrado em Ciências] - Universidade Federal Rural do Rio de Janeiro, Rio de Janeiro; 2013. Disponível em http://www.nepral.com.br/2013-metodos-de-lotacao-e-suplementacao-em-pastagens-diferidas-de-capim-piata-para-recria-de-gado-de-corte-no-periodo-seco-no-norte-do-estado-do-tocantins-2/.