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Performance of dairy heifers grazing on *Urochloa decumbens* pastures deferred for two periods

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ABSTRACT. Voluntary intake and performance of dairy heifers grazing on *Urochloa decumbens* pastures with two deferral periods are evaluated. The totally randomized experimental design consisted of two treatments and seven replications, with two deferral periods: T1 = 95 and T2 = 140 days. Fourteen Holstein-Zebu heifers, average body weight (BW) 300 kg, were used. Intake of forage dry matter was 2.5% and 1.2 BW respectively for treatments 95 and 140 days. In treatment T2 the animals had an intake of only 139.5 g of CP, due to low nutrient content, or rather, 3.4% of CP in the forage available. There was an intake of NDF of 1.7% and 1.0 of BW for T1 and T2, respectively. The average daily weight gain was 785.8 g day^{-1} for T1 and average weight loss of -31.1 g day^{-1} for T2. Deferral of pastures *Urochloa decumbens* for 95 days to allow a 1.5 lodging index provides greater consumption and performance of dairy heifers. Deferral of *Urochloa decumbens* pastures to allow a 1.5 lodging index provides greater intake and performance of dairy heifers.

Keywords: structural features, voluntary intake, weight gain, tropical pastures.

Desempenho de novilhas leiteiras em pastagens de *Urochloa decumbens* diferidas por dois períodos

RESUMO. O objetivo deste trabalho foi avaliar o consumo voluntário e o desempenho de novilhas leiteiras em pastos de *Urochloa decumbens* diferidos com dois períodos de diferimento. O delineamento experimental adotado foi inteiramente casualizados com dois tratamentos e sete repetições, que consistiram em dois períodos de diferimento: T1= 95 e T2= 140 dias. Foram utilizadas 14 novilhas Holandês/Zebu com peso corporal (PC) médio de 300 kg. O consumo de matéria seca da forragem representou 2,5 e 1,2% do PC para os tratamentos 95 e 140 dias, respectivamente. Para o tratamento T2 os animais tiveram um consumo de apenas 139,5 g de PB, consequência do baixo teor deste nutriente, 3,4% de PB, na forragem disponível. Verificou-se um consumo de FDN 1,7 e 1,0% do PC para os tratamentos T1 e T2, respectivamente. O ganho de peso médio diário foi de 785,8 g dia^{-1} para o tratamento T1, enquanto no T2 houve perda de peso, em média -31,1 g dia^{-1}. Na prática, o diferimento de pastos de *Urochloa decumbens* por 95 dias que permitam uma estrutura com índice de acamamento de 1,5 proporciona maior consumo e desempenho de novilhas leiteiras. Na prática, o diferimento de pastos de *Urochloa decumbens* que permitam uma estrutura com índice de acamamento de 1,5 proporciona maior consumo e desempenho de novilhas leiteiras.

Palavras-chave: características estruturais, consumo voluntário, ganho de peso, pastagens tropicais.

Introduction

Production of heifers on grazing pastures is one of the most competitive and income-producing alternatives when administered and planned rationally. However, the phenology of tropical grass and variations of climate conditions throughout the year cause high forage production during the summer and low forage production during the dry period, featuring seasonality in animal production.

Pasture deferral, an easy and low-cost method, is one of the relevant strategies for the availability of forage during the dry period. Pasture deferral may not reach productivity targets. Proportionally to increase in pasture deferral period, forage yield also increases due to stem lengthening. Consequently, there are increasingly high proportions of stems and a decrease in leaf:stem ratio in the pasture biomass. Since the latter are scarcely consumed, the animals' low productivity may occur in such conditions (SANTOS et al., 2004).

Heifers in deferred pastures have only a fair performance or they simply maintain their body weight (SANTOS et al., 2004) since deferred forage is characterized by low nutrition rates. So that supplementation in deferred pastures may be maximized, the available forage must be of such quality, composition and structural features that it would not restrict animal intake.

Intake is relevant for decision-taking and planning in pasture management since it is the main cause for the performance of ruminants bred on pasture (REIS; SILVA, 2006). Voluntary intake during grazing is not only controlled by physical and chemical static mechanisms (BALCH; CAMPLING, 1962), but it is also affected by the animals' capacity in collecting forage. Animal performance is directly dependent on daily forage intake and indirectly by the effects of the grazing process on forage composition, structural characteristics and productivity. Further, modifications in mass and supply of available forage occur during the grazing period and they influence the animals' ingestion behavior and performance (SANTOS et al., 2009c).

Understanding changes in forage composition and structure on animals' intake and performance may trigger efficient management recommendations on deferred pastures. Current assay evaluates voluntary intake and performance of dairy heifers on deferred pastures *Urochloa decumbens* (Stapf) R. D. Webster cv. Basilisk [syn. *Brachiaria decumbens* Stapf cv. Basilisk], with two deferral periods.

Material and methods

The assay was performed at the cattle section of the Universidade Estadual do Sudoeste da Bahia (UESB) in Itapetinga Bahia State Brazil, in the southwestern region of the state of Bahia, Brazil, at 15º18'14"S and 40º12'10"W, altitude 268 m, between March and August 2009. According to Köppen's classification, the region's climate is Cw, with humid and sub-humid mesothermal climate, with hot dry winters. Summers, between October and March, are hot, whereas the dry period, between May and October, is cold, with 25% of yearly rainfall. Average yearly rainfall is 892 mm and mean annual temperature is 27ºC (Table 1).

The totally randomized experimental design comprised two treatments and seven replications. Two 0.8 ha paddocks, hedged by electrified wires, were installed. The *Urochloa decumbens* pastures were out of bounds from the beginning of February and late March and used in June 2009, with deferral period of 140 and 95 days respectively. Treatments comprised two deferral periods: T1 = 95 and T2 = 140 days. Fourteen 23-day-old Holstein-Zebu heifers, mean body weight (BW) 300 ± 25.5 kg, identified by numbered tags on the right ear, were used. After treated for ecto- and endo-parasites and vaccined according to local timetable, the heifers were weighed and distributed randomly in the paddocks.

Table 1. Monthly averages of daily temperature, monthly minimum temperature, historical rainfall index and index during the experimental period between November 2008 and November 2009.

Month/Year	Mean Temperature (°C)	Minimum temperature (°C)	Historical rainfall index (mm)	Rainfall index during assay (mm)
November/2008	26.4	21.0	131.8	113.4
December/2008	26.8	21.0	124.7	189.3
January/2009	27.6	20.0	75.6	78.4
February/2009	28.0	20.0	82.4	5.6
March/2009	28.9	20.0	136.5	83.4
April/2009	27.6	21.0	75.2	112.4
May/2009	25.2	17.0	46.0	17.8
June/2009	23.9	16.0	27.6	41.1
July/2009	26.0	15.0	46.0	6.1
August/2009	25.9	16.0	33.0	70.4
September/2009	26.8	16.0	21.2	41.2
October/2009	28.5	18.0	60.4	145.9
November/2009	30.5	19.0	131.8	13.8

A complex, approximately 50 m from the pasture, comprising a pen and a 2,000 kg balance, was installed for the management of the heifers. Mineral salt supplementation was supplied *ad libitum* in covered fiber troughs placed in the paddocks. Total experimental period consisted of 76 days. For adaptation's sake, the heifers were placed in a 2-ha annex during the first 20 days, supplied with conditions and pasture similar to those of the experimental area. Pasture area was used intensively and pasture lowered to a height of 10 cm. Animals were not allowed to enter between the beginning of February and the end of March, with a period of 95 days (T1) and 140 days of deferral (T2), respectively.

Pasture and plant height were measured by ruler at 40 sites of each paddock, after the deferral period and prior to the entrance of the animals. Height of extended plant was measured by extending vertically the grass shoots and registering the greatest distance from the ground to the tip of the shoots, calculated by the quotient between the height of the extended plant and the height of the pasture. Lodging index and percentage of the deferred pasture were determined according to Santos et al. (2009b).

Three samples from each paddock were collected prior to the introduction of the animals. The samples, measuring 0.70 x 0.70 m (0.49 m^2) x 1.40 m high, were harvested every 0.20 m, beginning from the canopy top, at three vertical layers A, B and C, by a stratificator. An iron square linked to the stratificator and supported by metal grips was used to guide the cutting height (HACK et al., 2007). Samples were cut at ground level with a 0.70 x 0.70 m (0.49 m^2) square for the other harvests.

Samples were then conditioned in plastic bags and weighed in the laboratory. They were homogenized and divided into two representative sub-samples. One sub-sample was divided into leaf lamina, stem + shield and senescent matter; the components were then conditioned in paper bags, weighed and dried in an air buffer at 60°C, for 72 hours. The other sub-sample was also conditioned in a paper bag, weighed and dried in an air buffer at 60ºC for 72 hours. After ground in a Willey mill with a 1 mm sieve, dry matter rates (DM), total nitrogen and neutral detergent fiber (NDF) in total forage samples were determined according to Silva and Queiroz (2002). Total carbohydrates (CHOT) were derived by equation: 100 - (%CP + %EE + %Ashes), whereas non fibrous carbohydrate (CNF) were obtained by the difference between CHOT and NDFcp (NDF without ashes and protein). Total digestible nutrients (TDN) were calculated by TDN (%) = 83.79 – 0.4171 x NDF (%) (CAPPELLE et al., 2001). Indigestible NDF (NDFi) was estimated by digestibility *in situ* for 240 hours in the rumen of fistulated cross-bred Holstein-Zebu heifers and potentially digestible dry matter (DMpd) was calculated by formula: DMpd = [0.98x(100-NDF)] + (NDF-NDFi) = [0.98x(100-NDF)] + NDFpd.

Forage volume density and its morphological components in kg cm^{-1} ha^{-1} were calculated by dividing forage mass and the mass of its morphological components, respectively, by pasture height. Ratio leaf:stem was calculated as the quotient for dry mass of leaves and dry mass of stems. The evaluation of tiller population density was undertaken in two collections, prior to the introduction of the animals and at their exit. A plant sample per parcel, measuring 0.25 x 0.25 m, with a total area of 0.0625 m^2, was retrieved from each collection. After cutting, the samples were transported to the laboratory for separation and counting of total number of basal vegetative, reproductive and dead tillers. Continuous stocking with a fixed stocking rate of 5.8 UA ha^{-1} was used. Forage Supply (FS) was calculated by FS = {(DRB*area + DAR*area)/totalBW}*100, where FS = forage supply in kg DM 100 kg^{-1} PC day^{-1}; DRB = daily residual biomass, in kg DM ha^{-1} day; DAR = daily accumulation rate, in kg DM ha^{-1} day; total BW = total body weight in kg.

Chromium oxide (Cr_2O_3), as external indicator supplied daily at 9:00 am by a single 10 g dose during 11 days, was used to calculate fecal production. A 7-day period was calculated for the adaptation and regulation of the marker's excretion flow and five days for the collection of feces. Approximately 200 g of feces were collected once a day at the time of the dispensing of indicator, directly from the rectal vial, and stored in a cold chamber at -10ºC. Feces samples were analyzed by atom adsorption spectrophotometry (AAS) for chromium dose, following Williams et al. (1962).

Fecal production was determined by:

FP = OF/COF, where FP is daily fecal production (g day^{-1}); OF supplied chromium oxide (g day^{-1}) and COF is the concentration of chromium oxide in the feces (g g^{-1} DM).

For the determination of internal indicator, indigestible neutral detergent fiber (NDFi), samples of forage of feces were incubated in the rumen of four fistulated animals for 264h. Residue was considered indigestible.

Partial and total apparent digestibility and the intake of dry matter were estimated by fecal production and verified by chromium oxide (Cr_2O_3) and by NDFi respectively as external and internal indicators.

DM intake was given by the equation:

CDM = FP*CIFZ/CIFR, where CDM is the intake of dry matter (kg day^{-1}); FP is fecal production (kg day^{-1}); CIFZ concentration of indicator in feces (kg kg^{-1}) and CIFR is the concentration of the indicator in forage (kg kg^{-1}).

The animals were weighed before admittance to pasture, on the 28th day and at the end of the experiment so that mean daily gain (MDG) could be evaluated. Weighing was preceded by 12-h fasting and animal performance was determined by the difference between initial BW and final BW divided by the experimental period in days.

Data were evaluated by analysis of variance with F test at 5% probability and by coefficients of variation. Statistic and Genetic Analyses System (SAEG) was employed for statistic analyses.

Results and discussion

Mean feces production was estimated when chromium oxide reached 0.96 kg of DM 100 kg^{-1} of body weight (BW). Rates were higher than 0.75 and 0.84 kg of DM 100 kg^{-1} of BW registered by Euclides et al. (2000) for heifers grazing on *Urochloa decumbens* during summer and during the dry period, respectively. Differences were reported ($p \leq 0.05$) in forage intake and its components between pastures with different deferral periods, with special reference to high intake levels of DM, CP, NDF, NFC and TDN for pasture with 95-day deferral (T1) (Table 2).

Table 2. Daily intake of dairy heifers grazing on deferral pasture *Urochloa decumbens*, evaluated in pastures with two deferral periods.

Item	Deferral periods (days)		CV (%)
	95	140	
Intake DM (kg DM)	7.3a	3.7b	14.0
Intake (% BW)	2.5a	1.2b	13.9
Cons. CP (g)	592.4a	139.5b	15.6
Cons. NDF (kg)	5.0a	3.0b	13.7
Cons. NDF (% BW)	1.7a	1.0b	13.7
Cons. NFC (g)	1.146.6a	152.5b	16.7
Cons. TDN (kg)	4.9a	1.8b	14.9

Crude protein (CP); neutral detergent fiber (NDF); non-fibrous carbohydrates (NFC), total digestible nutrients (TDN). Means followed by different letters in the same line differ by F test ($p \leq 0.05$).

Intake of dry matter of *Urochloa decumbens* was 2.5 and 1.2% BW respectively for treatments T1 and T2. Higher intake in pastures with 95-day deferral periods may be attributed to high forage availability (Table 3). Teixeira et al. (2011a) evaluated the production of *Urochloa decumbens* distributed during Summer, Autumn, Winter and Spring and reported productions 8.573, 6.738, 984 and 1.155 kg ha^{-1} of dry matter for 95-day deferred pastures and 6.027, 7.591, 839 and 2.530 kg ha^{-1} of dry matter for 140-day deferred pastures respectively during the seasons. High forage availability may be underscored in autumn, the deferral season, for two deferral periods under analysis.

Table 3. Percentage and availability of dry matter in three vertical layers in *Urochloa decumbens* pastures evaluated in pastures with two deferral periods.

Layer[1]	Deferral periods	
	95	140
	Dry Matter (%)	
A	27.3	-
B	27.8	-
C	31.9	30.6
	Availability of dry matter[2]	
A	732.2	-
B	1.777.2	-
C	4.694.0	4.869.2

[1] Layer A: over 0.40 m; layer B: 0.20-0.40 m; layer C: 0-0.20 m from the ground; [2]kg ha^{-1} of dry matter.

Rates in T1 were close to 2.24% of BW reported by Cavalcanti Filho et al. (2004) who also evaluated the intake of Holstein-Zebu heifers with mean BW close to 300 kg estimated by the use of chromium oxide. Higher rates were reported by Euclides et al. (2000) who evaluated voluntary intake of *Urochloa decumbens* with supply of chromium oxide and reported intake of 2.67 and 1.98% BW, respectively for the rainy and dry periods.

The factors that affect intake and the regulating mechanisms are several and not totally known. Nutrient rate of available forage may affect the amount of forage consumed by ruminants whilst deficiencies in specific nutrients may restrict intake. Animals seek high nutritive amount and rate, whereas plants envisage lower frequency and intensity of leaf shedding leading towards a structure with a great proportion of leaves in the pre- and post-grazing period and thus warranting the maintenance of production and productivity of pastures. Understanding the relevance and contribution of such relationships triggers the establishment of management strategies to provide adequate conditions that would favor forage intake and fast and vigorous re-shooting by the plant (TEIXEIRA et al., 2010). Since the animals were supplemented with mineral salt *ad libitum*, it may be surmised that intake was not restricted by macro- and micro-nutrients.

High CP intake ($p \leq 0.05$) in pastures with 95-day deferral periods may have been caused by the nutrient's high rate on the canopy's vertical layers which were probably more accessible to animals and had high participation of leaves (Table 4). The animals on 140-day deferral pastures had a daily intake of only 139.5 g CP, caused by the low rate of the nutrient, namely 3.4%, of available forage (Table 4).

Table 4. Rates of crude protein, neutral detergent fiber and total digestible nutrients in three vertical layers in *Urochloa decumbens* pastures evaluated in pastures with two deferral periods.

Layer 1	Deferral periods(days)	
	95	140
	Crude Protein[2]	
A	10.0	-
B	7.0	-
C	4.6	3,4
	Neutral detergent fiber[2]	
A	66.4	-
B	73.3	-
C	79.9	88,1
	Total digestible nutrients[2]	
A	53.6	-
B	48.3	-
C	41.5	42,7

[1]Layer A: over 0.40 m; layer B: 0.20-0.40 m; layer C: 0-0.20 m from the ground; [2]%DM.

There was a lower NDF intake in pastures with 140-day deferral periods (Table 2) which may be attributed to higher NDF rates in the forage consumed during the period (Table 4). The rumen-reticulum distension is one of the factors that limit the intake of tropical grass due to high NDF rates. In fact, the nutrient's intake represents the ability to consume dry matter for roughage-based diets which constitute the cell wall that occupies the greatest space in the rumen. Euclides et al. (2000) reported a negative co-relationship between forage intake and NDF of diet selected by animals. Mertens (1997) suggested a quantitative strategy to perceive that intake was restricted by rumen completeness (physical control), or rather, the verification that NDF intake was higher than 1.20% of BW. Since the above author developed the system for high milk-producing cows in temperate regions, the suggested rate is a mere parameter to foreground research in the case of investigations in tropical regions and with animals with high Zebu blood levels.

Current study registered forage intake of 2.5 and 1.2% of BW (Table 2) for treatments T1 and T2, respectively. Foregrounded on Merten's (1997) theory, intake during the first period was limited by NDF, whereas intake during the second period was not limited by completeness. Analyzing the same grass and heifers of the same category as those in current study, Cavalcanti Filho et al. (2004) reported mean NDF intake of 1.53 BW, due to voluntary intake. Euclides et al. (2000) registered mean NDF intakes of 1.46 and 1.82% BW respectively in the dry and rainy periods.

Low NFC intake occurred for 95-day deferral pastures with an intake of only 13% NFC for the last period when compared to nutrient intake for the first period (Table 2). Low intakes for the nutrients may be due to decreased TDN intake during the period (Table 4), which may be considered a diet energy deficit. Euclides et al. (2007) simulated *Urochloa decumbens* diet with deferred pastures and revealed maintenance energy deficiency of 1.16 Mcal per Day. The authors concluded that energy and protein supplementation was required for weight gain of animals on such pastures.

Drastic decrease in the intake of all nutrients under analysis may be due not only to the reduction of the forage's nutrition quality (Table 4) but mainly to the difficulty in its selection and collection by animals. The intake of grazing animals may be controlled by factors associated to management and/or structural characteristics inherent to forage plants which affect biting and selecting. Although plant-animal relationships interfere in the animals' decision to seek food on the pastureland, the grazing process causes changes in the plants' structure. Further, a type of feedback triggers modifications in patterns of displacement, seeking and grasping of food, unfolding of leaves and shoots during lowering of the pasture height to compensate decrease in intake rates. The above effects are more relevant in tropical pastures that have special stalk harshness and density which become an impairment in the animals' grazing process, especially to the older ones (TEIXEIRA et al., 2010).

The structural characteristics of deferred *Urochloa decumbens* pastures in Table 5 detail difficulties in the selection of forage by animals in 140-day deferral pastures. Euclides et al. (2000) evaluated the voluntary intake of *Urochloa decumbens* and reported that animals preferred leaves to stems and green forage to senescent one even when there was low availability of leaves. In fact, leaves constituted more than 84% of the diet selected by the animals. On the other hand, the low leaf:stem ratio, or rather, high quantity of green stalk in 140-day deferral pastures may be an impairment to defoliation. In fact, it decreases ease in forage collection endeavored by the grazing animal, since maximum intake occurs when animals are grazing on high densities of available leaves. Although a higher percentage of stalks in the pasture has already been expected, the grazing animals also consume green stalks in deferred pastures proportionally to increasing difficulties in leaf selection.

Table 5. Structural characteristics of *Urochloa decumbens* pastures evaluated in pastures with two deferral periods.

Item	Deferral periods (days)	
	95	140
Lodging index	1.5	2.2
Lodging (%)	37.7	53.3
Leaf:stalk ratio	2.3	1.9
Leaf (%)	50.3	17.3
Forage density (kg cm^{-1} ha^{-1})	97.1	74.1
Vegetative tiller density (m^2)	986.5	640.0
Dead tiller density (m^2)	144.4	358.2

[1]quotient between extended plant height and pasture height.

Teixeira et al. (2011b) suggested that nitrogenated fertilization close to the deferral period potentiated stalk lengthening as one of the nitrogen effects. Although the great accumulation of dry mass is an asset, the plant's extended heightening, compared to the height of deferred pastures, may cause the collapse of the plants which is unwanted due to the reduction of forage quality and subsequent intake liability by heifers. According to Santos et al. (2009a), deferred pastures generally form a type of pasture structure with horizontally placed tillers. A consequence of such structure is the possible increase of forage loss during pasture and lower efficiency in forage use caused by plant lodging. Santos et al. (2013) evaluated defoliation patterns in *Brachiaria decumbens* tillers with different heights and reported interdependence between patterns of defoliation caused by cattle and the spatial variability of vegetation with the pasture's horizontal structure. The latter changes the patterns of defoliation of individual tillers and alters the animals' ingestion behavior. Further, Pariz et al. (2011) evaluated the spatial variability of forage production and the soil's physical qualities in *Urochloa decumbens* pastures and reported decrease in forage dry matter plus density increase of soil from 0 to 0.10 m. The above indicated physical degradation (impounding), especially on pastures with high stocking rates and excessive trampling on the savannah soil.

Forage density and vegetative tiller density had higher rates in 95-day deferral pasture which would probably facilitate larger mouthfuls and, consequently, higher intakes when compared to 140-day deferral pasture. Mouthful size may be affected by the volume density of the grazed layer and may define the bit size or mass which is the most determinant variable of animal intake. Therefore, any change in bit mass, either due to a response to the canopy's variation or to a behavioral decision, may be associated to the spatial arrangement of the plant community.

Lodging percentage increased ($p \leq 0.05$) in 140-day deferral pastures (Table 5) due to animal trampling during grazing. Although the great accumulation of dry matter is an asset, plant lodging is common in deferred pastures but not desirable in canopy structure. In fact, it provides liability in heifers' intake. High lodging percentage reported in pastures in proportion to grazing certainly formed the canopy's spatial structure which made difficult the access to animals to the most nutritive factors and probably increased grazing time. This fact may be attributed to intake decrease. According to Euclides et al. (2000), grazing period ranges between seven and ten hours. Long grazing period indicates that intake is restricted by the forage's structural characteristics which make difficult the selection and grasping of forager.

Mean weight gain was 785.8 g day^{-1} in 95-day deferral pastures (T1), whereas mean weight loss of -31.1 g day^{-1} occurred in 140-day deferral pastures (Table 6). Good performance in animals in T1 may have been caused by the high forage supply, 17.9% BW, and by easy access for the most nutritive components, leaf blades and green stems by the heifers (Table 5). The above characteristics represented high nutrient intake (Table 2) which, in its turn, explained the high performance of heifers during this period. Although similar pasture conditions were provided during the adaptation of the animals, compensatory gain by heifers may have occurred.

Table 6. Forage performance and supply in *Urochloa decumbens* pastures evaluated in pastures with two deferral periods.

Variable	Deferral period (days)		CV (%)
	95	140	
Supply of DM in % BW	17.9	10.9	-
DMG (g day^{-1})	785.8^a	-31.1b	18.0
DDM (%)	60.7^a	22.5b	8.8

Daily mean weight gain (DMW); digestibility of dry matter (DDM). Means followed by different letters in the line are different by F test ($p < 0.05$).

Results in current study may be justified due to the high forage mass (7203.4 kg ha^{-1} DM) especially at the higher layers, with a high proportion of leaves with crude protein rates close to 10% (Table 4), easily available to heifers in pastures with 95-day deferral.

High stocking rate in current assay, 5.8 UA ha^{-1}, aimed at forcing a faster intake, decrease lodging and provide a better benefit of low quality forage. However, the strategy may have contributed towards weight loss in animals in 140-day deferral treatment.

Conclusion

Although deferred *Urochloa decumbens* pastures provide a high accumulation of forage at the end of Summer, they reveal structural characteristics that affect intake decrease, drastically reduced with 140-day deferral. In practice, pasture deferral period that would permit a structure with a 1.5 lodging rate provide a higher intake and performance of dairy heifers.

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