Research Note

Cattle Grazing Distribution and Efficacy of Strategic Mineral Mix Placement in Tropical Brazilian Pastures

Ricardo C. D. Goulart,[1] Moacyr Corsi,[2] Derek W. Bailey,[3] and Silvio S. Zocchi[2]

Authors are [1]Graduate Student and [2]Professor, São Paulo University, Escola Superior de Agricultura Luiz de Queiroz, Departamento de Zootecnia, Av. Pádua Dias, 51, Brazil; and [3]Department of Animal and Range Sciences, New Mexico State University, Las Cruces, NM 88003, USA.

Abstract

A study was conducted in Brazil to identify factors affecting grazing distribution of yearling Nelore cross heifers and to evaluate the efficacy of placement of a salt–mineral mix away from water to improve uniformity of grazing. Two pastures (25 ha and 42 ha) were evaluated for four 15-d sessions. Mineral mix was placed 590 m to 780 m from water during two sessions and at water for two sessions. Stubble heights were measured at the beginning and end of each session in 1-ha subunits of each pasture. Cattle locations were recorded on day 13 and 14 of each session by horseback observers. Heifers avoided areas with a preponderance of forbs and taller grass ($P < 0.001$). For the first 15 days of the study cattle avoided subunits farther from water. Thereafter, horizontal distance from water had no affect on grazing use ($P > 0.10$). Stubble height reduction was more uniform ($P < 0.05$) when the mineral mix was at water compared to away from water. In contrast, heifers spent less time farther from water when mineral mix was placed at water ($P = 0.02$) based on visual observations. Strategic placement of a salt–mineral mix away from water does not appear to be a reliable tool to improve cattle grazing distribution in humid tropical pastures from 25 ha to 45 ha in size.

Resumen

Este estudio se llevó a cabo en Brazil para identificar los factores que afectan la distribución de vaquillas de sobre-año cruzadas con la raza Nelore y para evaluar la eficiencia de la colocación de una mezcla mineral retirada de los bebederos para mejorar la distribución del pastoreo. Se evaluaron dos potreros (de 25 y 42 hectáreas) en cuatro sesiones de 15 días cada una. La mezcla mineral se colocó a una distancia de 590 a 780 de los bebederos por dos sesiones y cerca del agua durante otras dos. La altura de los tallos se midió al inicio y al final de cada una de la sesiones en sub-unidades de una hectárea en cada potrero. La localización del ganado se registró en los días 13 y 14 de cada sesión por medio de observadores a caballo. Las vaquillas evitaron áreas compuestas de herbáceas y gramíneas altas ($P < 0.001$). La distancia horizontal no afectó ($P > 0.10$) el porcentaje de uso con excepción de los primeros 15 días del estudio, cuando las vaquillas evitaron las sub-unidades localizadas lejos de la fuentes de agua. La reducción de la altura de los tallos fue más uniforme ($P < 0.05$) cuando la mezcla mineral estaba cerca de las fuentes de agua comparada cuando estaba lejos de el agua. En contraste, las vaquillas dedicaron menos tiempo alejadas del agua cuando los minerales se colocaron cerca de los aguajes ($P = 0.02$) basándose en la observaciones visuales. La colocación estratégica de la mezcla mineral lejos de las fuentes de agua parece que no es una herramienta confiable para mejorar la distribución del pastoreo en potreros de áreas tropicales con una superficie de de 25 a 45 hectáreas.

Key Words: behavior, salt, supplement

INTRODUCTION

Grazing distribution can be an issue in diverse rangeland systems, from arid areas with low stocking rates to intensively grazed pastures. Beef and milk production in Brazil is based on pasture, ranging from intensive pastures with 8–10 animal units (AU) $\cdot$ ha^{-1} to low input systems with 0.7 AU $\cdot$ ha^{-1} (Maraschin 2001). Although grazing distribution problems occur frequently, few studies have evaluated management strategies to improve grazing distribution under conditions present in Brazil, which include different cattle breeds, climate, forage growth, and spatial scale than rangelands elsewhere. Placement of salt away from water has been recommended for years (Williams 1954); however, research in Montana and Oregon suggests that salt and mineral supplements are not effective attractants for modifying cattle distribution (Ganskopp 2001; Bailey and Welling 2007). Moreover, placing salt away from water may reduce mineral intake (Martin and Ward 1973), which could severely limit weight gain on Brazilian pastures because of low mineral content in forage.

Objectives of this study were to determine factors affecting cattle grazing patterns on tropical Brazilian rangeland and to evaluate the efficacy of strategic mineral placement to modify grazing distribution.

Correspondence: Derek W. Bailey, Dept of Animal and Range Sciences, New Mexico State University, PO Box 30003, MSC 3-I, Las Cruces, NM 88003, USA. Email: dwbailey@nmsu.edu

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MATERIAL AND METHODS

Study Site

The study was conducted at "Georgina von Pritzelwitz" Experimental Station, at Londrina, Paraná, Brazil (lat 23°32′42″S, long 50°58′19″W), which has clay soils and a

Table 1. Mineral mixture composition.

Mineral	Concentration
Calcium	16%
Phosphorus	1%
Sulfur	4%
Sodium	14%
Copper	1 010 ppm[1]
Manganese	780 ppm
Zinc	3 750 ppm
Iodine	75 ppm
Cobalt	60 ppm
Selenium	19 ppm
Fluoride	660 ppm

[1]ppm indicates parts per million.

humid subtropical climate. Average annual precipitation ranges between 1 400 m and 1 600 mm. Average annual temperature is 21°C, with an average maximum temperature of 27.6°C and minimum temperature of 15.8°C. Temperature humidity index (THI; American Meteorological Society 2008) averages 70 to 75 throughout the year. Two pastures were used. Caixa seca was 42 ha (roughly 850 × 640 m) with a maximum distance from water of 865 m and slopes varying from 1% to 17%. The Oncinha pasture was 25 ha (roughly 950 × 380 m) with a maximum distance from water of 946 m and slopes of 7% to 18%.

Protocol

One hundred sixty-five heifers were used in the Caixa seca pasture and 57 heifers in Oncinha. Heifers were 16 mo of age and predominantly Nelore (at least three-fourths) with some Charolais breeding. Stocking rates were light to ensure there was sufficient forage to exhibit grazing preferences.

The study consisted of two 30-d periods, beginning 14 January and 13 February of 2005. Periods were further subdivided into two 15-d sessions. Mineral feeders were placed either near or far from water using a crossover design so that feeders were near and far from water during a session, and each pasture was evaluated with the mineral feeders near and far from water during a period. In the Caixa seca pasture, mineral was placed 590 m from water in session 2 of period 1 and 670 m from water during session 2 of period 2. In the Oncinha pasture, mineral was placed 720 m from water in session 1 of period 1 and 780 m from water in session 1 of period 2. Mineral feeders were placed next to the water tank during other sessions. Mineral mix was 35% salt (NaCl) and 65% supplemental minerals (Table 1). Mineral mix intake was estimated by measuring disappearance during 15-d sessions.

Pastures were divided into 1-ha subunits and sampled before and after each 15-d session. Four parallel transect lines (20 m apart) were established within each subunit. Two transect lines were 60 m, and two were 80 m. Stubble height of the dominant grass (*Panicum maximum* Jacq.) and basal cover (point intercept) were recorded every 2 m on each transect for a total of 140 measurements per subunit. Consecutive measurements were made at approximately the same locations along these permanent transects, which were relocated with a global positioning system receiver (Garmin eTrex Vista, Olathe, KS).

Plant part components score data were collected on the transect lines every 4 m, resulting in 70 measurements in each subunit, which were averaged together. The plant components score was a categorical classification ranging from 1 to 5 representing leaf to stem ratios that varied from 0.66 to 1.8 (Goulart et al. 2007).

Visual observations were made every 13th and 14th day of the 15-d period. Two observers on horseback using binoculars observed cattle locations and activities every 20 min from sunset to sunrise. Observers were not able to move close enough to the cattle to distinguish between resting and ruminating, so activities were recorded as either grazing or resting (including rumination). The number of animals observed in each 1-ha subunit was recorded using a reference map that contained trees and other references that permitted recognition of subunit boundaries. Horizontal distance from water, vertical distance from water, and average slope for each subunit were calculated using digital elevation models and ArcView 3.3 (ESRI, Redlands, CA). For analyses, values from days 13 and 14 during a session were averaged together.

Statistical Analyses

Multiple regression using stepwise selection (SAS 1999) was used to identify factors related to where cattle grazed. The 1-ha subunits were the experimental units. Dependent variables included the following: 1) percentage of reduction in stubble height during a session (SHR), calculated as the difference between *P. maximum* height before and after each period divided by the height of the grass at the beginning of the period and multiplied by 100 and 2) percentage of cattle observed grazing in each subunit, calculated by dividing the number of cattle observed grazing in each subunit by the total number of cattle in a pasture. Independent variables were forb cover, initial stubble height, plant part components score, horizontal distance from water, vertical distance from water, and slope. Pasture and period were included as binary variables. A significance level of 0.15 was used as a criterion to allow variables to enter the model or to stay in the model after an inclusion of another variable. Simple correlations were used to evaluate the relationship and potential colinearity between independent variables. Variables that were highly related ($r > 0.30$) were not included in the same model.

Analysis of covariance was used to evaluate the effect of mineral placement (near or far from water) on SHR and cattle locations (Littell et al. 1996). The model included pasture, period, mineral placement (at or far from water), distance to water, and the mineral placement by distance to water interaction.

Mineral mix intake was compared between placement near and far from water using analysis of variance (SAS 1999). The model included mineral placement location, pasture, and period.

RESULTS AND DISCUSSION

Botanical Composition

Panicum maximum made up 88% and 87% of grass basal cover on Caixa seca and Oncinha pastures, respectively. *Paspalum notatum* Flugge (6%) and other grasses made up

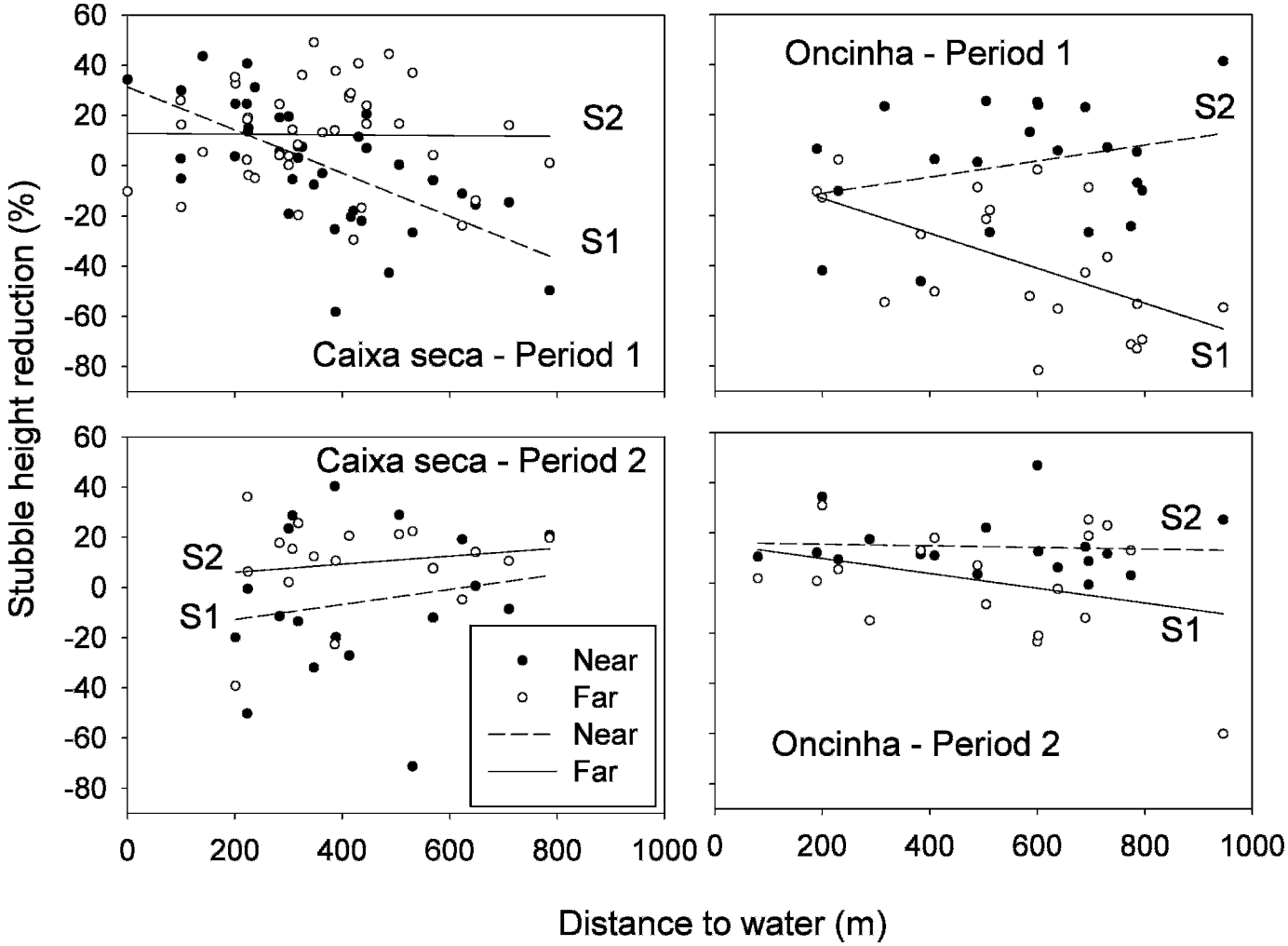

Figure 1. Scatter plot of stubble height reduction (%) and distance to water in the Caixa seca and Oncinha pastures during the first 30 d (period 1) and second 30 d of the study (period 2). During each period, a salt–mineral mix was placed near water (within 10 m) for 15 d (a session) and far from water (≥ 590 m) for 15 d. Stubble height reduction is the percentage of change in height of *Panicum maximum* in a 1-ha subunit of a pasture from the beginning of a 15-d session to the end. The predicted relationships between stubble height reduction and distance that a subunit was from water based on simple linear regression are plotted for the first and second sessions during a period and are indicated by S1 and S2, respectively.

the remaining grass cover. Stubble height before grazing averaged 78 cm (range, 33 cm to 189 cm) in the Caixa seca pasture and 45 cm in the Ochinha pasture (range, 31 cm to 66 cm). Forbs made up 11% to 67% of total basal cover in the Caixa seca pasture and 6% to 35% in the Oncinha pasture.

Correlations

Visual observation data were not related to SHR ($r = 0.05$, $P = 0.49$). Overall, visual observations during days 13 and 14 within a session were related ($r = 0.25$, $P < 0.001$). When sessions within a pasture were evaluated separately, there was no correlation between days 13 and 14 ($r \leq 0.20$, $P \geq 0.20$) in half of the sessions, but there was a relationship ($r > 0.40$, $P < 0.01$) in other sessions. Such results are not surprising, because cattle rarely remain in the same area for more than two consecutive days in relatively homogenous pastures (Bailey et al. 1990). Observations were conducted on consecutive days for efficacy of labor use rather than estimation of cattle spatial use. The SHR measurements are likely to be a more reliable estimate of pasture use than the visual observations in this study. To obtain accurate estimates of cattle grazing patterns, observations should be collected on several days spread across the observation period, even on small pastures.

Prediction of SHR and Cattle Location

Mineral was placed near water in the Caixa seca pasture and far from water in the Oncinha pasture during the first 15 d of period 1 (session 1). Stubble height reduction was greater near water during session 1 regardless of mineral placement (Fig. 1). During session 1, SHR declined by 8.6 percentage points ± 1.8 SE for every 100-m increase in distance from water in the Caixa seca pasture ($P < 0.001$) and decreased by 7.0 percentage points ± 2.3 SE in the Oncinha pasture ($P = 0.007$). However, horizontal distance to water was not a useful predictor of SHR when evaluated over the entire study (Table 2). The maximum distance from water in this study was 946 m, which is less than the value of 1 600 m that Holechek (1988) suggested might reduce grazing use.

In addition to pasture and period, SHR was affected by stubble height and forb cover (Table 2). Cattle avoided subunits

Table 2. Multiple regression models used to predict stubble height reduction and time spent by heifers in subunits based on visual observations. Parameters, standard errors (SE), *P*-values, and R^2 for the model selected from stepwise regression are presented.

	Stubble height reduction, %		Time spent in subunit, %	
	Parameter ± SE	*P*-value	Parameter ± SE	*P*-value
Intercept	10.073 ± 4.606	0.03	5.99 ± 0.49	< 0.001
Pasture		< 0.001		
Caixa seca	19.139 ± 4.428		NS[1]	
Oncinaha	0.000 ± 4.428		NS	
Period		0.01		
First	−8.936 ± 3.299		NS	
Second	0.000 ± 3.299		NS	
Initial stubble height, cm	−0.082 ± 0.042	0.05	−0.022 ± 0.005	< 0.001
Forb cover, %	−0.299 ± 0.145	0.04	−0.050 ± 0.013	< 0.001
R^2	0.12		0.19	

[1]NS indicates that variable was not significant and was not included in the model.

with taller grass and more forbs. Taller grass height is often associated with a more mature phenology and lower forage quality (Corsi et al. 2001). In tropical rangelands with rapid growth rates, it is important to graze grasses sufficiently and uniformly so that the forage does not become tall, rank, and unpalatable. Differences in crude protein and in vitro digestible organic matter can differ by 5.5% and 12%, respectively, between young and mature *P. maximum* plants (Reiling et al. 2001).

Heifers appeared to seek out areas with more grasses and avoid subunits dominated by forbs. Goulart et al. (2007), using measurements from this study, found that grasses in sampling points without forbs were grazed more than grasses next to forbs.

Visual Observations

Similar to SHR, time spent in a subunit was related to *Panicum* height and forb cover (Table 2). Heifers avoided subunits with taller grass and more forbs.

Shade

Because shade density was highly correlated to other important variables, distance from water and stubble height, it was excluded from analysis. Visual observations data show that heifers used shade infrequently and use was not related to THI. On 50% of the observation days, cattle did not use shade, whereas average daily THI varied from 68.5 to 72.9. On the other half of observation days, 2.2% of time spent by heifers was in the shade (average daily THI varied from 68.4 to 75.5). Efficacy of constructing shade structures and the value of shade trees for Nelore and other cattle with *Bos indicus* breeding continues to be a question in this region.

Mineral Intake

Mineral intake was similar ($P = 0.55$) when placed at water (46.9 $g \cdot d^{-1}$ ± 5.9 SE) and when placed ≥ 590 m from water (41.4 $g \cdot d^{-1}$ ± 5.9 SE). Although placing salt in remote areas can affect salt intake (Ganskopp 2001), it had no effect on mineral intake in tropical pastures in this study. Cattle do not need to drink water immediately after licking salt, contrary to commonly held expectations (Martin and Ward 1973).

Based on this and other studies, salt and mineral may be placed at areas other than at water with no adverse impact on intake. This gives managers the flexibility to place salt and mineral in locations that minimize time and effort needed for trough monitoring and refilling. Mineral supplementation in Brazil is critical for cattle performance because of soil mineral deficiencies (Corsi et al. 2001), and empty mineral troughs may lower weight gain.

Mineral Placement

Placement of mineral mix away from water did not improve uniformity of SHR (Fig. 1). Overall, there was an interaction between horizontal distance to water and placement location ($P = 0.02$). When the mineral mix was placed away from water, SHR declined 3.7 percentage points ± 1.2 SE for every 100-m increase in the horizontal distance from water. In contrast, SHR changed very little with increasing horizontal distance from water when mineral mix was placed at water (0.0 percentage points ± 1.6 SE for every 100-m increase in distance from water).

In contrast, visual observations showed that heifers spent less time away from water when mineral was placed at water ($P = 0.02$). When mineral was placed away from water, cattle spent 0.2 ± 0.1% less time in subunits for every 100 m these areas were from water. Heifers spent 0.5% ± 0.2 SE less time in subunits for every 100 m these areas were from water when mineral was at water.

Based on SHR and visual observations, strategic placement of mineral mix away from water in humid tropical conditions does not appear to be a consistent tool to improve uniformity of grazing. When yearling heifers first entered the pastures, SHR data show that they preferred areas close to water. During the first 10 to 12 d of the study, placement of mineral mix away from water was clearly not effective. Later, after some forage had been removed near water, visual observations suggest that strategic placement of mineral may have contributed to improvement of grazing uniformity, but only to a limited extent. Other research, conducted in the western United States, also found that mineral supplements and salt were not persuasive tools for increasing cattle use of distant areas (Ganskopp 2001; Bailey and Welling 2007).

Supplements that are used more frequently or in greater quantities than salt or mineral may be more effective for modifying cattle grazing patterns (Cockwill et al. 2000). Bailey and Welling (2007) reported that low-moisture blocks were more effective attractants when herbage is nutritionally deficient than mineral supplements.

IMPLICATIONS

In tropical pastures, cattle tend to avoid areas with taller grass and areas with more forbs, but these factors may explain only a small part of the variability in grazing use. Horizontal distance to water was only a limiting factor at the beginning of grazing in this study. Strategic mineral placement away from water does not appear to be a persuasive and reliable tool to improve uniformity of cattle grazing patterns in tropical pastures that are 25 ha to 45 ha.

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