Japanese Society of Grassland Science ISSN1744-6961

ORIGINAL ARTICLE

Argentine rangeland quality influences reproduction of yearling pregnant heifers?

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Keywords
Beef cattle management; cow-calf production, Flooding Pampa; native grasslands; yearling heifers.

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Received 24 January 2008; accepted 24 December 2008

doi: 10.1111/j.1744-697X.2009.00141.x

Abstract

The Flooding Pampa natural grasslands are gradually being transformed into croplands to increase the economic returns of ranches. It is therefore becoming necessary for stockmen to increase beef cattle efficiency to compete with crops and to maintain the native grassland and its associated fauna. However, natural grasslands during winter have the lowest content of nutrients of the year. We intend to demonstrate that, with breeding weights of over 65% of cow mature weight, low forage quality of rangelands during winter does not have a negative effect on reproduction. These higher breeding weights were obtained by selecting early born female calves and by grazing annual and cultivated pastures. Pregnant Aberdeen Angus yearling heifers ($n = 90$) were evaluated using a pregnancy test (May 2005) until the second calving (July 2006). At the beginning of the experiment, yearling heifers with live weight ranging 360–514 kg (mean, 425 kg ± 3.5 SE) were used. Cattle grazed native grasslands (humid mesophytic meadows and humid prairie grasslands) and old mixed pastures. The second pregnancy was high (100%), with the same mean calving date as in the first pregnancy (227 Julian days). Heifers which calved later in the first calving year were early calvers in the second year, resulting in the relatively constant average calving dates across the animals.

Introduction

Cow-calf operations in the Flooding Pampa need to increase biological efficiency in order to compensate for the rise in land values that has occurred in the last decade. The use of yearling pregnant heifers is one of the significant factors for increasing biological efficiency of breeding cattle. Beef production in the Flooding Pampa has been estimated to have a high energetic efficiency based on the use of natural grasslands, mild climate and extensive management.

The Flooding Pampa is an extensive region covered with subhumid natural grasslands and a flat surface with almost no gradient (100 m in 400 km). The occasional high rainfalls, occurring usually during fall and spring, produce extensive flooding reaching 2 million ha or more. Flooding damages seeded pastures and crops. Also, low soil phosphorous availability and the abundance of saline and saline sodic soils preclude extensive replacement of natural grasslands with cultivated pastures (Cauhépé and Hidalgo 2005).

Rangelands of the Flooding Pampa have a forage quality suitable for breeding cattle and an annual primary productivity (ANNP) of 5000 kg DM ha^{-1} $year^{-1}$ which support 0.55 animal units $month^{-1}$ (AUM; Alberta Agriculture and Rural Development 2007). However, winter forage quality and ANNP have the lowest annual value (Hidalgo and Cauhépé 1991; Rodríguez *et al.* 2007) which decreases the performance of yearling pregnant heifers with winter calving at 2 years old. In addition to low winter forage quality, young pregnant heifers show decreased forage consumption as a consequence of the fetal growth in late gestation (Forbes 1986; Vanzant *et al.* 1992). Therefore, lower voluntary intake combined with lower forage quality during winter months would produce a negative intake of net energy, loss of body condition and consequently a negative impact on the next pregnancy and calving interval.

The current methods of management of pregnant yearling heifers often have adverse results on reproduction because of the restrictions mentioned, and this usually results in longer calving intervals and lower pregnancy levels in the following year. Consequently, the availability of seeded and fertilized improved pastures, in most situations, is an important factor for successful management of pregnant beef heifers. Cultivated pastures would then be needed to grow the female calves of approximately 160 kg at weaning to reach to 60–65% of adult weight, close to 260–280 kg head^{-1} in November at the onset of breeding (Lynch *et al.* 1997). However, cultivated pastures are also frequently used to feed pregnant heifers during winter months.

The objective of the experiment was to demonstrate that heifers with 300 kg live weight at the end of October (mid-spring), 70% of cow mature weight, and approximately 400 kg in May (mid-fall), can feed on the low forage quality native rangelands and not have a negative effect on subsequent reproductive performance.

Materials and methods

Study area

The region has a temperate and subhumid climate (mean temperatures are 8.5°C in winter and 21.5°C in summer and annual rainfall ranges of 850–1050 mm). The experiment was carried out on a commercial ranch located in the Flooding Pampa close to Salado River. Forage resources are composed mainly of native grasslands (humid mesophytic meadows [HMM] and humid prairies [HP]) and old mixed pastures (MP) (Perelman *et al.* 2001). The HMM are located in flat areas in intermediate topographic position, the A1 horizon is acidic, non-saline and B2 is highly alkaline. The HP are extended lowlands, with ground water near the surface, subject to winter flooding. Soils range from acidic throughout the profile to acidic in the upper and alkaline in the deeper layer. Species composition of HMM grassland are: *Lolium multiflorum* Lam., *Bromus* sp., *Paspalum dilatatum* Poir, *Stipa neesiana* Trin & Rupr., *Stipa papposa* Neem, *Phyla canescens* Greene, *Ambrosia tenufolia* Spreng, *Trifolium repens* L.; HP grassland: *L. multiflorum* Lam, *Stipa* sp., *Bromus* sp., *Leersia hexandra* Sw., *Carex bonariensis* Desf., *Juncus* sp., Kunth., *Adesmia bicolor* Poir.; MP are dominated by *L. multiflorum* Lam., *Festuca arundinacea* Schreb and *Trifolium repens* L. Rainfall for 2005 and 2006 was 932 and 1009 mm, respectively, according to data from the National Meteorological Service for Las Flores, located 40 km from the experimental site.

Experimental herd management and animal measurements

In March, weaned female calves of approximately 160 kg head^{-1} grazed annual ryegrass (*L. multiflorum* Lam.) through fall and winter months in order to reach a live weight of 300 kg at mid-October when the natural mating with 2% of Angus bulls selected for easy parturition. Parasite control was carried out monthly using endectocides.

Pregnant Angus yearling heifers were evaluated from pregnancy test (May 2005) until the second calving (July 2006). At the beginning of the experiment, yearling heifers ($n = 90$) with live weights ranging 360–514 kg (mean, 425 kg ± 3.5 SE) were used. Calving started on 20 July. Rebreeding started on 20 October 2005 and finished on 20 January 2006 using two Angus bulls.

Heifers grazed humid mesophytic meadows and humid prairie grasslands and old cultivated and naturalized pastures from May to September 2005. After September, all heifers were managed on rangelands in a single herd including the next breeding. Stocking rate varied through time from 0.25–1 AUM during winter.

Calving dates of each heifer between 2005 and 2006 were recorded. Calving dates were transformed to Julian days (1 January = Julian day 1 and 31 December = Julian day 365). Calving interval was calculated as the Julian day for the second calving minus the Julian day for the first calving to highlight whether the interval was shorter or longer than 1 year, that is, minus, zero and plus values represent the intervals of less than 1 year, 1 year and more than 1 year, respectively.

A commercial individual scale was used to weigh the heifers. In early May of each experimental year, rectal palpation was carried out for pregnancy confirmation.

Vegetation and fecal measurements

Nutritive value of forage resources and diet quality were determined at the stages of gestation, precalving, calving and lactation (May, July, September and October). Three random samples of forage were hand-clipped at each sampling date using 0.5×0.2 m quadrats. Samples were frozen and hand separated into dead and green tissues (grasses and forbs, legumes and dicots). After drying, samples (green and dead components together) were weighed and ground to pass through a 1-mm screen in a Willey mill. The *in vitro* digestibility (IVDMD) was analyzed according to the method of Tilley and Terry (1963) and the crude protein (CP) concentration was calculated by multiplying micro-Kjeldahl nitrogen by 6.25 (AOAC 1984). Composite fecal samples were taken from 10 fresh feces and then put into nylon bags, frozen, dried and ground. Fecal samples were analyzed by the near-infrared reflectance spectroscopy (fecal-NIRS) technique (Lyons and Stuth 1992) to predict dietary CP and digestible organic matter. When combined with the Nutritional Balance Analyzer (NUTBAL) program, fecal-NIRS permits assessment of CP and net energy of maintenance/gain (Nem/Neg) and dry matter (DM) intake (Stuth and Lyons 1995). According to NUTBAL, voluntary intake (kg DM day^{-1}) = (upper limit to fecal output [kg DM day^{-1}])/(diet indigestible fraction

Table 1 Botanical composition (% dry matter) of humid mesophytic meadows (HMM), humid prairies (HP) and mixed pastures (MP)

	Fall (May)			Early spring (September)			Late spring (October)		
Component	HMM	HP	MP	HMM	HP	MP	HMM	HP	MP
Grasses	16	7	8	26	8	24	39	30	32
Dicots	0	20	23	12	9	6	10	29	4
Legumes	0	7	1	0	10	0	0	0	2
Green biomass	16	34	32	38	27	30	49	59	38

[kg dry matter intake [IDM] kg^{-1} DM]), where IDM diet = 1 – (% total digestible nutrients [TDN] × 0.01) and TDN = 1.05 × DOM.

Data analysis

Data were analyzed using the *F*-test. Correlation analysis was employed for the relationship between live weight and calving interval and between date of first calving and calving interval.

Results and discussion

Forage botanical composition, digestibility and forage consumption during pregnancy and early lactation

In Table 1, grouped species (grasses, legumes and dicots) in the rangelands and old mixed pasture are shown. Biomass availability varied among forage resources from 600–1200 kg DM ha^{-1} and grasses and dicots were the dominant groups of species. The seasonal nutritive values of rangelands and pastures are shown in Table 2. Patterns of IVDMD and CP differed between the rangelands and the mixed pasture: in the rangelands they varied more as a function of live/dead ratios than of contribution of functional groups. In mixed pasture, the variation in biomass availability of grasses was the main factor affecting the forage quality. During the growing season, there was an increase in warm and cool season grasses (the most abundant component of the biomass), forbs and legumes, mainly *T. repens*. The contribution of dicots did not exceed 30% and *Ambrosia tenuifolia* was the most conspicuous. Dead biomass was the dominant component in fall and early spring and varied from 62–84% between sites.

Diet quality selected by heifers in 2005 (Table 3) showed higher digestibility values than forage on offer (Table 2) as is expected according to Pinchak *et al.* (1990), especially during fall and early spring.

The herbage growth dynamics seem to be a major factor influencing cattle diets on rangeland (Hirschfeld *et al.* 1996). Seasonal differences in IVDMD and CP of animal diets have been reported in native grasslands of the Flooding Pampa which reflected the changes in forage quality (Hidalgo 1985).

Results in Table 3 show that diet CP and energy content were sufficient to meet energy and protein requirements of pregnancy and lactation of heifers. The availability of forage value obtained in different periods was the correction factor for the nutritional balance. In May, CP intake was low (0.7 kg) because of the low forage availability (700 kg DM ha^{-1}). DM intake varied 2.0–2.8% of live weight through the physiological stages of the heifers on native grasslands and pastures.

Forage consumption permitted weight gains of 120–130 kg from the beginning of breeding in late October to May. After May, winter low temperatures decreased the growth rate of forage to 3–10 kg DM ha^{-1} day^{-1} and frosts killed most of the warm season grasses. From this month on, mean heifer live weight decreased from 391 kg in May to 357 kg in October.

Relationship of live weight in fall and first calving date with calving interval

The pregnancy percentages were 97% and 100% for the first and the second year, respectively. Heifers showed the same mean calving date, 227 Julian days, in both 2005 and 2006. Perhaps the high live weight of heifers at breeding and also at the beginning of winter were the main factors for

Table 2 Green to dead biomass ratio (GB : DB), *in vitro* dry matter digestibility (IVDMD) and crude protein (CP) of forage in humid mesophytic meadows (HMM), humid prairies (HP) and mixed pastures (MP)

	Gestation (May)				Calving (September)				Lactating (October)			
Item	HMM	HP	MP	Mean Gestation	HMM	HP	MP	Mean Calving	HMM	HP	MP	Mean
GB : DB	0.19	0.52	0.48	–	0.62	0.37	0.43	–	1.42	0.96	0.6	–
IVDMD (%)	56.0	52.4	46.0	51.47[a]	50.3	46.6	48.5	48.5[a]	63.6	64.4	58.0	61.9[b]
CP (%)	8.0	7.10	8.0	7.7[a]	10.1	10.7	10.4	10.4[b]	13.2	12.0	9.1	11.4[b]

Means within a row without a common letter (a or b) are different at $P < 0.05$. Differences among HMM, HP and MP are not significant ($P > 0.05$).

Table 3 Diet quality and dry matter intake of Angus yearling heifers grazing humid mesophytic meadows (HMM), humid prairies (HP) and mixed pastures (MP)

	Gestation (May)	Calving (September)			Lactating (October)		
Component	HMM	HMM	HP	MP	HMM	HP	MP
Dry matter intake (kg)	7.9	8.89	9.0	8.8	9.16	9.1	9.63
CP (%)	8.85	13.36	11.79	9.42	12.58	13.39	12.83
DOM	61.4	69.50	66.90	61.32	69.60	69.77	66.16
CP requirements (kg)	0.49	0.83	0.83	0.83	0.84	0.84	0.84
CP intake (kg)	0.7	1.19	1.06	0.84	1.14	1.22	1.23
Nem requeriments (Mcal d^{-1})	7.92	12.37	12.29	12.29	11.93	11.97	11.94
Nem intake (Mcal d^{-1})	11.53	15.35	14.74	12.89	15.85	15.79	15.58

CP, crude protein; DOM, digestible organic matter; Nem, net energy for maintenance. Differences among HMM, HP and MP at the calving and lactating stage are not significant ($P > 0.05$).

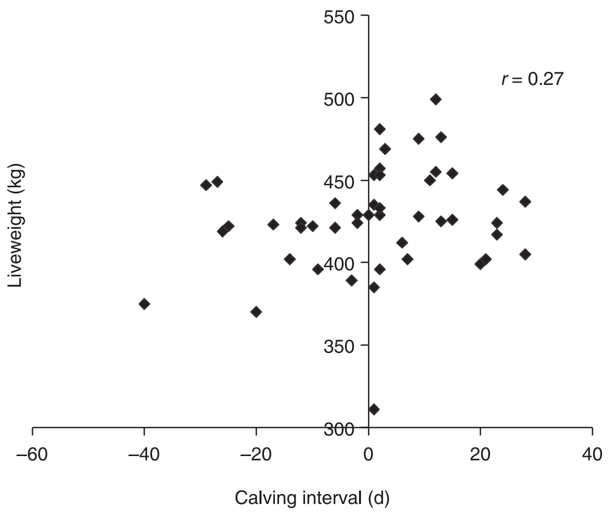

Figure 1 Relationship between live weight in fall and calving interval (–, <1 year; 0, 1 year; +, >1 year) in Angus yearling heifers.

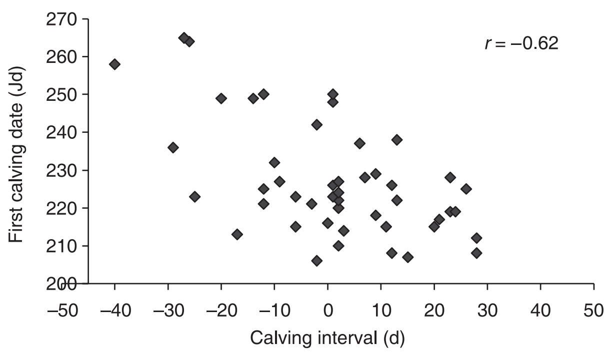

Figure 2 Relationship between date of first calving and calving interval (–, <1 year; 0, 1 year; +, >1 year) in Angus yearling heifers.

maintaining the calving interval and high pregnancy levels in the second year (Schillo *et al.* 1992).

There was no significant correlation between the live weight of the pregnant heifers in fall and the calving interval ($r = 0.27$, $P = 0.063$; Figure 1). By contrast, the calving interval was significantly correlated with the date of first calving ($r = 0.62$, $P = 0.016$; Figure 2), that is, heifers calving later in the first year were early calvers in the second year. A similar result has been reported by Urioste (2008).

Given a sound selection of early born female calves, parasite control and the winter use of cultivated pastures, it is possible to get heifers with live weights heavier than 300 kg $head^{-1}$ at breeding in November. During spring and summer the good forage quality of native grasslands will permit a live weight close to 400 kg $head^{-1}$ at the beginning of winter. The natural grasslands have enough nutrients during late fall and winter to maintain appropriate calving dates and pregnancy levels at the first breeding These results imply that the potential nutritional values of rangeland are adequate and could lead to a decrease in the need for cultivated pasture.

Conclusion

We conclude that forage quality during winter did not have a significant effect on the calving date at the second calving nor on the percent pregnancy of Angus heifers with a live weight greater than 350 kg at breeding or 400 kg at the beginning of winter. The consumption of nutrients was at equilibrium with requirements for pregnancy and early lactation.

Acknowledgments

This research was supported by the Comisión Nacional de Investigaciones de la Provincia de Buenos Aires, Argentina. We wish to thank Dr Michael Wade for help with the manuscript.

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