Liveweight gains of steers at different stocking rates on monospecific Gatton panic and Estrella grass pastures in the Chaco Central region of Paraguay

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Abstract

A grazing trial to study the effect of stocking rate on animal production and botanical composition of Gatton panic (Panicum maximum) and Estrella grass (Cynodon nlemfuensis) was conducted in the central region of the Paraguayan Chaco between 1992 and 1998.

The experiment included 6 stocking rates (0.5, 0.8, 1.1, 1.4, 1.7 and 2.0 AU/ha) on individual 4-ha paddocks. The pasture treatments were continuously grazed by yearling steers, replaced annually, over a 4-year grazing period. No fertiliser was used. Botanical composition was recorded annually in autumn from 1992 to 1998 while animal production data were recorded monthly from 1992 to 1996. Relationships between animal productivity and stocking rates were determined by regression analysis.

Gatton panic produced greater liveweight gains per head than Estrella grass at low and intermediate stocking rates. However, the slope of the linear relationship between liveweight gain per head and stocking rate increased each year in Gatton panic indicating that the productivity of this grass progressively declined at higher stocking rates over the period of observation. Estrella grass showed less sensitivity to stocking rate but was affected severely by periods of low rainfall.

Introduction

There are approximately 1.1 M ha of monospecific improved pastures of Gatton panic (Panicum maximum) and Estrella (= African star) grass (Cynodon nlemfuensis) in the Chaco Central region of Paraguay. This area is increasing by land clearing at a rate of 50,000 ha/yr (Dück 1997). The region contributes 50 and 20% of milk and beef, respectively, produced in Paraguay. The Central Chaco region is edapho-climatically similar to other subtropical regions of the world such as central Queensland, Australia (Hacker et al. 1996) and the northern areas of South Africa (B. Pengelly, personal communication).

Pasture management practices in the area are based on anecdotal experiences of producers and are not necessarily the most appropriate for long-term sustainability of the pasture resource. There is a need to quantify the productive characteristics of the pastures used in the region, such as pasture and animal response to different levels of stocking and to the climatic variability inherent to the region. This knowledge is required to determine sustainable systems of production.

A grazing trial was conducted between 1992 and 1998 to compare the performance of the main improved grasses of the region, Gatton panic and Estrella grass, at different stocking rates.

Methods

Experimental site

The grazing trial was initiated in 1991 by the Estación Experimental Chaco Central (MAG/GTZ) in cooperation with a local co-operative, at the Rio Verde Station (23° 05' S, 59° 37' W). The region is classified as semi-arid, has an average temperature of 24.5°C and a mean annual rainfall (58-year average) of 862 ± 230 mm (Filadelφia), 70 per cent of which falls from October–March (Königstein 1995). Long-term rainfall data are
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not available for Rio Verde Station but the mean figure is estimated to be 50 mm higher than for Filadelfia. Monthly rainfall at Rio Verde Station from September 1992–November 1996 is shown in Figure 1. The soil is a fertile luvisol (pH 7.2; OM 2.4%; nitrogen 0.17%; available phosphorus 78 ppm) (Stosiek 1994). No fertiliser was applied during the experiment.

Experimental design and site development
Experimental planning and land subdivision began in 1991. An area of 120 ha, previously cultivated with sorghum, was divided into paddocks of 4 ha. Twelve homogeneous paddocks were selected to be included in this experiment. Monospecific pastures of Gatton panic and Estrella grass were established with 6 paddocks of each species. Gatton panic was sown in December 1991 at a seed density of 4 kg/ha. Estrella grass was planted vegetatively in the wet season 1991–92 at a distance of 2 × 2 m between plants. Paddocks were cut in March 1992 to standardise uneven growth.

Six levels of stocking (0.5, 0.8, 1.1, 1.4, 1.7 and 2.0 AU/ha, with one Animal Unit [AU] corresponding to 450 kg of liveweight) were randomly assigned to the paddocks of each grass species. There was no replication.

Botanical analysis
Botanical analyses were conducted yearly in autumn from 1992–1998. A point-intercept method (Glatzle 1990) was used along representative permanent transects in the paddocks. Measurements evaluated bare ground, sown grass, other grasses and herbs. Sown grasses (Gatton panic and Estrella grass) were included with “other grasses” when they were invading a paddock in which they were not planted.

Experimental management
Pastures were continuously grazed by stock from 1992–1998. Liveweight gain data, however, are available only from 4 year-long grazing periods from September 1992–November 1996. Young Brahman × Hereford steers were introduced at the start of each grazing period (Table 1). Grazing of the Gatton panic paddocks at 0.8 and 1.7 AU/ha started in the second year of the experiment because of slow establishment. As animals grew, stocking rates were maintained at the same level of AU/ha by removing individual animals from the paddock. Whenever total metabolic body weight within each paddock exceeded the theoretical total metabolic weight for that stocking rate treatment by more than 50% of the average metabolic weight of an animal within the group, one animal was removed. Fasted liveweight was recorded every 4 weeks. A commercial mineral mixture was available ad libitum. Stock were treated adequately to control parasites. Woody weeds (Acacia spp.) were eliminated manually each year.

Figure 1. Monthly rainfall at Rio Verde Station from September 1992–November 1996.
The animal production data were analysed following the methodology described by Jones and Jones (1997). Mean animal liveweight gains per head and per hectare were used to calculate the relationship between animal production and stocking rate.

Results

Animal production

Overall, liveweight gains supported by the 2 grasses were quite similar. In all years and for both pasture types, animal gain/head was inversely related to stocking rate. Slopes of the regressions of liveweight gains/head against stocking rate for the 2 pastures were similar for years 1993–94 and 1994–95. The ‘b’ values for the regressions for Gatton panic decreased dramatically from –18.2 kg liveweight/unit stocking rate in 1992–93 to –59.6 kg liveweight/unit stocking rate in 1995–96, indicating that the deleterious effect of high stocking rates on Gatton panic increased with time (Table 2) (Figure 2).

In contrast, Estrella grass showed less sensitivity to heavy grazing than Gatton panic. The linear relationship between animal production/head and stocking rate for Estrella grass was characterised by a moderate and relatively constant slope throughout the 4 years (range: –33.8 in 1992–93 to –24.4 in 1995–96).

The amount and distribution of rain had a major influence on animal production with marked differences in gains in different years. Lowest liveweight gains were recorded in 1992–93, associated with low rainfall (561 mm). Poor animal production was also observed in 1994–95 due to the very dry winter.

Botanical composition

Figure 3 shows the proportion of the principal botanical components and bare ground from 1992–1998. A high proportion of the sown grass (>90%) was maintained in all paddocks of Estrella grass. In contrast, the proportion of sown pasture was lower in paddocks of Gatton panic, and the proportion decreased successively at the highest stocking rate of 2 AU/ha from an initial 80% to about 31% in 1998. The decline in the proportion of Gatton panic was accompanied by an increase in the proportion of other grasses and bare ground. Cynodon dactylon was the major invasive grass. In the last year of the experiment, about 14% of the soil surface remained bare at low stocking rates (0.5, 0.8, 1.1 AU/ha) and about 35% at the high stocking rates of 1.7 and 2 AU/ha (Figure 3).

The relatively high proportion of native species in the establishment year comprised annual grasses and herbs which disappeared in subsequent years.

Discussion

This study suggests that Estrella grass may be less sensitive to stocking rate than Gatton panic. The sensitivity of Gatton panic to higher stocking rates was illustrated by the decreasing ‘b’ values in Table 2 of the linear regressions between liveweight gain per head and stocking rate from 1992–1996 (Figure 2). This indicated a decline in animal production at high stocking rates in Gatton panic as the study progressed. This can be explained by the observed reduction in the proportion of Gatton panic, an increase in the less productive *C. dactylon* and an increase in proportion of bare soil. Stosiek (1994) reported a
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Figure 2. Effect of stocking rate on liveweight gain (LWG) per head (--- $y_{hd} = a + bx$) and per hectare (--- $y_{ha} = ax - bx^2$) for (a) Gatton panic, and (b) Estrella grass.
Figure 3. Proportions of sown grass, other grasses, herbs and bare soil in paddocks of (a) Gatton panic and (b) Estrella grass at 6 stocking rates.
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Decline in the proportion of Gatton panic grass at high stocking rates within the first 2 years of this experiment. Thus, Gatton panic can be regarded as less tolerant of frequent defoliation than Estrella grass or C. dactylon.

The loss of Gatton panic at high stocking rates was more pronounced than suggested by the reduction in liveweight gain. This indicated that pasture degradation preceded loss of animal production. Stosiek (1994) showed an increase in soil bulk density in heavily stocked Gatton panic paddocks, suggesting that at least part of the reported shift in the botanical composition may have been due to soil compaction. Jones et al. (1995) described a similar decrease in animal production in heavily stocked paddocks of green panic (Panicum maximum var. trichoglume) under conditions comparable with the Paraguayan Chaco. In our study, paddocks stocked at up to 1.4 AU/ha remained highly productive over the 4 years of the experiment, and the proportion of Gatton panic was maintained at a fairly high level during 6 years of continuous grazing (Figure 3).

In contrast, paddocks sown to Estrella grass remained almost pure grass throughout the study regardless of stocking rate. This phenomenon may be explained by:

- the higher tolerance of Estrella to defoliation and treading, due to the large number of less palatable stolons close to ground level; and
- the better soil coverage by stolons and litter which protected the soil from compaction and weed invasion.

Heavily stocked Estrella grass paddocks had a lower soil bulk density than Gatton panic paddocks after 4 years of continuous grazing (Cabrera et al. 1997).

Animal production from Estrella grass followed patterns similar to those suggested by Wilson (1986) and described by Rickert (1996). At the lowest stocking rate, liveweight was consistently lower than the predicted level. They suggested that, at very low stocking rates, low forage quality might limit animal productivity. In our study, data from the first 2 years showed that ME levels in Estrella grass fell below maintenance levels for the grazing animals (572.5 kJ/kg of dry matter), particularly during winter and at low stocking rates (Stosiek et al. 1997).

Rainfall had a major effect on animal production throughout the experiment. Low rainfall in 1993 and a very dry winter in 1995 reduced liveweight gains. Stocking rate effects in Estrella paddocks were most pronounced in 1995, as indicated by the lowest ‘b’ value. This suggested that sustainable or optimal stocking levels will vary from year to year with rainfall.

Re-establishment of pasture to restore productivity in the Chaco region requires expensive farming intervention to reduce woody weed density and to promote soil aeration (Glatzle et al. 1996). For an enterprise to be economically viable, the costs of production and marketing must not exceed total income from the product (Glatzle and Cabrera 1999). High stocking rates on Gatton panic appear not to be biologically sustainable. Whether or not they are economically sustainable will be a function of the increased costs of renovation versus any increase in production before they succumb to the high pressure of grazing.

Estrella grass appears more sustainable at higher stocking rates than does Gatton panic, although the latter had better forage quality.

Conclusions

For Gatton panic, the need for intervention to restore productivity increased at high stocking rates. At stocking rates below 1.4 AU/ha, relatively high animal production was achieved through the 4 years of the experiment. Pasture condition and animal productivity at stocking rates above 1.4 AU/ha were less sustainable. By contrast, Estrella grass stands were not depleted and decline in animal production was less pronounced.

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References


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