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Planning as a tool to improve production and function of grasslands in the mid-north of South Australia

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Abstract

The consequences for grassland production and function arising from a planned approach to grazing and animal management were compared to regional practice on 11 properties in the mid-north of South Australia. Planning based on either plant phenology or plant growth rate and herbage mass were also compared. Planning based on the key phenological events of germination and seed set did not provide consistent benefits to grassland production or function. Planning based on plant growth and herbage mass led to increased pasture growth rates and stocking rates with a 6% improvement to water use efficiency. These improvements to productivity were associated with largely beneficial effects on grassland function and landscape condition. For example, regional practice led to a 36% decline and a planned approach to a 58% increase in the contribution of native perennial grasses to herbage mass. Perennial grass basal cover declined by 20% and increased by 100% in response to regional and planned approaches respectively. Ground cover declined from 96 to 58% with regional practice but was largely unchanged (96 to 94%) with a planned approach. These results indicate that planning of grazing and animal management events based on plant growth characteristcs but not phenology offer productivity and conservation benefits to the grazing industry of the mid-north of South Australia.

Introduction

Grasslands in the mid-north of South Australia are often managed as part of a mixed sheep/cropping farm. Typically, grasslands are confined to the nonarable areas of the farm with lower land capability. Not only are grasslands restricted to these inherently less productive areas but management of these areas commonly defers to the requirements of crops. The most common grazing system in the region is that of summer rest, where grasslands are grazed more or less continuously for a 6-month period from the autumn break until crops are harvested. Stock are then moved to graze crop residues providing grasslands with a 6-month rest from grazing. This grazing regime has significantly altered the botanical composition of grasslands and led to loss of native perennial grasses and dominance of introduced annual grasses such as wild oats (*Avena barbata*), brome grasses (e.g. *Bromus molliformis*, *Bromus rubens*), and barley grass (*Hordeum leporinum*).

In the year 2000, the project *Impact of grazing management on native grasses of non-arable pastures in the mid-north of South Australia*, was initiated by the Mid-North Grasslands Working Group to demonstrate that appropriate grazing management could allow grasslands to be grazed for production and result in improved conservation outcomes; as measured by an increased productivity of native perennial grasses. There were 2 components to this project. The first component involved 10 commercial demonstration properties where a planned approach to grazing management was compared to regional practice. The second component investigated the consequences to grassland function and production arising from 2 different planning approaches.

Materials and Methods

Ten sheep/cropping properties located from Robertstown in the south east (139º 4'E and 33º 59'S) to Carrieton in the north (138º 36'E and 33º 12'S) of South Australia took part for varying periods in the 5-year project. Data collected from 8 of these properties over the period 2000-2004 is included in this paper. Farms received assistance to subdivide an existing paddock or paddocks producing a minimum of 5 and a maximum of 30 paddocks among the properties with resultant paddock size of 4-80 ha. Grazing and animal management plans were developed to optimize the timing and duration of key production events such as mating, lambing and shearing and minimise grazing and maximise rest periods. Feed budgets were calculated to determine stocking rates. Typically, the duration of individual grazing events, outside the lambing period, varied from 2-30 days and rest periods from 30-150 days. Periods of rest from grazing were shortest during the peak pasture growth season and longest over summer. Four of the 8 properties maintained a control paddock where grazing regimes reflected regional practice of almost continuous grazing restricted to the period April till November.

Two approaches to planning the grazing process were compared with regional practice and nil grazing by domestic herbivores at the property "Anama", 15 km north of Clare (138º 35'E and 33º 47'S), South Australia. The first approach to planning the grazing system was structured on the key phenological events of seed set and germination and required that the timing of grazing and rest periods be guided by the notion of phenological season. The 4 phenological seasons were defined according to the phenological stages of the predominant native grasses present in the pastures, *Austrostipa* spp., *Austrodanthonia* spp. and *Aristida behriana*. The timing and length of each season were as follows; (1) summer 14th December – 16th April; (2) autumn 17th April – 16th June; (3) winter 17th June – 24th August; and (4) spring 25th August – 13th December.

The second approach to planning the grazing system was structured on the mass of pasture and plant growth rate. Similar to that practiced on the demonstration properties, the duration of each rest event was inversely related to pasture growth rate and was therefore shortest during spring and longest over summer/autumn. The average duration of grazing and rest periods was approximately 2 and 130 days respectively. During the growing season of May – October, the duration of the rest period ranged from 33 – 99 days. Herbage mass at the start and end of each grazing event was typically in the range 1500 – 3000 kg DM/ha and 750 – 2000 kg DM/ha respectively. Short grazing periods were achieved through the use of high stock density which averaged 300 sheep/ha.

In summary there were 6 grazing treatments (each allocated at random to a paddock of area 5-6 ha):

1) Regional practice with summer rest from grazing but continuous grazing at all other times. The stocking rate was planned to mimic typical stocking rates in the region of 2.4 DSE/ha.
2) Autumn and summer rest from grazing with low density (14 sheep/ha) and long duration (40 day graze and 50 day rest periods) grazing at all other times to attain an annual stocking rate of 2.5 DSE/ha. This approach was designed to encourage germination and survival of cool-season perennial grass species.
3) Spring and summer rest from grazing with low density and long duration grazing at all other times to attain an annual stocking rate of 2.5 DSE/ha. This approach was designed to encourage seeding of perennial grass species.
4) Spring, summer and autumn rest from grazing during 2001and spring and summer rest from grazing during 2002 - 2004 with low density and long duration grazing at all other times to attain an annual stocking rate of 2.5 DSE/ha.. This approach was designed to capture benefits for germination and seeding of perennial grass species.
5) High density and short duration grazing, in 4 x 1.25 ha sub-paddocks, based on herbage mass and plant growth rate, able to be applied for the complete 12 months of each year without other restrictions on stocking rate.
6) No grazing for the complete 12 months of each year which represented the typical management regime philosophy for grassland conservation reserves.

At each demonstration property, a 100 m transect was established in each of 5 paddocks. At "Anama", 5 x 50 m transects were established in each paddock. The transects were established to monitor changes in a number of vegetation parameters over time. Monitoring of vegetation was undertaken within 0.5 x 0.5 m quadrats located at 5 m intervals along each transect and was conducted during September 2000, July 2001, November 2001, November 2002, November 2003 and November 2004. Measurements included, (i) estimation of the contribution of the dominant pasture species to the total dry weight of herbage mass using the Botanal procedure; (ii) the presence or absence of plant species; and (iii) the number of native perennial grasses. Basal cover was estimated at "Anama" from 100 points within 1.0 x 1.0 m permanent quadrats located 5 m from the end of 3 of the transects within each paddock.

Stocking rate (DSE/ha) in each paddock was calculated by reference to animal class and change in live weight at "Anama" but by use of available herbage mass at the other 8 properties. At each of the 8 properties the following variables were also calculated; (i) pasture growth rate (kg DM/ha/day); (ii) water use efficiency (kg DM/ha/mm rainfall); and (iii) pasture utilization rate (%; expressed as stocking rate/pasture growth rate). Pasture growth rates were calculated for the period May - October as the sum of green herbage mass in early November (assuming zero green herbage mass at the autumn break) and estimated feed intake (1 DSE = 1 kg DM/day).

Data collected from "Anama" were subjected to analysis of variance using general linear models (SAS Institute, Cary, New York, 1992). Least squares means ± standard error (se) are presented for untransformed data and ± 68% confidence intervals for backtransformed data.

Results

Pastures at all sites were dominated by annual grass species such as *Avena barbata*, *Bromus* spp., *Brachypodium distachyon* and *Vulpia myuros*. Across the 8 demonstration properties and "Anama", annual grasses contributed 50-80% and 40-50% of herbage mass respectively. Annual rainfall averaged 521 (2001), 305 (2002), 430 (2003) and 401 mm (2004) across all properties with 73% of the annual total recorded in the growing period May – October.

Demonstration properties

Implementation of grazing and animal management plans, in concert with paddock subdivision, resulted in greater pasture growth rates across the demonstration properties (Figure 1). The greater pasture growth over the 6-month growing period amounted to an extra 356 kg DM/ha of herbage.

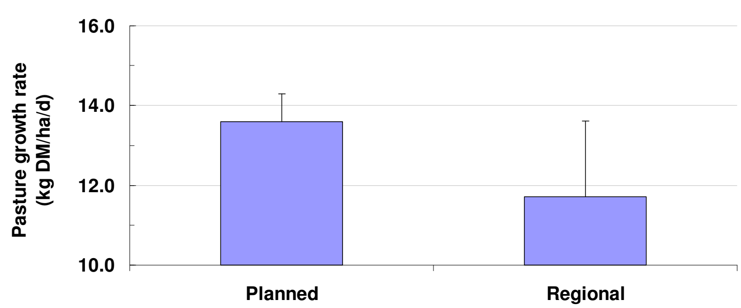

Figure 1: Pasture growth rates (± se) calculated for the period May – October, 2001 – 2004 in subdivided paddocks grazed according to grazing and animal management plans (Planned) and in paddocks grazed according to regional practice (Regional).

Increased pasture growth rates and the use of planning tools, such as the feed budget, resulted in a 30% increase in average stocking rate over the 4-year period (Figure 2). Average stocking rate among planned paddocks ranged from 0.2 – 7.7 DSE/ha and among regional grazing paddocks from 0.5 – 5.4 DSE/ha. Greater stocking rates were also achieved, in part, by increased pasture utilisation which averaged (mean ± se) 37 ± 2.2% and 28 ± 6.2% in planned and regional grazing paddocks respectively over the growing periods of 2001 – 2004. Water use efficiency was also increased with planning and averaged (mean ± se) 9.0 ± 0.41 and 8.5 ± 1.17 kg DM/ha/mm in planned and regional grazing paddocks respectively.

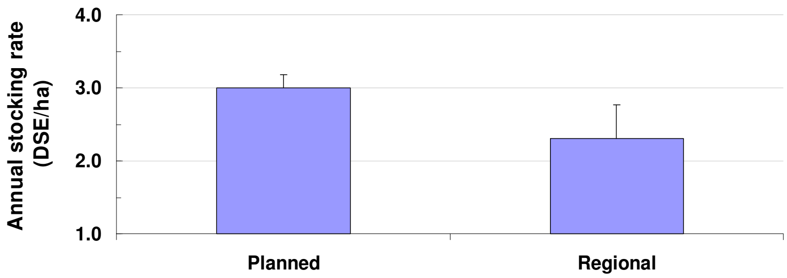

Figure 2: Stocking rates (± se) calculated for the period May – October, 2001 – 2004 in subdivided paddocks grazed according to grazing and animal management plans (Planned) and in paddocks grazed according to regional practice (Regional).

"Anama"

Increased stocking rates in response to planning based on mass of pasture and plant growth rate but not phenological season were recorded over the 4-year period (Table 1). On average, stocking rate in the paddock grazed at a high stock density and for a short duration was 70% greater than for Regional practice.

Table 1: Annual stocking rates (DSE/ha) calculated for the grazing treatments at "Anama".

	Grazing treatment					
	Regional	Autumn	Spring	Aut/spr/spr	Planned	Nil
2001	2.7	3.0	3.7	4.0	5.6	0
2002	2.4	1.8	1.7	1.3	3.0	0
2003	2.3	1.9	1.8	2.3	3.5	0
2004	2.3	1.7	1.7	2.3	4.5	0
Mean	2.4	2.1	2.2	2.5	4.1	0

Effects of grazing practices on grassland function were assessed by examining changes in (i) the relative contribution to herbage mass from the major native perennial grass species, *Austrostipa* spp. and *Aristida behriana* (Figure 3); (ii) basal cover of native perennial grasses; (iii) the relative contribution to herbage mass from the woody introduced plant *Scabiosa atropurpurea*; (iv) plant species diversity; and (v) the percentage bare ground. Over the 4-year period, the contribution of perennial grasses to herbage mass declined by 36 and 53% in paddocks grazed according to Regional practice or with an autumn rest. Spring rest led to a small 5% increase in perennial contribution whereas resting in autumn and spring in year 1, followed in later years by an annual spring rest, led to a 98% increase. Planned grazing and nil grazing had a similar effect on perennial contribution and were associated with a 58% and 49% respective increase (Figure 3). Changes in basal cover of perennial grasses was described by 3 groupings, namely declined, remained unchanged or increased over the 4-year period. Regional practice and nil grazing led to a decline of 20% and 78% respectively, spring rest led to no change, rest in autumn, rest in autumn and spring in year 1 followed in later years by an annual spring rest and Planned grazing led to increases in perennial grass basal cover of 11%, 100% and 100% respectively (Figure 4).

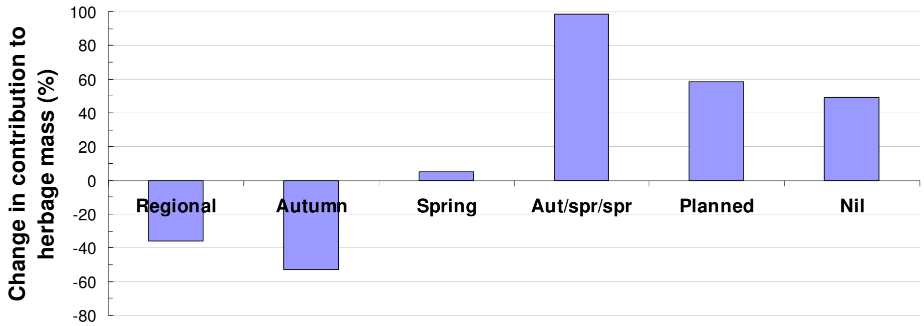

Figure 3: Change in the percentage contribution of *Austrostipa* spp. and *Aristida behriana* to herbage mass averaged over the period September 2000 – November 2004, according to grazing treatment.

Percentage contribution to herbage mass from *Scabiosa atropurpurea* was largely unchanged in all grazing treatments with the exception of nil grazing where contribution increased 5-fold over the 4-year period to account for 16% of herbage mass at the final measure. Plant species diversity, as assessed from species number per 2.5m^2, declined with nil grazing to be recorded at 17.6 / 2.5m^2 at the final measure. Bare ground did not differ among grazing treatments at the start of the period and averaged 3.4%. By the final measure in 2004, bare ground had increased with Regional practice and when grazing was based on phenology, remained unchanged with Planned grazing and fell to zero with nil grazing (Figure 5).

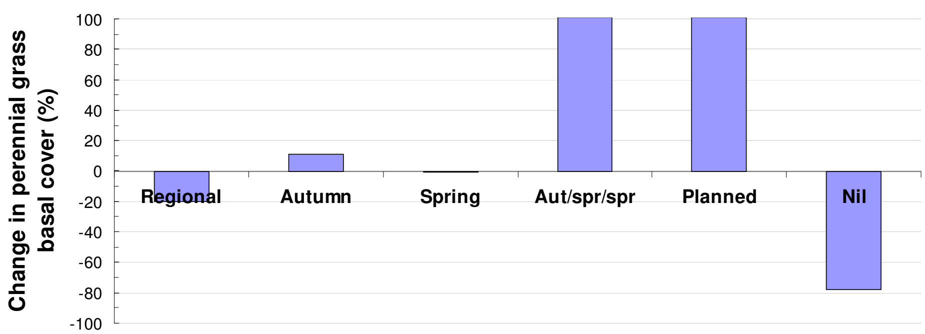

Figure 4: Change in basal cover of native perennial grasses averaged over the period September 2000 – November 2004, according to grazing treatment.

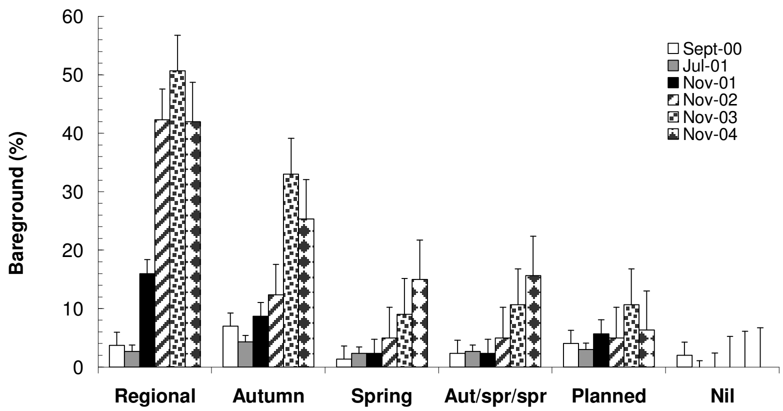

Figure 5: Bare ground (lsmean ± 68% c.i.) over the period September 2000 – November 2004, according to grazing treatment.

Discussion

The results presented in this paper, collected from 9 properties over the 4-year period, 2001-2004, indicate that planned grazing can result in greater production and improved grassland function. Increased stocking rates were achieved through greater pasture growth and increased utilisation as has been previously described by Earl et al. (2003) and Kahn et al. (2003). Importantly, these changes were recorded simultaneous to improvements in landscape condition. For example, stocking rate increased by 30% on the 8 demonstration farms and 70% at “Anama” in response to planning while the basal cover and biomass of native perennial grasses increased significantly and bare ground remained stable at 4-6%. Grazing according to Regional practice led to deterioration of landscape condition and autumn or spring rests did not correct this situation. Resting grasslands from grazing in autumn and spring, followed by annual spring rest did enhance grassland function but did not increase stocking rate and is not a system able to be applied across an entire farm. Nil grazing provided absolute cover but this was associated with a decline in species diversity and basal cover of perennial grasses. Of interest, recent data suggests that planned grazing at “Anama” has other benefits such as reducing soil bulk density and increasing the rate of water infiltration 15-fold from 0.8 to 11.0 mm/min. No such improvements were recorded in paddocks grazed to Regional practice. That planned grazing improved landscape condition at increase stocking rates challenges the conventional dogma that increased stocking rate is linked to grassland and landscape deterioration.

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