

Increase in ground cover under a paddock scale rotational grazing experiment in South-east Queensland

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Abstract

Time-controlled rotational grazing (TC grazing) has been adopted in some Australian rangelands over the last two decades to provide graziers with a relatively higher herbage production over traditional practices. This grazing system, which involves short periods of intensive grazing, has raised concerns about the sustainability and environmental impacts on ecosystem health. Ground cover as an indicator of soil health and sustainability was measured over a 6 year period using paired research paddocks treated by TC and continuous grazing practices in southeast Queensland. The TC grazing achieved and maintained a 72% average ground cover during the study period as compared with 59% for continuous grazing. In the second period of the study (2004-2006), increase in ground cover under TC grazing was as high as 85% as compared to 65% for continuous grazing. Use of TC grazing resulted in up to 92% cover when the soil was in good condition, whereas under continuous grazing ground cover did not increase beyond 70%. The improvement of ground cover under TC grazing in the study area was attributed to the effects of long rest periods, providing an exceptional chance of recovery and regrowth over wet seasons dominated by a high frequency of rainfall events.

Key Words

Surface cover, time-controlled grazing, continuous grazing, rangeland, soil protection.

Introduction

It is well known that grazing systems greatly affect vegetation cover that is the primary layer for soil protection against water erosion. Ground cover intercepts and absorbs the energy of rainfall and impedes the flow of runoff. It resists the erosive force of flowing water and maintains a high infiltration rate over a longer period of time during runoff events. Decrease in vegetation cover increases the exposure of soil surface to raindrop and runoff impacts (Busby and Gifford 1981) ultimately increasing runoff and soil loss. In addition to the effects of surface cover on soil erosion, it also provides a favourable habitat for soil organisms and improves physical and chemical characteristics of soil surface.

Time-controlled rotational grazing (Savory and Parsons 1980; McCosker 2000) as an alternative to continuous grazing has potential to increase above and below ground organic materials. Under rotational grazing, some studies report on the positive effect of rest periods and grazing exclusion on the increase of organic materials and the subsequent decrease in runoff and soil loss (McGinty *et al.* 1979; Wood and Blackburn 1981) when compared with continuous grazing and even non-grazed areas.

In southeast Queensland, time-controlled (TC) grazing is the main alternative to continuous grazing. This paper briefly provides information on the effects of TC grazing on ground cover in the region to address some environmental concerns of such a practice on surface soil protection. The results are based on a 6 year period of data collected from 2 research paddocks comparing TC and continuous grazing systems.

Methods and materials

Study area

The research was conducted at "Currajong", a grazing property 40 km west of Stanthorpe in the semi-arid region of south-east Queensland, Australia. The study area, known locally as Traprock, is located in the catchment of the MacIntyre Brook at the northern headwaters of the Murray Darling basin. The annual rainfall for this area is 645 mm, with a summer dominance of around 70%, which is characterized by relatively high frequency of medium to large events of short (thunderstorms), and long (cyclonic depressions) durations. The soil is shallow to moderately deep with a hard setting brown to dark clay loam

underlined by a bleached A2 horizon. Vegetation is Eucalypt open woodland with understory native and naturalized perennial grass species dominated by a desirable species known as Queensland blue grass [*Dichanthium sericem* (R. Br.) A. Camus].

Definition

Ground cover is one of the main attributes of vegetation in grazing practices often recognized as a reliable indicator of soil protection and sustainability. It refers to any non-soil material remaining on or near the ground that protect the soil surface against erosive forces of raindrops and overland flow (McIvor *et al.* 1995). The definition of ground cover is originally based on the commonly used method of aerial plant cover (Greig-Smith 1983) which measures the proportion of the ground occupied by perpendicular projection of the aerial parts of plants but includes all live/dead organic materials plus stone cover.

Treatments

The research was conducted using two paddocks, one under time-controlled and the other under continuous grazing practices. These paddocks were each divided into two sections (sub-treatments) based on the physiographic features of the land (slope and soil depth). Under this arrangement, the sub-treatments 1 and 2 belong to TC grazing, and the sub-treatments 3 and 4 belong to continuous grazing. Similarities between sub-treatments 1 and 4 (deep soils and gentle slopes) on the one hand and between sub-treatments 2 and 3 (shallow soils and steep slopes) on the other hand, reduces error when comparing the two grazing treatments.

Stocking

The paddock of continuous grazing was grazed with a constant stocking rate of 1.6 DSE (Dry Sheep Equivalent)/ha. This grazing intensity is normal in the region and exerts a light to moderate pressure on the pasture. The other paddock was stocked under TC grazing system with high stocking rates of differing grazing/rest periods depending on feed availability and the rate of grass growth in the paddock. Much care was taken to keep the total DSEdays/ha similar between the two grazing systems. More details on the stock management and sampling have been reported by Sanjari *et al* (2008).

Results

The results on the ground cover show a general trend of decrease over the first period of the study (2001-2003) from around 65 to 50% in both treatments, but more pronounced under continuous rather than TC grazing treatments (Figure 1A). Such decreasing trend in the cover can be explained by a similar decrease in the annual rainfall over the same timeframe. This period coincides with a moderate water shortage over the years of 2002 and 2003 with a total rain of 8 – 17 % below the long term average in the region.

Unlike the first period of the study, ground cover in 2004 increased to 75% reaching to 90% by end of the second period (2004-2006) under TC grazing, while it remained from 62 to 68% in continuous grazing. The overall increase in the cover, from 2004 to 2006 appears to be associated with the high rainfall in 2004, which was around 23% above the long term average rainfall for the region. Although the total rainfall decreased in 2005 and 2006 to slightly below the long term average rainfall, the ground cover continued to increase under TC grazing but not under continuous grazing.

The different responses by the sub-treatments shown in Figure 1B reflect the combined effects of the grazing treatment and the soil variation (depth and slope). It shows that sub-treatment 1 of TC grazing with a better soil condition achieved the highest cover level over the study period and the sub-treatment 3, under continuous grazing management with a poor soil condition, the lowest. This is despite the fact that in 2001 all the four sub-treatments had about the same level of ground cover (65%). Surprisingly, ground cover in sub-treatment 2 of TC grazing increased to a higher level than that of sub-treatment 4 in continuous grazing from 2004 to 2006 despite having a poorer soil condition, thus highlighting the importance of management effect.

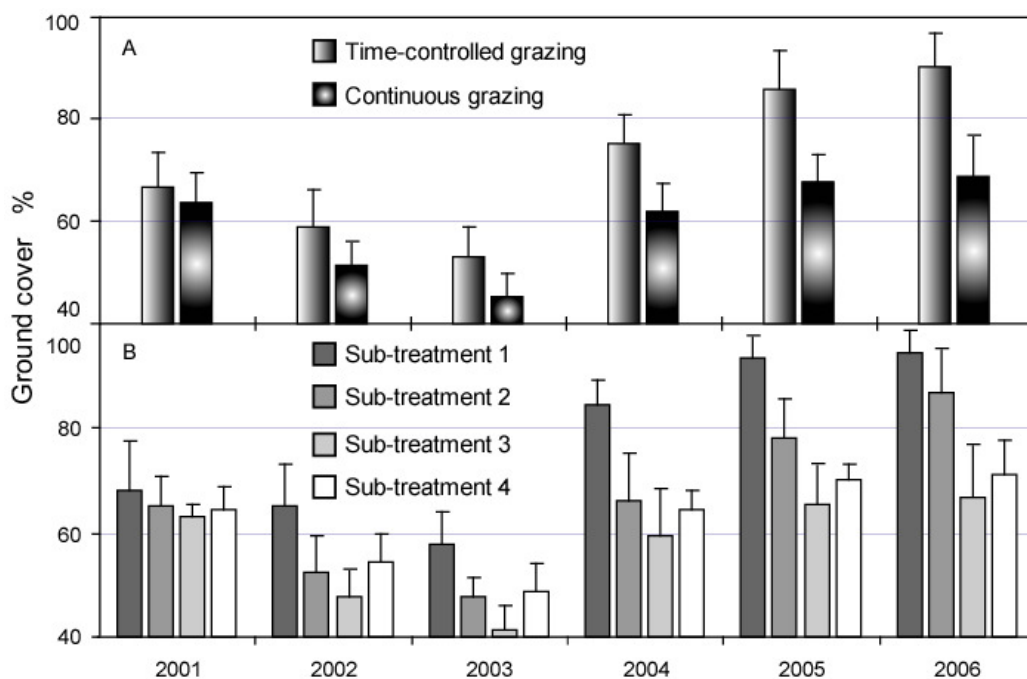


Figure 1. Ground cover changes under time-controlled and continuous grazing in the study area.

Analysis of variance (two tailed T test) on the pooled data verified the significantly higher ground cover achieved under TC grazing than continuous grazing. The average increase in surface cover under TC grazing (time-controlled *minus* continuous) was 7% ($p \leq 0.05$) over the first period and then increased to the higher level of 16% ($p \leq 0.01$) during the second period (2004–2006).

The results of the ANOVA on the data of sub-treatments presented in the table 1 show the superiority of TC grazing even at sub-treatment level over continuous grazing. For instance the mean cover for sub-treatment 1 (TC grazing) had been 8% and 22% more than the one for sub-treatment 4 (continuous grazing) over the first (2001-2003) and the second (2004-2006) periods, respectively.

Table 1. Ground cover ANOVA between sub-treatments over the first and the second periods

Sub-treatments	+Sub-treatment 1		+Sub-treatment 2		+Sub-treatment 3	
	1st	2nd	1st	2nd	1st	2nd
-Sub-treatment 2	+9%***	+16%***				
-Sub-treatment 3	+14%***	+27%***	+5% <i>ns</i>	+11%***		
-Sub-treatment 4	+8%***	+22%***	-1% <i>ns</i>	+6%***	-6%*	-5%**

* $p < 0.1$; ** $p \leq 0.05$; *** $p < 0.01$; *ns* – non significant

Increase in ground cover reported here, is inline with residue accumulation reported earlier by the authors (Sanjari *et al.* 2008) under TC grazing. Ground litter is derived from primary plant production and was a major contribution to ground cover, thus any changes to the cover levels can be directly related to pasture production and management. In this study, a major coincidence of an exceptionally long rest period of 156 days with multiple favorable conditions of rain and temperature produced a massive pasture production in 2004 that resulted in large amounts of residue and in turn a high percentage of ground cover.

Results of a catchment scale runoff experiment in the study area (Sanjari *et al.* 2009) support the findings of this paper on ground cover improvement under TC grazing. The authors found a strong link between the ground cover levels and runoff and soil loss, introducing a minimum safe surface cover threshold of 70% for the study area to be maintained by the graziers.

The improvement of ground cover in TC grazing is attributed to the proper management of grazing frequency and the durations as well as the provision of adequate rest periods. Application of long rest periods following short durations of intensive grazing provides a highly favourable condition for the defoliated plants in the pasture to recover over the growth season where a high frequency of rainfall events are expected in the study area.

Conclusion

Time-controlled grazing, which involves long rest periods under a flexible grazing management, provides a significantly higher ground cover level than continuous grazing in the study area. Contrary to continuous grazing, TC grazing maintained a cover level above the minimum safe threshold recommended for the study area (70%) providing an effective soil surface protection against water erosion. Surface cover under the poor soil condition of shallow and steep slope is better maintained by TC grazing than continuous grazing.

References

- Busby FE, Gifford GF (1981) Effects of livestock grazing on infiltration and erosion rates measured on chained and unchained pinyon-juniper sites in Southern Utah. *Journal of Range Management* **34**, 400-405.
- Greig-Smith P (1983) 'Quantitative plant ecology.' (WileyBlackwell: Oxford).
- McGinty WA, Smeins FE, Merrill LB (1979) Influence of soil, vegetation, and grazing management on infiltration rate and sediment production of Edwards Plateau rangeland. *Journal of Range Management* **32**, 33-37.
- McCosker T (2000) Cell grazing - the first 10 years in Australia. *Tropical Grasslands* **34**, 207-218.
- McIvor JG, Williams J, Gardener CJ (1995) Pasture Management Influences Runoff and Soil Movement in the Semiarid Tropics. *Australian Journal of Experimental Agriculture* **35**, 55-65.
- Sanjari G, Ghadiri H, Ciesiolka CAA, Yu B (2008) Comparing the effects of continuous and time-controlled grazing systems on soil characteristics in Southeast Queensland. *Australian Journal of Soil Research* **46**, 348-358.
- Sanjari G, Yu B, Ghadiri H, Ciesiolka CAA, Rose CW (2009) Effects of Time-Controlled Grazing on Runoff and Sediment Loss *Australian Journal of Soil Research* **47**, 796-808.
- Savory A, Parsons SD (1980) The Savory grazing method. *Rangelands* **2**, 234-237.
- Wood MK, Blackburn WH (1981) Grazing Systems: Their Influence on Infiltration Rates in the Rolling Plains of Texas. *Journal of Range Management* **34**, 331-335.