Spelling strategies for recovery of poor land condition

Jones, P[1]; Hough, B[2,4]; O'Reagain, P3; Walkington, D[1]

[1] Department of Primary Industries, Queensland, LMB 6 Emerald, Qld 4720, Australia.

[2]Department of Primary Industries, Queensland, Townsville, Qld. 4810

[3] Department of Primary Industries, Queensland, PO Box 976, Charters Towers, QLD 4820,

[4]Corresponding author: Email: brad.hough@*daf.qld.gov.au*

Key words: annual vs biennial wet-season spelling; *Bothriochloa ewartiana*; basal cover; moderate vs heavy stocking; Wambiana grazing trial

Abstract

Pasture condition has declined across many pasture communities across northern Australia. Pasture spelling is a key recommendation for the recovery of land condition but there is limited information on the optimum length and frequency of spelling or the recovery rates possible under different spelling and stocking rate combinations. This 12-year study examined the effects of early and full wet season spelling applied annually or biennially, on the recovery of poor condition land and the demography of the key perennial grass, *Bothriochloa ewartiana*, under heavy and moderate stocking rates. The study period was characterised by low rainfall and extreme drought conditions in some years. Average basal cover of perennial species declined with the onset of dry years with the effects of drought amplified under heavy stocking. Basal cover later increased as conditions improved but cover under heavy stocking never recovered to that under moderate stocking. Annual early and full wet season spelling under moderate stocking had a positive effect on the basal cover of *B. ewartiana* but this effect was only significant ($P < 0.03$) after 12 years. Spelling had no effect on basal cover under heavy stocking, emphasising the overriding effect of stocking rate on recovery. Basal cover through the drought was largely maintained through the persistence of original tussocks, emphasising the importance of maintaining established plants through good management. In later years, an increasing number of recruits also increased basal cover. Land condition can be improved with annual wet season spelling provided stocking rates are appropriate, but recovery can initially be slow, particularly through dry years. These results emphasise the key role that spelling has in maintaining and improving pasture condition.

Introduction

Pasture condition has declined across many pasture communities across northern Australia as evidenced by the reduced density of many desirable perennial grasses (e.g. Tothill and Gillies 1992). Karfs *et al.* (2009) rated from 20 to 50% of the area of several major catchments in north Queensland as being in C (poor) condition, based on the 'ABCD' land condition rating. Areas in C condition typically have 50% or more lower carrying capacity and a much increased risk of soil erosion than those in A or B condition (McIvor *et al.* 1995; Ash *et al.* 1997).

Wet season spelling (i.e. resting through the growing season) is a key recommendation for maintaining or recovering pasture condition. Work by Ash *et al.* (2011) in northern Australia showed that recovery of condition can occur relatively quickly, at least with annual wet season spelling. However, their study was relatively short (7 years) with the best results achieved on relatively fertile basalt and granodiorite soils. Currently, there is little other relevant information, particularly on the rates of recovery with a different timing, duration, or frequency of spelling, to guide cost-effective (Scanlan et al. 2013) and practical resting regimes for managers. There is also little data available on the demographic processes underpinning how pasture condition responds to management actions like grazing intensity and spelling. As such, management guidelines are relatively unsophisticated, with consequently varying results. There thus remains a major challenge to understand the ecological processes which drive the recovery of poor pasture condition.

The aim of this study was to improve guidelines to recover poor condition land and hence carrying capacity in northern Australia. The study had two major objectives: first, to determine the optimum frequency and duration of spelling for recovery of poor (C) condition land under two stocking rates. And second, to monitor and improve the understanding of the demographics of the major perennial grasses that underpin the processes of recovery.

Method

The trial reported here was established within the larger Wambiana grazing trial (O'Reagain et al. 2009), 70 km south of Charters Towers, Queensland (20º32'S, 146º7'E). Mean annual long-term rainfall is 647 mm with most occurring between October and March. The vegetation is an open eucalypt-acacia woodland. The present study was conducted on an area dominated by *Eucalyptus brownii* and the native shrub *Carissa ovata,* on brown sodosols. The soils are moderately fertile with a pasture layer containing *Bothriochloa ewartiana, Aristida* spp*., Chrysopogon fallax*, and other grasses.

The Wambiana trial was established in 1998 to test different grazing strategies (see O'Reagain et al. 1998). These included a heavy stocking rate (HSR: 4–5 ha/AE) and a moderate stocking rate (8–10 ha/AE). After 14 years of heavy grazing, the HSR paddocks were in C (poor) condition (Quirk and McIvor 2003). In 2011, part of one HSR paddock was selected and equivalent sets of 25 treatment plots (30 × 30 m) laid out in two blocks. One block was near an adjacent MSR paddock. The intervening paddock fence was realigned to incorporate this block containing all treatments into the adjacent MSR paddock, while the other block remained in the HSR paddock.

Four different spelling regimes involving either early or full wet season spelling and applied either annually or biennially were then implemented on these treatment plots in both the HSR and MSR paddocks (O'Reagain et al. 2023). Spelling was implemented by closing up plots with a temporary fence but were otherwise left open to grazing. A series of replicated unrested, continuously grazed control plots were also installed. Twelve 0.25-m^2 quadrats were permanently located in each plot with quadrats stratified to contain an adequate number of *B. ewartiana* plants (O'Reagain et al. 2023). Quadrats were surveyed annually at the end of the wet season (May/June) and the number and size of all individual perennial grasses recorded graphically on gridded paper.

Statistical analysis

Data was analysed by randomised block analyses of variance, with plots as experimental units. Treatment response patterns over seasons were analysed using repeated measures analyses of variance with GENSTAT (release 18.1, VSN International, Hemel Hempstead, UK) with the pre-treatment (2011) basal cover a covariate. For this paper, only the basal cover of *B. ewartiana* was analysed.

Results

Rainfall was good in the first 2 years and following the 3 previous, above-average years. Thereafter drought conditions ensued, with 2014/15 the fourth driest year on record (Figure 1). Rainfall remained below average and was often poorly distributed thereafter, before exceptionally good rains in the 2022/23 season.

Average total perennial grass basal cover increased slightly in the early years of the trial, but then declined in both stocking rates in the dry years between 2013 and 2016 (Fig. 1). This decline resulted from mortality of established plants and a reduction in basal cover of survivors. With the advent of drought, cover declined sooner and to a much lower level in 2016 in the HSR (0.23%) than in the MSR (0.53%). Thereafter, basal cover slowly increased in both the HSR and MSR treatments as seasons gradually improved. However, average basal cover of perennial grasses in the HSR never recovered to that observed in the MSR, even in the exceptionally wet year of 2023. These results show that while drought had a major impact on basal cover under both stocking rates, these effects were amplified under heavy stocking.

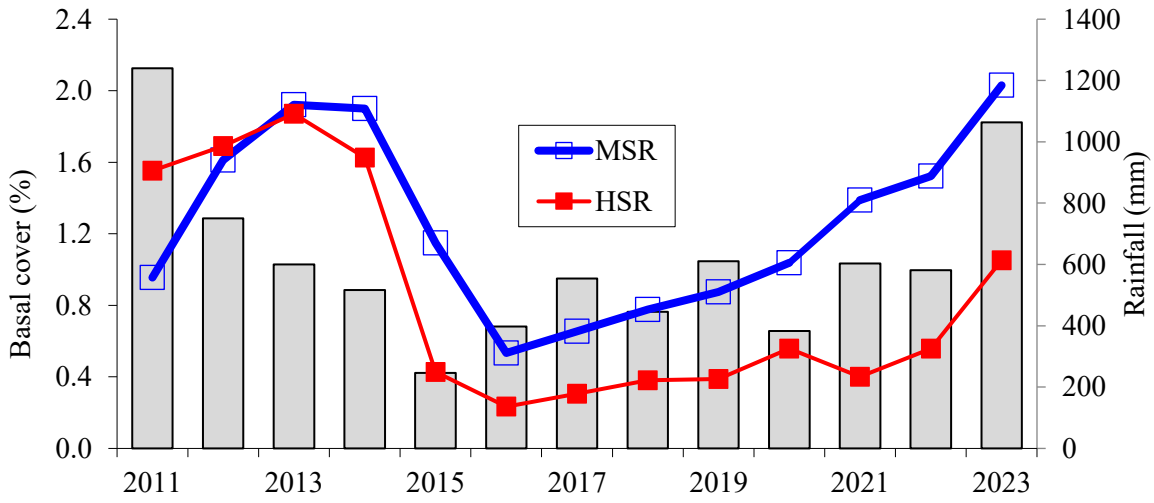

Fig. 1. Change in total perennial grass percentage (%) basal cover, averaged across the annual early wet season spell, annual full-wet season spell and unspelled control for the moderate (MSR) and high stocking (HSR) plotted against rainfall (grey bars).

Wet season spelling had a positive effect on the basal cover of the key species *B. ewartiana*, at least in the MSR (Fig. 2). However, this difference was only statistically significant in 2023 ($P < 0.03$) for the annual early and full wet season spelling, with biennial spelling having little or no effect on basal cover (Fig. 2). Importantly, in the HSR, spelling, even if applied annually and for the full wet season, had virtually no effect on *B. ewartiana* basal cover (data not shown).

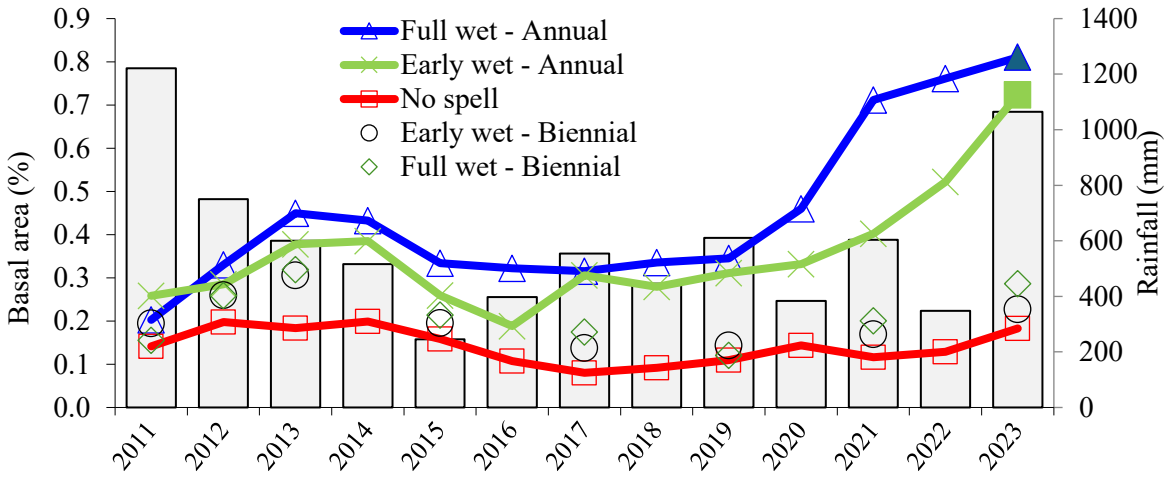

Fig. 2. Change in the basal area of B. ewartiana with different spelling treatments or no spelling in the moderate stocking rate treatment. (Values with a closed symbol in 2023 are significantly different to those with an open symbol; $P < 0.05$.)

The increase in basal cover of *B. ewartiana* in the MSR (Fig. 2) resulted predominantly from the increased basal area of the surviving, original plants from 2011 (Fig. 3). However, new recruits made an increasing contribution to basal cover in later years, at least under moderate stocking. For example, in 2017 the basal area occupied by recruits was 0.04% of a total 1.02% in the MSR.

However, by 2023, basal area from original plants was 1.72%, while the area occupied by recruits was 0.49%, almost a 12-fold increase.

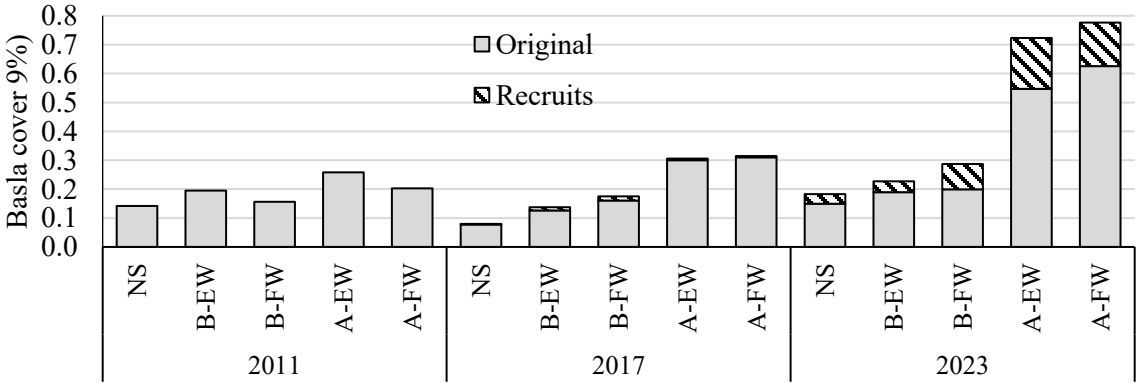

Fig. 3. Contribution of original 2011 plants and new recruits to total basal cover of B. ewartiana under different spelling regimes in 2011 and again in 2017 and 2023.

Discussion

The present study has shown that recovery of land condition can occur with the application of wet season spelling but that this can be an extended process, particularly during below-average rainfall conditions. This partly reflects the fact that *Bothriochloa ewartiana,* the key perennial grass, is a long-lived species whose recruitment appears to

be limited by low seed production. These results strongly emphasise the importance of maintaining existing plants by good management, particularly going into drought, as recruitment is very slow (Orr and O'Reagain 2011).

The present results also show that recovery is far faster under annual wet season spelling than under less frequent regimes. This suggests the need for some form of rotational grazing if recovery is to occur. Importantly, spelling had no effect on *B. ewartiana* basal cover under heavy stocking. This clearly indicates that the effect of stocking rate overrides that of spelling, that is, the benefits of spelling are only likely to be realised under appropriate stocking rates.

Acknowledgements
This paper is dedicated to our late friend and colleague Paul Jones who initiated and led this project. The trial is funded via a Meat and Livestock Australia, Queensland Department of Primary Industry and Federal Government donor company project. Animal ethics approval was obtained under SA 2022-11-862.

References

Ash AJ, Corfield JP, McIvor JG, Ksiksi TS (2011) Grazing management in tropical savannas: Utilization and rest strategies to manipulate rangeland condition. *Rangeland Ecology and Management* 64, 223–239.

Karfs RA, Abbott BN, Scarth PF, Wallace JF (2009) Land condition monitoring information for reef catchments: a new era. *The Rangeland Journal* 31, 69–86

McIvor JG, Ash AJ, Cook GD (1995) Land condition in the tropical tallgrass pasture lands: 1. Effects on herbage production. The Rangeland Journal 17, 69–85.

McIvor J, Bray S, Grice T, Hunt L, Scanlan J (2011) Grazing management options for improving profitability and sustainability. 1. New insights from experiments. Proceedings of the Northern Beef Research Update Conference, Darwin NT. Pp. 41–47.

O'Reagain PJ, Bushell JJ, Holloway CH, Reid A (2009) Managing for rainfall variability: effect of grazing strategy on cattle production in a dry tropical savanna. *Animal Production Science* 49, 1-15.

O'Reagain P, Scanlan J, Hunt L, Cowley R, Walsh D (2014) Sustainable grazing management for temporal and spatial variability in north Australian rangelands – a synthesis of the latest evidence and recommendations. *The Rangeland Journal* 36, 223–232.

O'Reagain PJ, Bushell J, Jones P, Smith D, Pringle MJ, Owens JS, Anderson A (2023) Wambiana: Grazing strategies and tools to improve profitability and land condition: Final Report B.ERM.0108. Meat and Livestock Australia, North Sydney. Available at https://www.mla.com.au/research-and-development/search-rd-reports/.

Orr DM, O'Reagain PJ (2011) Managing for rainfall variability: impacts of grazing strategies on perennial grass dynamics in a dry tropical savanna. *The Rangeland Journal* 33, 209–220.

Quirk M, McIvor J (2003) 'Grazing Land Management: Technical Manual.' (Meat and Livestock Australia: North Sydney, NSW.)

Scanlan JC, MacLeod ND, O'Reagain PJ (2013) Scaling results up from a plot and paddock scale to a property – a case study from a long-term grazing experiment in northern Australia. *The Rangeland Journal* 35, 193–200.

Tothill JC, Gillies C (1992) 'The Pasture Lands of Northern Australia.' Tropical Grassland Society of Australia Occasional Publication No. 5, St. Lucia, Qld.