



Managing for a variable climate: long-term results and management recommendations from the Wambiana grazing trial

The Wambiana field day
29 August 2015

CS4359 09/15



Lyons Family
Wambiana Station
Charters Towers



CS4359 08/15

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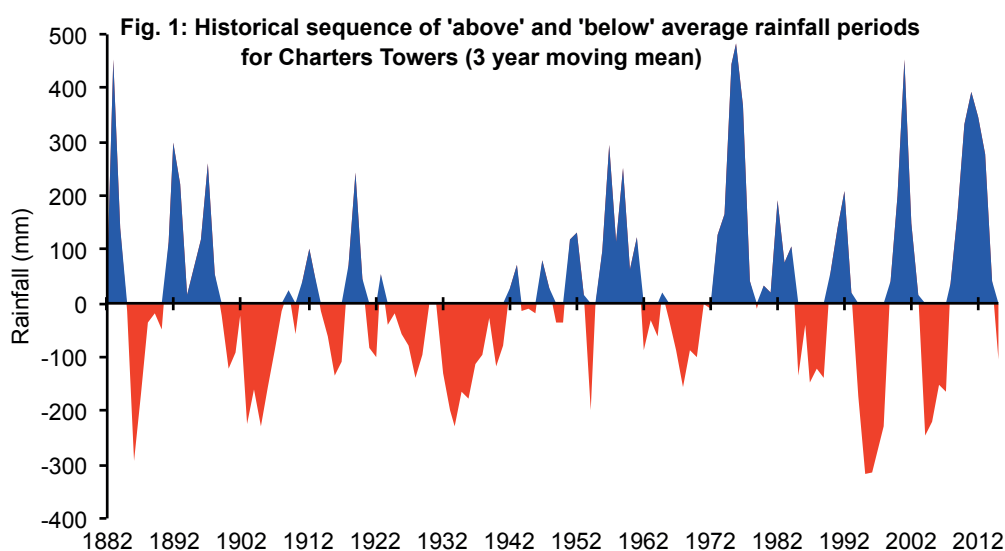


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Introduction

- Rainfall in Queensland is extremely variable (see Fig. 1).
- In dry years, overstocking causes pasture degradation and soil erosion and increases financial loss.
- Sustainable grazing strategies—such as moderate and variable stocking—are not widely adopted due to a belief that they are unprofitable.



Trial objectives

- Assess the ability of different stocking strategies to cope with rainfall variability in terms of their effects on **animal production, profitability** and **land condition**.
- Develop practical, improved grazing strategies to manage for rainfall variability.

Grazing strategies

Phase 1: 1998–2010

1. **Heavy stocking rate (HSR):** Constant stocking at about twice the long-term carrying capacity (LTCC)¹, i.e. 24 AEs/100 ha (4 ha/AE).²
2. **Moderate stocking rate (MSR):** Constant stocking at around the LTCC, i.e. 12 AEs/100 ha (8 ha/AE).
3. **Rotational wet-season spelling (R/Spell):** Constant moderate stocking (16 AEs/100 ha until 2003, then 12 AEs/100 ha) with a third of the paddock wet-season spelled each year, i.e. one paddock with three sub-paddocks. In 2000 and 2001, spelled sections were burnt prior to locking up.
4. **Variable stocking (VAR):** Stocking rates adjusted up or down in May based on pasture availability at the end of the wet season (range 8–26 AEs/100 ha, i.e. 3–12 ha/AE).
5. **SOI-variable stocking (SOI):** Stocking rates adjusted in November based on available pasture and Southern Oscillation Index (SOI) seasonal forecasts for the next wet season (range 8–24 AEs/100 ha, i.e. 4–12 ha/AE).

¹ LTCC = 25% utilisation of the pasture expected to be produced in 70% of rainfall years.

² 1 AE = 1 adult equivalent weighing 450 kg.

Note: Stocking rates were chosen based on the estimated long-term carrying capacity, district averages and discussion with the Grazier Advisory Committee.

In 2010, some strategies were changed to apply management lessons learnt in Phase 1:

- more stocking rate adjustment points through the year (3 vs 1)
- limits set on maximum stocking rate change and rate of change between years
- wet-season spelling applied in a flexible, adaptive manner (6 vs 3 sub-paddocks; length of spell depends on season).

Phase 2: 2010–2015

1. **HSR** (24 AEs/100 ha).
2. **MSR** (12 AEs/100 ha).
3. **Rotational wet-season spelling** (12 AEs/100 ha) with 6 sub-paddocks (previously only 3).
4. **'Flexible' stocking (no spelling)**: a combined version of the SOI and VAR but with 3 potential adjustment points through the year (end of wet season, end of dry season, early wet season).
5. **'Flexible' stocking + spelling**: As for (4.) above but with 6 sub-paddocks to allow wet-season spelling.

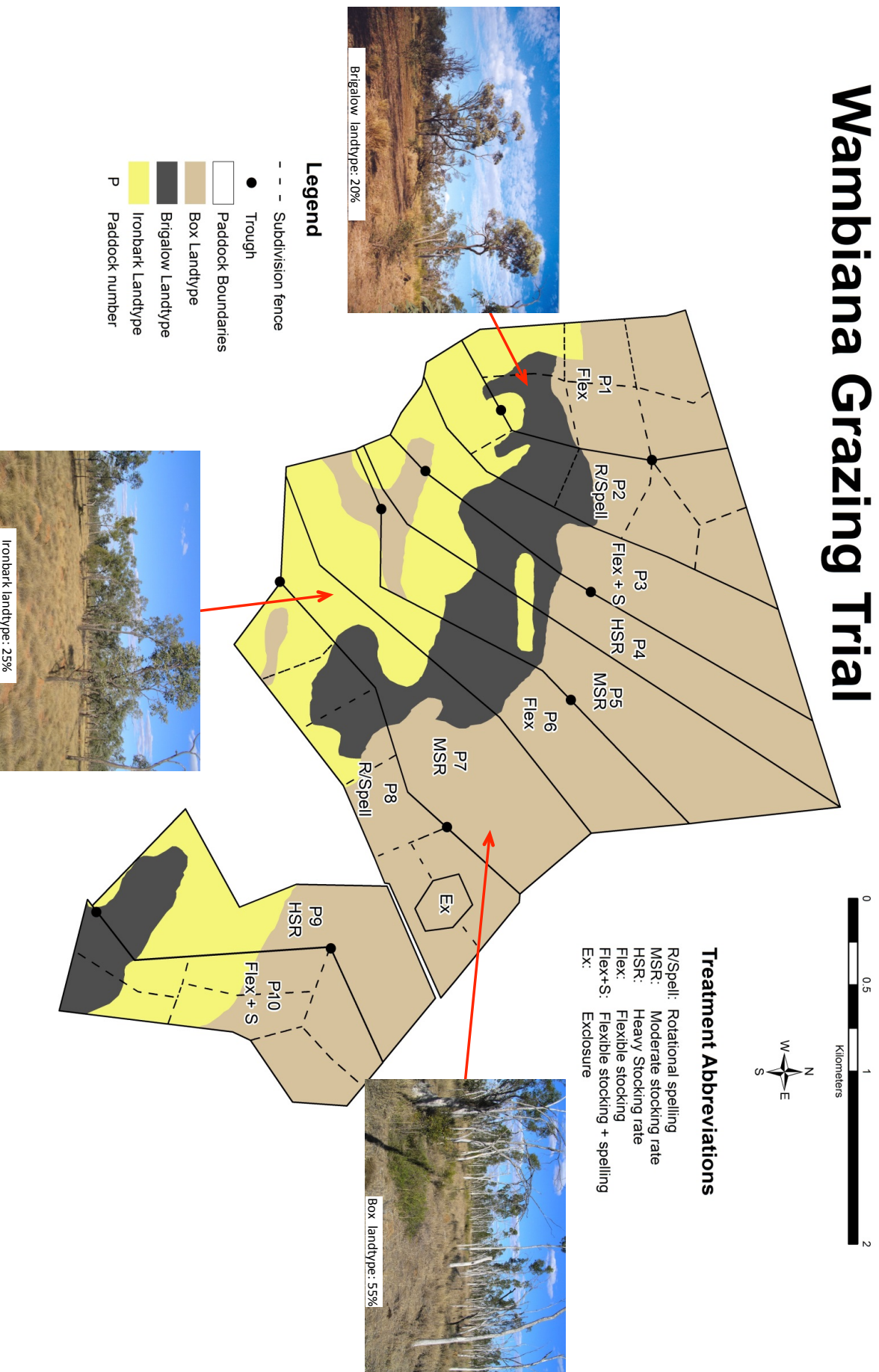
General trial features

- **Start date:** 19 December 1997
- **Area:** 1100 ha composed of 3 soil-vegetation associations
- **Long-term average rainfall:** 630 mm
- **Five treatments:** replicated twice
- **Paddock sizes:** 93–117 ha, fenced so that soil types are in the same proportion in each paddock (see map)
- **Cattle:** Brahman-X steers 18 and 30 months old, steers stay on trial for 2 years
- **Supplements:** Dry season urea, wet season phosphorus
- **Drought feeding:** molasses and urea (8%) when required

Trial measurements

- Animal production—weight gains, carcass values etc.
- Pasture condition and production, plant demography
- Soil loss and water quality
- Biodiversity—fauna and flora
- Soil carbon and sequestration
- Fire effects on trees and shrubs

Wambiana Grazing Trial





Measuring pasture yields



The Grazier Advisory Committee has been essential in ensuring the trial remains relevant to the grazing industry.



Checking rainfall and runoff equipment



Biodiversity monitoring by JCU



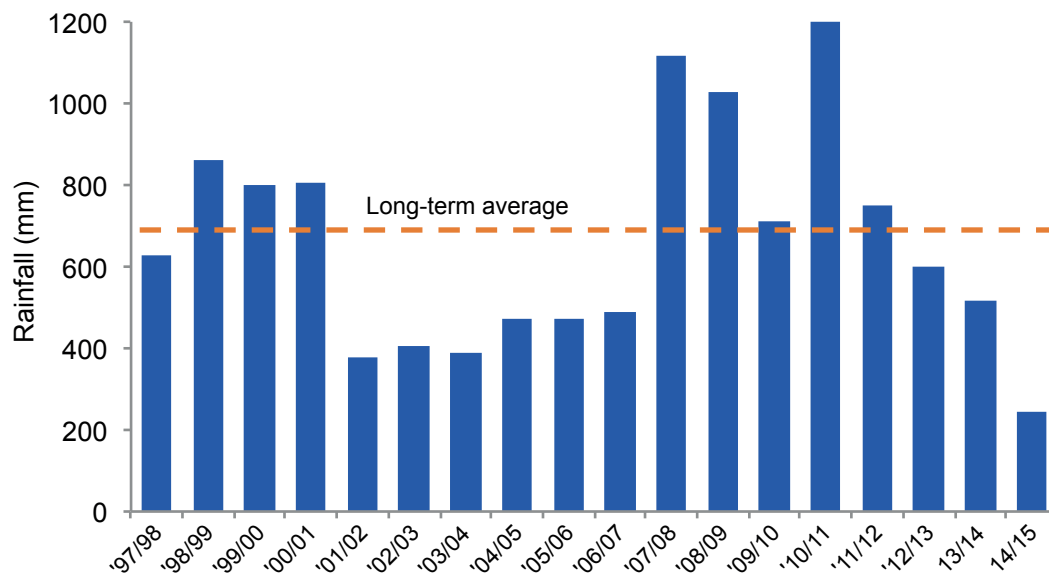
Monitoring fire effects on woody plants

What happened?

Rainfall

Rainfall varied a lot over the course of the trial with wet and dry cycles (see Fig. 2). In particular, 2014–15 was very dry with only 246 mm (4th driest year in 105 years).

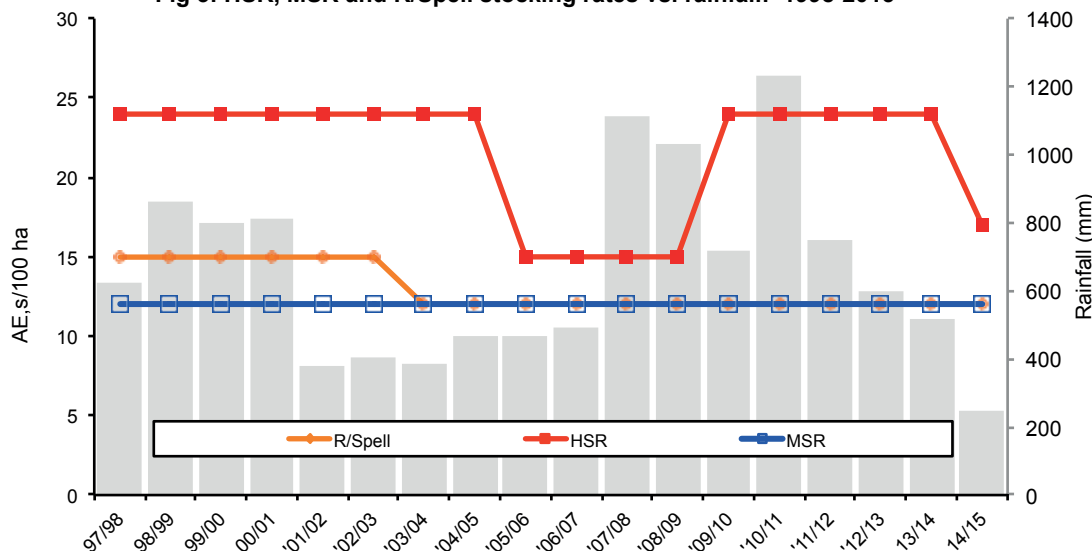
Fig. 2: Wambiana rainfall: 1998-2015



Stocking rates

HSR: The heavy stocking rate in the HSR was easily maintained initially, but in later dry years drought feeding was required and stocking rates had to be reduced (Fig 3). Although the original heavy stocking rate was restored when better seasons returned, paddocks collapsed relatively early in the 2014–15 drought, with some animals having to be withdrawn and drought feeding initiated.

Fig 3: HSR, MSR and R/Spell stocking rates vs. rainfall: 1998-2015



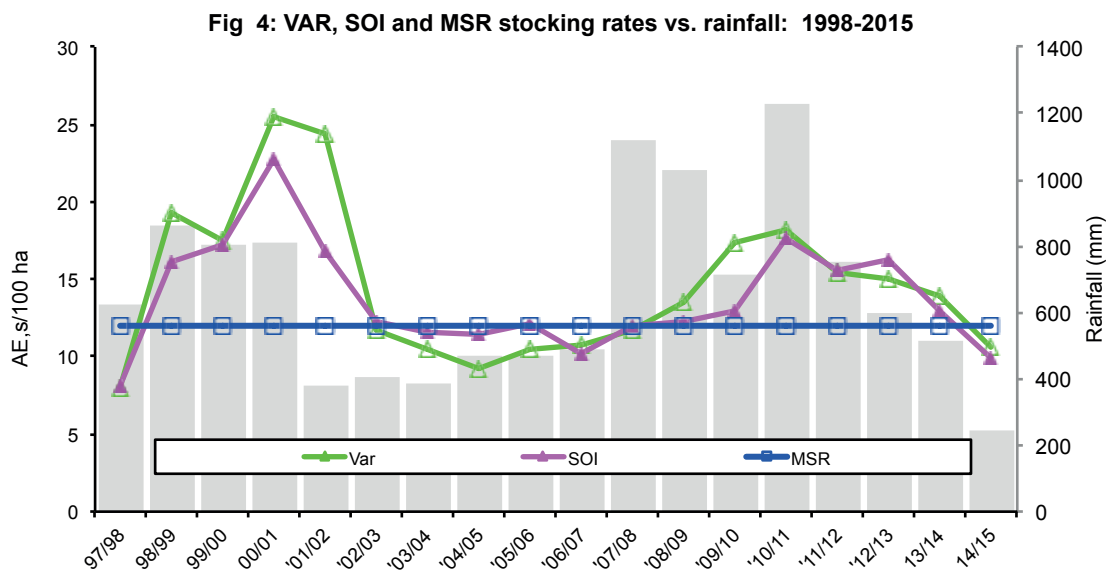
MSR: The MSR was maintained across all years without requiring drought feeding or any reduction in stocking rate (Fig 3). However, there was some evidence of overgrazing in the driest years.

In the 2014–15 drought, stocking rate reductions and drought feeding in the HSR started a lot earlier than in previous droughts—this indicates a big drop in resilience in the HSR.

R/Spell: This was initially stocked at 16 AEs/100 ha but stocking rates were reduced to 12 AEs/100 ha in 2003 due to the effects of the 2001 pre-spelling fire and ongoing drought. As with the MSR, this stocking rate was safely maintained throughout the trial (Fig. 3).

VAR: Stocking rates were increased sharply in the VAR in early wetter years in line with good pasture yields. Although stocking rates were cut sharply from June 2002 onwards as conditions declined, severe overgrazing still occurred. Since then, stocking rates have been adjusted far more cautiously (see Fig. 4).

SOI: This followed a similar trend to the VAR; however, the declining SOI in late 2001 triggered a stocking rate reduction 6 months earlier than in the VAR.



Results

Pastures and pasture change

- Rainfall had a huge effect on pasture composition, with annual grasses such as firegrass and weaker perennials such as wiregrass and cotton panic fluctuating up and down as seasons changed.
- Perennial grasses such as desert bluegrass, Queensland bluegrass and silky browntop, in contrast, were far more stable and resilient.
- The perennial black speargrass was an exception, however, and suffered 100% mortality in the 2003 drought. Despite this, it recovered rapidly via mass seedling recruitment the next year.

3P grasses

Perennial, productive and palatable grasses are known as 3P grasses. Examples of 3P grasses are desert bluegrass, Queensland bluegrass, buffel grass and Mitchell grass. 3P grasses are the backbone of the production system because of their stability and reliability in even the worst of seasons.

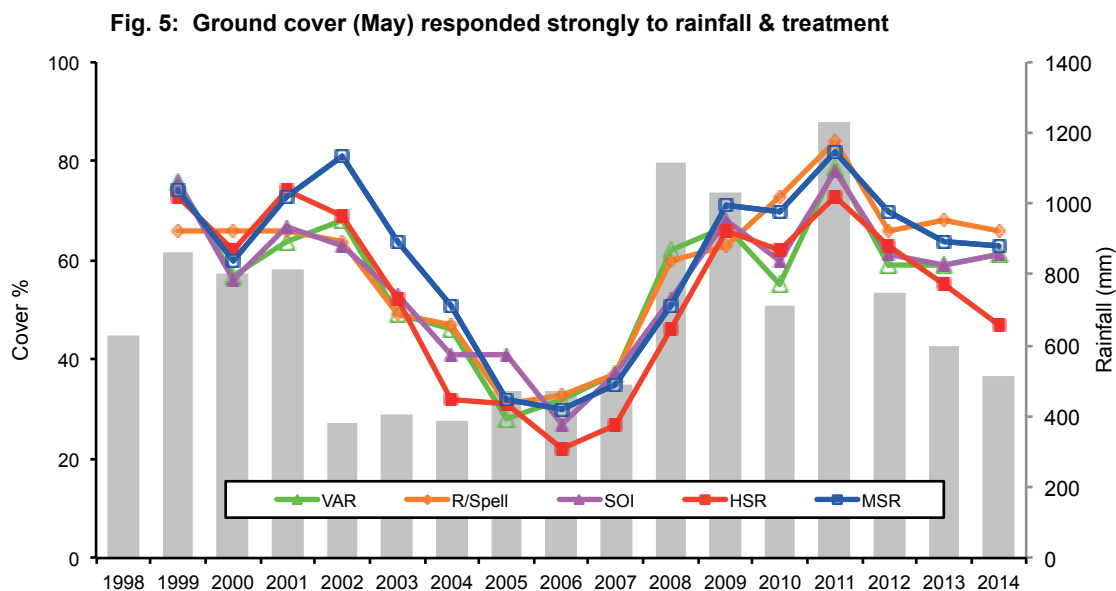
Desert bluegrass is probably the most important 3P grass in the upper Burdekin. Detailed plant population studies at Wambiana show that desert bluegrass:

- is long-lived (20–30 years) and relatively drought tolerant, so is a dependable source of forage
- is reduced by heavy grazing pressure, particularly in drought
- seldom recruits from seed, so recovery can be slow and unpredictable.

3P grasses such as desert bluegrass are long-lived but seldom recruit from seed, so it is essential to maintain existing tussocks through good management.

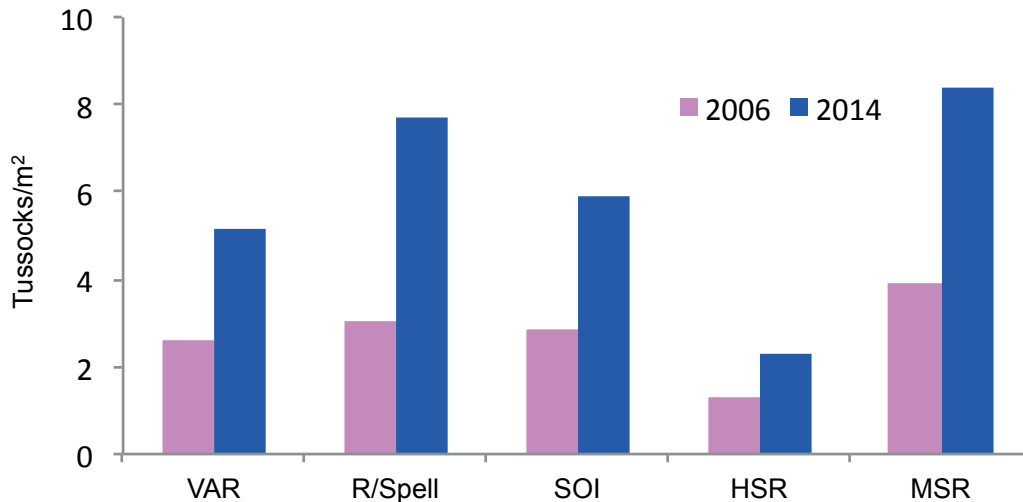
Changes in pasture yield, ground cover and composition

- There were big changes in pasture yield and ground cover over the course of the trial, driven largely by rainfall (see Fig. 5).



- Ground cover and pasture mass declined sharply in drought years but recovered strongly in wet years.
- Although pasture mass and ground cover also rebounded strongly after drought in the HSR with increased rainfall, there was little or no recovery in 3P species in this treatment (see Fig. 6).

Fig 6: Density of 3-P tussocks post drought (2006) and after 5 good years (2014)



The apparent recovery in the HSR following drought was visually impressive but largely cosmetic, with no recovery of 3P grasses.

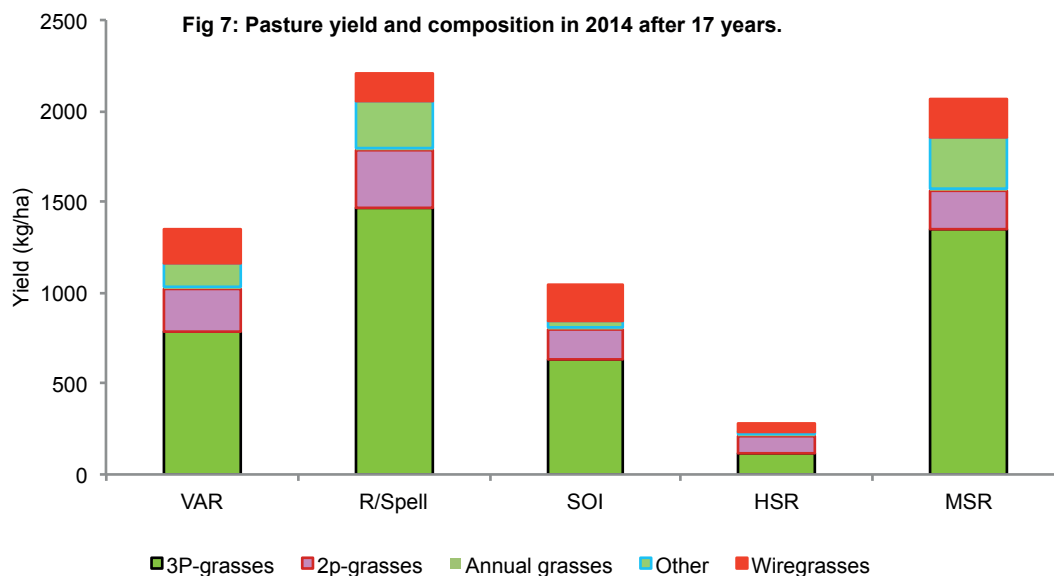
- Consequently, after 18 years the density of 3P grasses is 3 to 4 times greater in the MSR and R/Spell than in the HSR.
- In 2014 3P density in the VAR and SOI was also lower than in the MSR and R/Spell—this reflects the long-lasting impact of the heavy stocking rates in the SOI and VAR leading into the 2002–07 drought.

The lower 3P densities in the VAR and SOI reflect the long-lasting (12-year) impacts of overgrazing at the start of the early 2000s drought. This illustrates the dangers of not destocking quickly when drought follows better seasons.

The decline of 3P grasses in the HSR has in turn sharply reduced pasture production and composition (see Fig. 7).

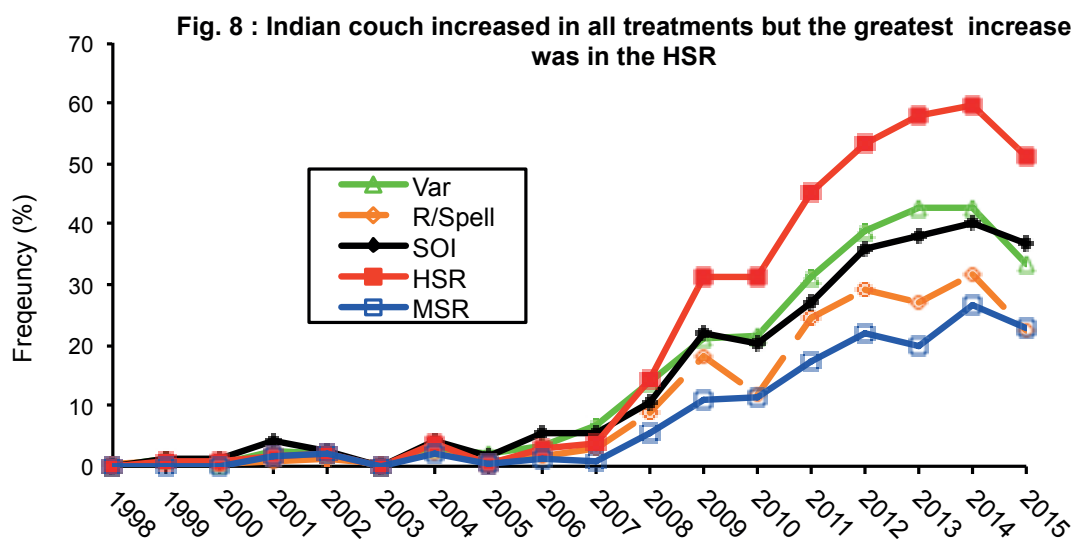
- Pasture production and composition in the VAR and SOI are also significantly lower than in the MSR and R/Spell—again reflecting the long-term consequence of heavy grazing some 12 years previously.

After 18 years, pasture condition and productivity are by far the worst in the HSR and are best in the MSR and R/Spell.



Indian couch

- Indian couch was initially rather rare on the trial, but exploded and spread rapidly across the trial in the good years following the 2002–07 drought. This occurred in all treatments, but the biggest increase was by far in the HSR (see Fig. 8).



Summary

- Heavy pasture utilisation rates lead to a decline in pasture condition—this decline is accelerated in dry years.
- Overgrazing leading into drought can also cause degradation. The timing of heavy utilisation rates relative to rainfall is therefore also important.
- Wet-season spelling is important but the response to spelling can be relatively slow.



In 2000 the MSR (left) and the HSR (right) were in good condition and dominated by 3-P grasses.



The same sites in 2014 - the MSR monitoring site (left) was still dominated by 3-P grasses but at the HSR site (right) 3-P grasses had disappeared and Indian couch was dominant .



The same sites in May 2015 . Although 2014/15 was the 4th driest year on record 3-P grasses are still present in the MSR (left) while there is only Indian couch stubble and tree litter in the HSR (right).



The entire trial was burnt in October 1999 and again in October 2011 to control woody vegetation.

Fire

- Fire killed relatively few (<20%) trees with most resprouting; those killed were generally less than 2 m tall.
- Fire had a significant effect on woodland structure, causing a big shift from large to smaller tree size classes.
- Fire top-killed *Carrisa* (currant bush) and caused a big decline in *Carissa* cover. However, *Carissa* cover recovered to previous levels within 5–6 years.
- The effects of fire on the pasture depend on land type and rainfall. A fire applied immediately before the 2001–02 drought caused significant pasture damage on silver-leaf ironbark country but not brigalow.

**Fire killed relatively few trees but opened up woodland structure.
Fire should be used cautiously and under the right conditions.**

Run-off and soil loss

- Heavy stocking adversely affected ground cover, pasture composition and soil condition.
- Collaborative work with CSIRO also showed a reduction in soil health and rainfall infiltration rates due to reduced activity of soil fauna such as termites.
- Heavy stocking increased the frequency and intensity of run-off, particularly in the early season. This will reduce pasture production and carrying capacity, especially in drier years.

Heavy stocking reduced rainfall infiltration and increased run-off.



Soil health is better under perennial grass tussocks (left) with higher soil faunal activity (right) and faster rainfall infiltration rates than bare patches or those dominated by 2-P or annual grasses.

Animal production

- Light to moderate stocking rates gave the best individual live weight gains (LWGs). Average annual LWG over 18 years was highest in the MSR (114 kg/hd), followed by the R/Spell (111 kg/hd), and the VAR and SOI (109 kg/hd). Annual LWGs were by far the lowest in the HSR (90 kg/hd).
- After 2 years, on the trial steers in lighter stocked strategies were 30–70 kg heavier, and had better meatworks grades and carcass prices than the HSR.

Steers from moderately stocked strategies generally received \$0.10/kg to \$0.20/kg more at the meatworks than heavier stocked steers.



Spot the difference: Despite the drought, in April 2015 moderately stocked steers (left) were in good condition. In contrast steers in the HSR (right) were in poor condition with many withdrawn while the remainder were drought fed

- Total LWG per hectare (LWG/ha) was greatest in the HSR (21 kg/ha), but drought feeding was needed in 5 of 18 years. Although LWG/ha was lower in the MSR (14 kg/ha), R/Spell (15 kg/ha), VAR (17 kg/ha) and SOI (16 kg/ha), these strategies did not require drought feeding.

Individual animal production and carcass values were highest under moderate stocking rates.

Total animal production was highest under heavy stocking, but this required drought feeding in dry years.

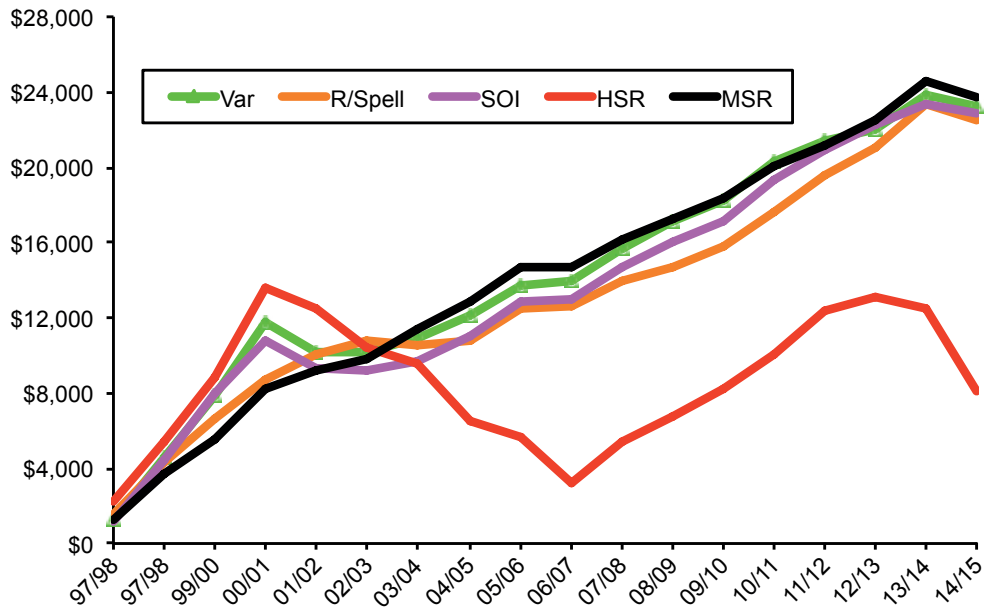
Economics

- The HSR was initially very profitable but lost money in dry years due to high costs, poorer meatworks grades and reduced production (see Fig. 9).
- The MSR gross margins were positive in nearly all years due to lower costs and higher returns per animal.
- The R/Spell was also profitable in most years but was temporarily undermined by the ill effects of the 2001 fire and subsequent drought.
- The VAR and SOI were also profitable but lost money in 2001–02 through the sale of animals that were in poor condition.

After 18 years, accumulated gross margins¹ in the MSR, R/Spell, SOI and VAR strategies were three times greater than in the HSR.

¹ Gross margins calculated using a 7.5% interest cost on livestock capital, cattle valued in at \$1.50/kg and out at from \$1.30/kg to \$1.50/kg based on body condition or carcass score.

Fig 9: Accumulated gross margins (\$/100ha) : 1998-2015



Do these results apply to breeders at the property level?

- Models were run for a 23 000 ha property with breeders over 6 different 30-year climate windows.
- The highest gross margins were achieved at stocking rates close to those used in the MSR in the trial, i.e. 6–9 ha/AE. However, the ‘optimum’ stocking rate varied with climate window, so flexible stocking around LTCC is the key.

Bioeconomic modelling at the property level with breeders supports trial outcomes, i.e. moderate stocking rates are most profitable.

However, the ‘optimum’ stocking rate varies with rainfall, so flexible stocking around LTCC is required.

Some conclusions after 18 years ...

Constant heavy stocking

- Initially performed well
- Economic loss in many years (6 out of 18)
- Big decline in land condition and productive capacity
- Reduced resilience to drought
- Increased runoff

Neither profitable nor sustainable

Problems: numerous

Moderate constant stocking

- Good individual animal production
- Profitable in nearly all years
- Maintained or improved land condition; lower run-off
- No decline in carrying capacity

Sustainable and profitable

Problems: overgrazing in dry years; lack of wet-season spelling

Variable stocking (VAR and SOI)

- Profitable in most years
- Animal production generally good
- Some decline in pasture condition, but recovering
- Higher risk than moderate stocking

Generally profitable; sustainable (?)

Problems: major risk of degradation in transition years (wet to dry); lack of wet-season spelling

Rotational wet-season spelling

- Good animal and economic performance (which improved in later years)
- Improved pasture condition (possibly better without 2001 fire?)
- Low runoff

Profitable and sustainable

Problems: spelling does not appear to allow large increases in stocking rates; potential overgrazing in dry years; overgrazing of non-spelled areas

Key recommendations

- Flexible stocking rates around long term carrying capacity.
 - Stocking rate adjustments in a risk-averse manner, i.e. slow increases, sharp decreases.
 - Regular wet-season spelling applied flexibly, depending upon season.
- These recommendations are being tested and refined in the current phase of the trial

The bottom line: five steps for sustainable and profitable management

Use long term carrying capacity as a general guide in setting stocking rates.

1. Adjust stocking rates in a flexible manner as pasture availability changes. Key adjustment points are the end of the wet season, the end of the dry season and early in the wet season.
2. Adjust stocking rates in a risk-averse manner: make sharp decreases with drought and slow increases in good years. Set maximum upper limits to the stocking rate irrespective of the season.
3. Apply regular wet-season spelling. This is essential to maintain and improve pasture condition and can also act as a feed reserve.
4. Apply fire judiciously to control woody plants.

Use all of the above in a flexible, adaptive manner.

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