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Wambiana Grazing Trial Extension: Testing and Developing Grazing Principles and Management Guidelines for the Seasonably Variable Tropical Savannas

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Abstract

The Wambiana grazing trial was initiated in December 1997 to test the ability of 5 grazing strategies to cope with rainfall variability and develop principles for sustainable, profitable management. Strategies tested were moderate stocking at long term carrying capacity (LTCC), heavy stocking at twice LTCC, rotational wet season spelling with moderate to light stocking (1.5 LTCC) and two variable strategies with stocking rates adjusted based on climate forecasts and/or standing pasture.

A report on the first 10 years of the trial (2008) showed that heavy stocking led to pasture degradation, was unprofitable and reduced carrying capacity and concluded that sustainable management was essential for longer-term profitability. This was confirmed in an updated report in 2009 that included another 2 years of data. This project reports on one subsequent year of data collection and briefly comments on the extent to which the data support previous conclusions.

Above average rainfall in 2009/10 followed the previous very good years of 2007/08 and 2008/09. These good seasons allowed a significant improvement in ground cover, pasture production and profitability in all treatments. Despite this apparent recovery, after 13 years accumulated gross margin in the heavy stocking strategy is still far lower and pasture condition significantly poorer, than in other strategies. These results reinforce earlier findings that light to moderate utilisation rates are not only sustainable but are far more profitable in the long term.

Executive Summary

Rainfall variability is a major challenge to sustainable and profitable grazing management in the northern savannas. Guidelines for sustainable management do exist but their profitability and sustainability have not been tested at the paddock scale. The Wambiana grazing trial was initiated in December 1997 to test the impacts of five different grazing strategies on profitability and sustainability. Strategies tested were (i) moderate stocking (MSR) stocked at the recommended long-term carrying capacity (c. 8 ha/ Animal Equivalent (AE)), (ii) heavy stocking (HSR) run at about twice the long term carrying capacity (c. 4 ha/AE), (iii) variable stocking (VAR) with annual stocking rate adjustments based on available pasture (range: 4-12 ha/AE), (iv) Southern Oscillation Index - variable stocking (SOI) with stocking rates adjusted based on the SOI and available pasture (range: 4-12 ha/AE) and (v) a 3-paddock rotational wet season spelling system (R/Spell) with moderate-light stocking (c. 6 - 9 ha/AE).

A full technical report on the first ten years of the trial was submitted to MLA in January 2008, followed by a further updated report in September 2009. These results form much of the grazing management section of the EDGE-GLM workshop and have been used in many other extension processes such as *SavannaPlan* and *Stocktake*. The present project was initiated to provide funding for the 2009/10 grazing season to maintain treatments, ensure data was collected and analysed and results updated.

Following the succession of 6 dry years between 2001/02 and 2006/07, rainfall over the last 3 years has been well distributed and above average. Stocking rates in the HSR were accordingly increased in May 2009 back to their original levels of 4 ha/AE and have also been increased slightly in the VAR and SOI with the better seasons.

Pasture mass and ground cover remain relatively high in all strategies but the proportion of 3-P grasses in the pasture is still lowest in the HSR (19%) and highest in the R/Spell (48%) and MSR (55%). The density of 3-P (palatable, perennial and productive) species tussocks in the HSR is also still only a third that in the MSR and R/Spell, and half that in the VAR and SOI. This indicates that despite the good seasons, pasture condition is still the best in the R/Spell and MSR (B+) followed by the VAR and SOI (B-) and is by far the lowest in the HSR (C-).

Animal live weight gain (LWG) in 2009/10 was also relatively good (mean: 109 kg/hd) but was somewhat reduced due to very low dry-season forage quality. Overall, individual LWG was highest in the MSR (118 kg) and lowest in the VAR (98 kg). There were obvious treatment differences for meatworks steers with carcass value being by far the lowest for the HSR (\$749) and highest for SOI steers (\$899). There was less variability between treatments in price/kg, but HSR prices were still about \$0.07/kg lower than the other treatments.

Total LWG/ha in the HSR (26 kg/ha) was double that in the other treatments; despite this, gross margins were still lowest in the HSR due to higher livestock interest costs and the lower product value. Accordingly, after 13 years accumulated gross margin in the HSR is still \$9,500 to \$13 000/100 ha below that in the other strategies. Scaling up to a property size of 20 000 ha this equates to a substantial economic advantage of more than \$2 million in favour of the other strategies relative to heavy stocking.

These results confirm and build upon those presented in earlier reports that heavy stocking leads to pasture degradation and is far less profitable than the other strategies tested.

After 13 years, the overall performance of the different strategies may be summarised as follows:

- (1) Moderate stocking at or near long-term carrying capacity is both sustainable and profitable and will maintain pastures in B+ condition.
- (2) Heavy stocking at twice LTCC is generally not profitable (except in wet years), is unsustainable and leads to degradation to at least C condition pastures. At heavier stocking rates, animal production on C condition pastures may be high in good rainfall years but will follow a boom and bust pattern with shifts between wet and dry years.
- (3) Variable stocking (with or without the SOI) largely avoids the costs of heavy stocking but is no more profitable than moderate stocking. Variable stocking is generally sustainable, but has a greater environmental risk relative to moderate stocking.
- (4) Rotational wet season spelling at light to moderate stocking rates is sustainable, resulted in good pasture condition (B+) but is marginally less profitable than either moderate or variable stocking.

These results largely verify previous key findings from the trial but add a new and critical dimension in the form of pasture condition. As such, it allows many of the current principles and guidelines to be extended to account for the effects of pasture condition and its interaction with rainfall in determining animal production, land condition and profitability.

Acknowledgments

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Peter O'Reagain and John Bushell

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1 Background

The purpose of this project is to provide interim funding for 2009-10 to ensure the Wambiana treatment paddocks are maintained and critical datasets collected, to ensure that there is a full harvest of all the useful guidelines, tools and insights from the project to date, that these outputs are integrated with outputs from other grazing studies in northern Australia (Pigeon Hole, Burdekin Catchment projects), and to help decide on the future role of the Wambiana trial site for addressing industry priorities in relation of grazing management, landscape heath and animal production.

Following a detailed technical review of the results and study site visit an experimental design and treatments for a new phase of research at Wambiana has been developed. This will be initiated in a new project starting June 2010. This variation will ensure the maintenance of the site and data collection until then.

2 Project Objectives

By May 2010:

1. Maintained the integrity of treatments at the trial site, and collected critical data sets, during 2007-08, 2008-09 and 2009-10.
2. Provided a concise final report, including data from 07-08, 08-09 and 09-10, with updating of key data sets and discussion of changes, or otherwise, in performance of the grazing strategies.
3. Produced a series of Tips and Tools that capture the key grazing management messages for industry benefit.
4. In cooperation with GLM workshop delivery staff and other extension officers, developed and implemented a strategy to effectively communicate project outputs and to ensure their full integration with the GLM workshop, the StockTake workshop and other relevant extension activities.
5. Contributed to the bioeconomic analysis of pasture-based production systems of northern Australia, leading to recommendations for on-going experimentation at Wambiana.

3 Methodology

A brief description of the Wambiana trial is given below – for more detail consult the 2008 final report (O'Reagain *et al.* 2008).

3.1 Site description and treatments

The Wambiana trial was established in 1997 near Charters Towers (20° 34' S, 146° 07' E) in an open *Eucalypt* savanna on relatively infertile soils. Experimental paddocks are c. 100 ha in size and contain similar proportions of three different soil-vegetation associations. Mean annual rainfall is 650 mm and is highly variable (C.V. = 40%). Precipitation is largely (70 %) concentrated in the wet season between December and April. Stocking strategies being tested are: (i) *moderate stocking* (MSR), stocked at the long term carrying capacity (LTCC) of 8 ha/large stock unit (AE= 450 kg steer) to achieve the recommended 'safe' average pasture utilisation rate of 20-25 % , (ii) *heavy stocking* (HSR) run at twice LTCC (4 ha/AE) to achieve an average of 40-50 % utilisation of pasture, and (iii) *variable stocking* (VAR) - stock numbers adjusted annually in May at the end of the wet season

(range: 3-10 ha/AE) according to available pasture, (iv) a SOI-Variable strategy - stock numbers adjusted annually at the end of the dry season according to available pasture and the Southern Oscillation Index (range: 3-10 ha/AE) and (v) *Rotational wet season spelling* – a third of the paddock wet season spelled each year (range: 6-9 ha/AE).

3.2 Animal production

Animal production is measured using Brahman-cross steers, supplemented with wet-season phosphorous and dry season urea. Molasses and urea drought feeding was provided in extreme circumstances. Accumulated gross margin (AGS) was calculated from annual gross margins (GM) i.e. the value of beef produced minus variable and interest costs (for more detail see O'Reagain *et al.* 2010).

3.3 Pasture condition and production

Pasture total standing dry matter (TSDM), species contribution to yield and cover are assessed annually in May and October. Species data is grouped into five functional groups i.e. 3-P and 2-P (palatable, productive and/or perennial) grasses, wiregrasses (*Aristida* and *Eriachne* spp.), annual grasses and 'other'. Species frequency is assessed annually in the mid- to late-wet season on permanent monitoring sites across the grazing trial. 3-P tussock densities are derived from tussock counts in 0.25 m² quadrats during frequency surveys.

4 Results and Discussion

4.1 Rainfall

Rainfall in 2009/10 was again above average (713 mm) but considerably lower than the previous two seasons (Fig. 1). Although rainfall in 2009/10 was lower, it was more effective than the previous two seasons, being relatively well distributed in a number of lower intensity falls. These three wet, above-average rainfall years follow an unbroken sequence of six low rainfall years from 2001/02 to 2006/07.

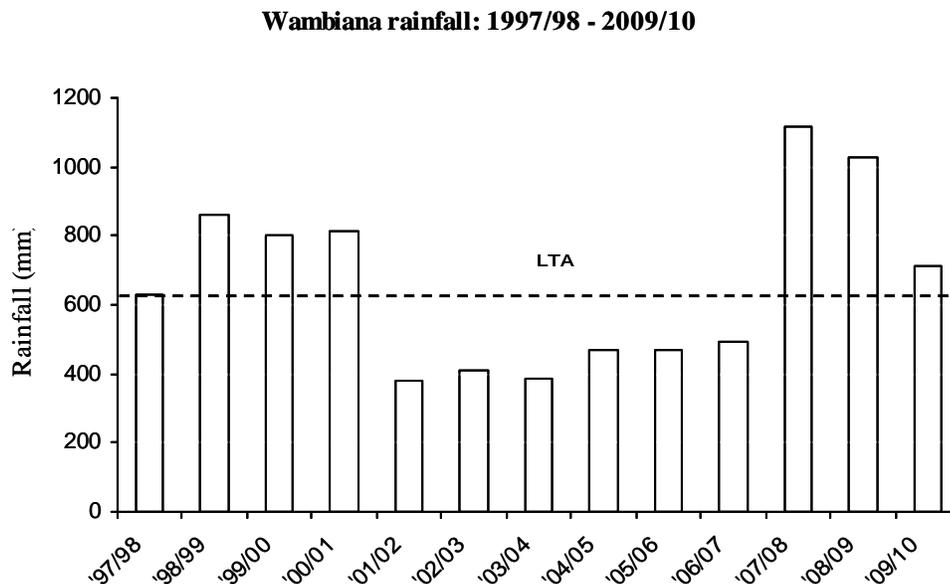


Figure 1. Annual rainfall between 1997/98 and 2009/10 at the Wambiana grazing trail. LTA=long-term average. NB: The 218 mm in June 2007 has been added to the 2007/08 total.

4.2 Stocking rates

After being run at a reduced rate of 6 ha/AE for the previous four years (HSR*), in May 2009 HSR stocking rates were increased back to their original level of 4 ha/AE (Fig. 2). This decision was sanctioned by the Grazier Advisory Committee, and was based on the argument that given the good seasons this is 'what a heavy stocker would be most likely to do.'

Stocking rates have also continued to be gradually increased in the VAR and SOI due to the better seasons. Nevertheless, the SOI and VAR remain relatively lightly stocked compared to the heavy stocking rates applied in these strategies in the earlier years of the trial (Fig. 2).

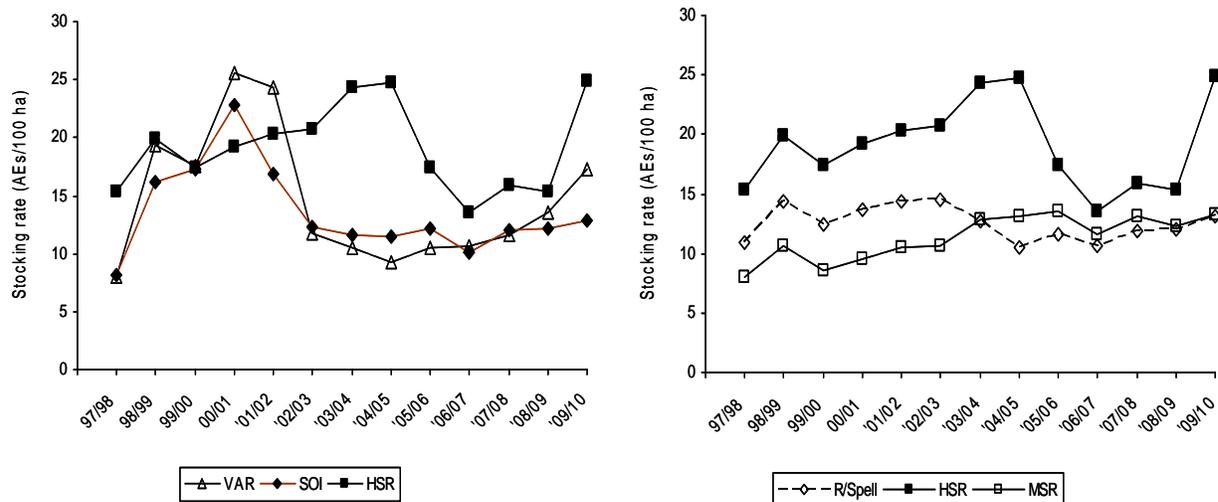


Figure 2. Change in stocking rate (expressed as AEs/100 ha) over different years at the Wambiana trial for (left) the VAR, SOI and HSR and (right) the R/Spell, MSR and HSR strategies.

4.3 Pasture change and composition

4.3.1 Pasture TSDM and composition

Pasture total standing dry matter (TSDM) remains relatively high across all treatments (Fig. 3) as would be expected given the recent wet years. There were some obvious treatments differences in May 2010 with TSDM being by far the highest in the MSR and R/Spell (2900 kg/ha), followed by the VAR and SOI (2100 kg/ha), with the HSR (1500 kg/ha) having the lowest TSDM of all strategies. Aside from the effects of the higher stocking rate, the lower TSDM in the HSR obviously reflects the lower proportion of 3-P species present in the pasture (Fig. 4) and hence the lower production potential of these paddocks.

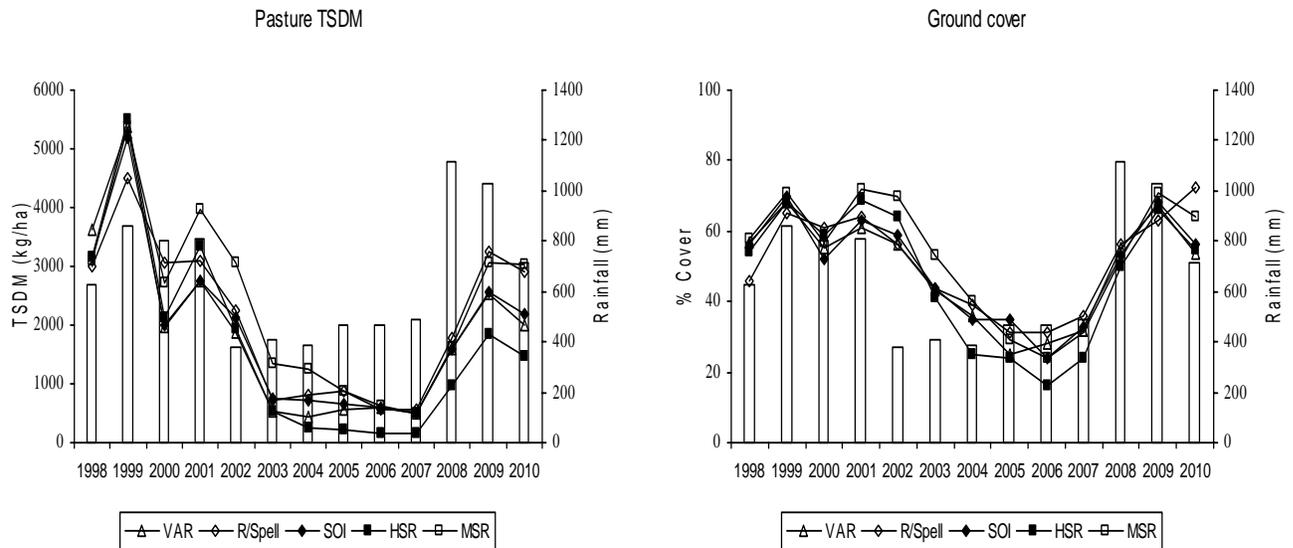


Figure 3. Change in pasture total standing dry matter (TSDM) and ground cover with rainfall between 1998 and 2010 at Wambiana for each calendar year i.e. with the exception of 2010, data is meaned across May and October TSDM estimates.

4.3.2 Ground cover

Ground cover declined slightly in most treatments in 2010 but remains relatively high (mean: 60 %) compared to earlier dry years (Fig. 3). Again, despite the good years there were still marked treatment differences with cover being noticeably higher in the R/Spell (72%) and MSR (64%) relative to the other treatments (mean: 55 %).

4.3.3 Pasture Composition

At the end of the wet season in May 2010, pasture TSDM was highest in the R/Spell and MSR, followed by the VAR and SOI, with TSDM being lowest in the HSR (Fig. 4). Despite the good seasons, the % contribution to yield of 3P species in the HSR (19%) was still far lower than that in the MSR (55%) and R/Spell (48 %) or in the VAR and SOI (36%). In contrast, the % contribution of 2-P species to yield in the HSR (19%) was nearly double that in the MSR (37%).

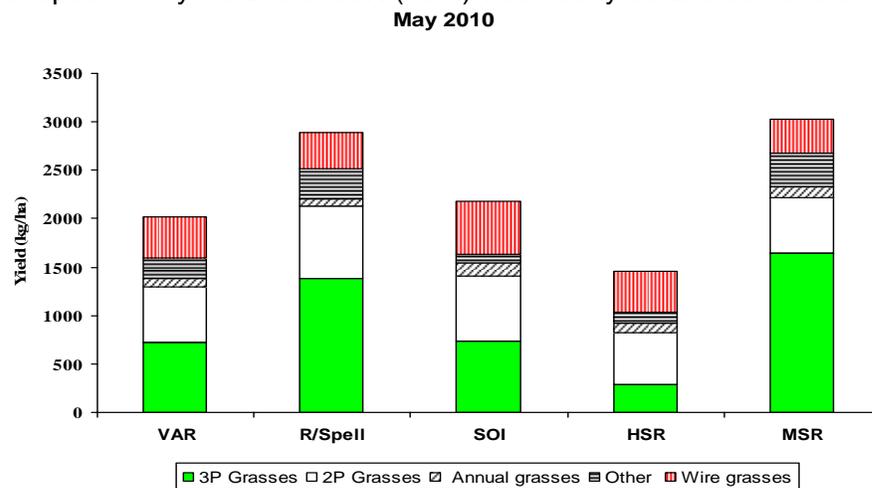


Figure 4. Contribution (kg/ha) of different species groups to pasture yield in May 2010 across five stocking strategies at Wambiana. Data meaned over both replicates.

Since the trial started in 1998, the absolute % contribution to yield of 3-P grasses has increased markedly in the MSR (19%) and R/Spell (15%), with some increase also occurring in the VAR (9%). In contrast, the % contribution of 3-P grasses has declined in the HSR (-9%) while the % contribution of weaker 2-P species like *Panicum effusum* and *Digitaria brownii* has increased by 23% (Table 1).

Surprisingly, the % contribution of wiregrasses (*Aristida* and *Eriachne spp.*) has declined since 1998 in most treatments, including the HSR (-9%). However, as noted in previous reports, this decline is an artefact of the extensive mortality of *Aristida* in the 2002/03 drought (Fig. 6). Since then, populations of most *Aristida* species have recovered strongly, particularly in recent wet years.

Table 1. Absolute change from 1998 to 2010 in the % contribution of different species groups to end of wet season pasture TSDM.

Sp. Group	VAR	R/Spell	SOI	HSR	MSR
3-P Grasses	+9	+15	0	-9	+19
2-P Grasses	+3	+1	+7	+23	0
Wiregrasses	-7	-17	0	-9	-17

4.3.4 Changes in species frequency

NB: For brevity, frequency data is only shown for four general indicator species. Figures for the other species are available on request.

There has been little or no change in the frequency of *Bothriochloa ewartiana* since 2009 (Fig. 5). This follows the general increase in *B. ewartiana* frequency that occurred from 2007 onwards with the good seasons. There has also been little change in the frequency of other significant perennial grasses such as *Dicanthium sericeum*, *Eulalia aurea*, *Eriachne mucronata* and *Chrysopogon fallax* (data not presented).

Following its rapid increase from 2007 to 2009, there has also been virtually no change in the frequency of *Bothriochloa pertusa*, aside from a slight decline in the R/Spell treatment. Conversely, *Heteropogon contortus*, and *Aristida benthamii* (the most common *Aristida* species) have a generally increased with the ongoing favourable conditions (Fig. 6). Weaker, semi-perennials like *Eragrostis spp.*, *Panicum effusum* and *Digitaria brownii* have also continued to increase in recent years (data not shown).

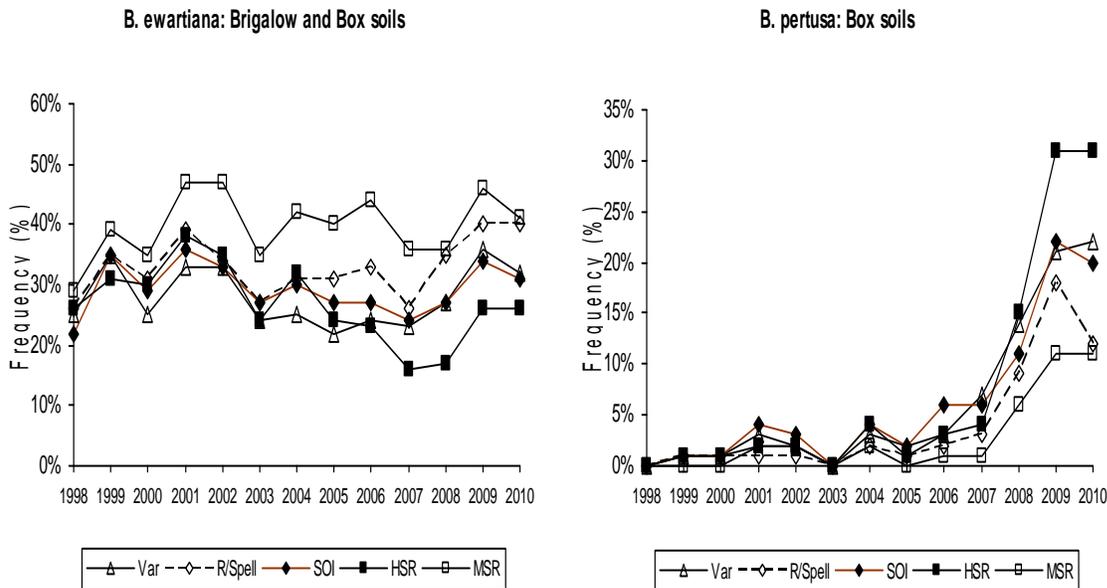


Figure 5. Change in mean % frequency of *B. ewartiana* (left) and *B. pertusa* (right) between 1998 and 2010 under five grazing strategies at Wambiana. Note different scale of vertical axes.

After 13 years, *B. ewartiana* frequency is highest in the MSR and R/Spell and lowest in the HSR (Fig.5). Although the frequency of *H. contortus* is also highest in the R/Spell and MSR and lowest in the HSR, this at least partially reflects the lower starting levels of the species in the latter treatment (Fig. 6). As in 2009, the frequency of *B. pertusa* remains highest (31%) in the HSR and lowest in the MSR (11%). Trends in the frequency of *Aristida benthamii* are interesting but difficult to interpret: although its frequency is far lower in the MSR (21%) than in other treatments, its frequency is almost identical in the HSR and R/Spell (32%).

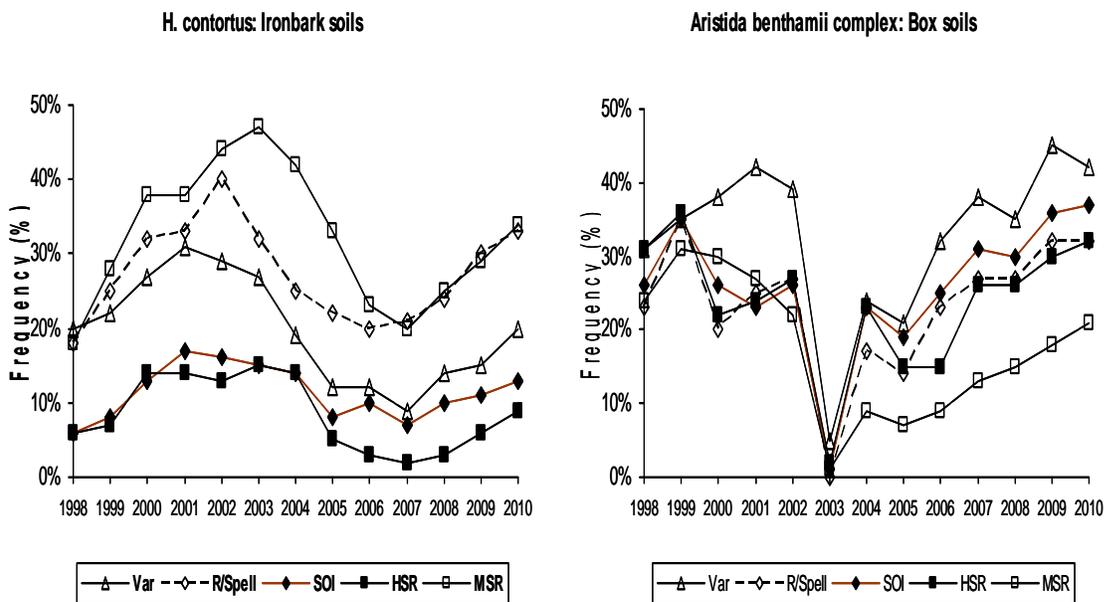


Figure 6. Change in mean % frequency of *H. contortus* (left) and *A. benthamii* (right) between 1998 and 2010 under five grazing strategies at the Wambiana grazing trial.

4.3.5 3-P Tussock Density

Despite three consecutive years of above average rainfall (mean: 881 mm), 3-P tussock densities in 2010 in the HSR (1.75/m²) were still only about one third those in the MSR (5.15/m²) and the R/Spell (4.95/m²), and less than half those in the VAR and SOI (Fig. 7). Comparison with the 2006 data collected at the end of a sequence of dry years (mean: 442 mm) is interesting: while substantial recovery has occurred in the R/Spell, VAR and MSR, there has been far less recovery in 3-P density in the SOI and HSR (Fig. 7).

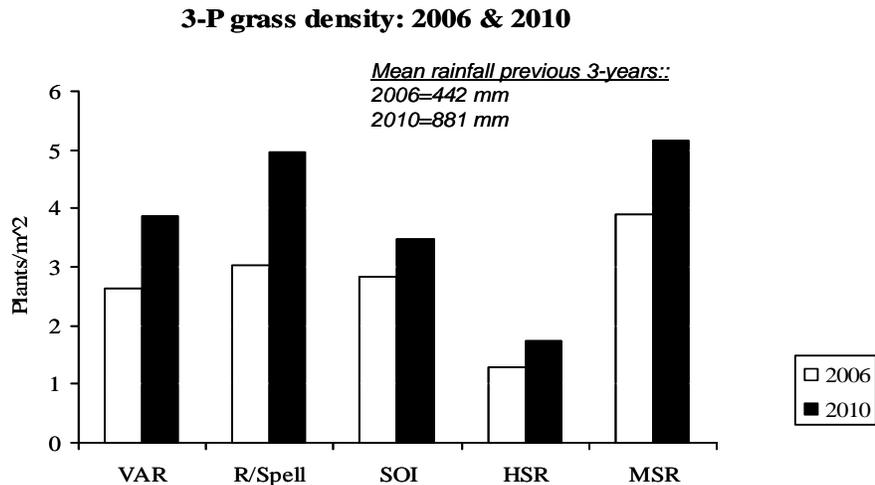


Figure 7. Mean 3-P tussock density (tussocks/m²) across all soil types in 2006 and 2010 across the five grazing treatments at the Wambiana trial.

There was also marked variability in recovery between soil types with the increase in 3-P density between 2006 and 2010 being far greater on the Ironbark (173%) than on either the Box (41%) or Brigalow soils (22%). This undoubtedly reflects differences in the rates of seedling recruitment between the main 3-P species on these soils: *H. contortus*, the major 3-P species on Ironbark soils is relatively short lived and has high rates of recruitment in wetter years. In contrast, *B. ewartiana* (Box and Brigalow) and *D. sericeum* (Brigalow) are longer lived but have relatively low recruitment rates.



Plate 1. Despite a big improvement in ground cover and pasture yield between 2006 (left) and 2010 (right) in the heavy stocking rate there has been no real improvement in the density of 3-P grasses.

4.3.6 ABCD Pasture condition

After 13 years pasture condition is best in the LSR and R/Spell (B+ condition), followed by the two variable treatments (B- condition). Pasture condition in the HSR is by far the worst (C- condition). As all paddocks would have been in similar condition at the start of the trial it is apparent that pasture condition has declined significantly in the HSR.

Table 2. Classification of treatments according to the ABCD condition framework based on May 2010 data.

	VAR	R/Spell	SOI	HSR	MSR
3-P % DM Yield	36%	48%	35%	19%	55%
3-P Crown cover	Moderate	Dense & healthy	Moderate	Sparse	Dense & healthy
% Ground cover	54%	72%	56%	55%	64%
3-P density per/m²	3.87	4.95	3.49	1.75	5.15
2-P % DM Yield	28%	26%	30%	37%	19%
Annuals % DM Yield	4%	3%	6%	7%	4%
Undesirables (wire grasses) % DM Yield	21%	13%	24%	29%	11%
Soil condition	1	1	1	2	1
Weeds	N/A	N/A	N/A	N/A	N/A
Tree density	Similar	Similar	Similar	Similar	Similar
Overall condition	B-	B+	B-	C-	B+

4.4 Dietary Quality

At present, no NIRS diet quality data is available for the 2009/10 grazing year as samples are still being analysed.

4.5 Animal performance

4.5.1 Individual animal performance

Seasonal effects

Individual live weight gain (LWG) averaged across all treatments (109 kg) in 2009/10 was slightly lower than 2008/09 (113 kg) and markedly below 2007/08 levels (139 kg: Fig. 8). LWGs for the present year are disappointing given the well-distributed rainfall in the wet season but undoubtedly reflect the poor dry-season animal performance (mean LWG: -25 kg).

Although dry season animal performance was poor in all treatments, there was a stocking rate effect with weight loss increasing with stocking rate ($r^2=0.35$). The poor dry season performance mirrored that reported in the district and appeared to be a direct result of particularly poor forage quality. This in turn was a consequence of first, the extended length of the dry season i.e. 202 days between consecutive falls of effective rain. And second, the heavy rains of the previous two years which would have reduced soil N availability through leaching. Plant N levels would also have been diluted due to good pasture yields, further reducing forage quality.

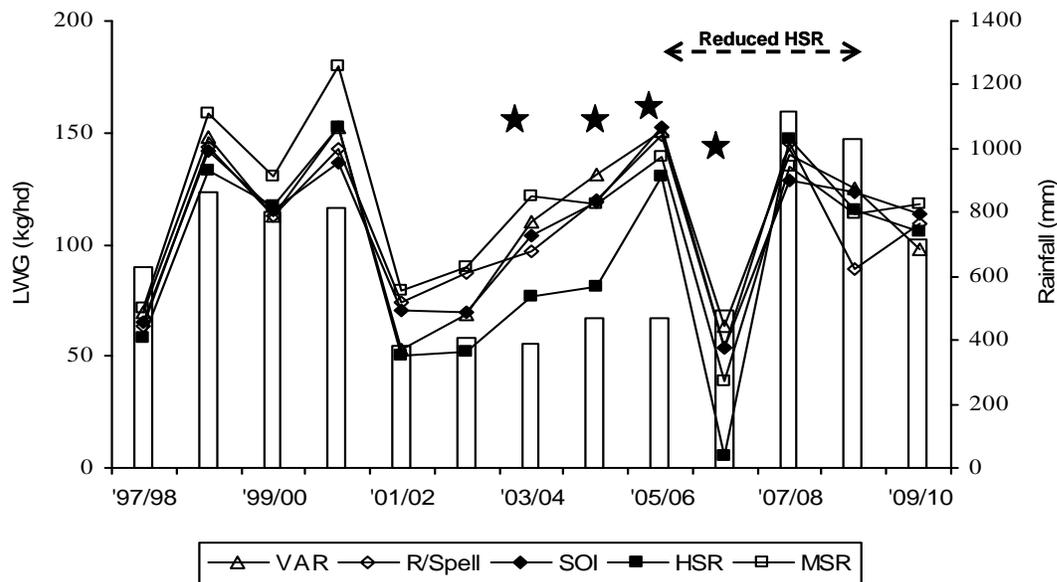


Figure 8. Annual rainfall and live weight gain (LWG) per animal for different grazing strategies at the Wambiana trial between 1997/98 and 2009/10. Stars=years when M8U fed to HSR. Treatment abbreviations as before.

Treatment effects

Total LWG per animal was highest in the MSR (118 kg) and least in the VAR (98 kg) with the other treatments between these levels (Fig. 8). In contrast with dry season LWG, there was no relationship between total LWG and stocking rate ($r^2=0.08$), possibly because of the uneven spatial distribution of the first thunderstorms across the trial. In November 2009, paddocks on the S side received 98 mm of rain compared to only 54 mm for those on the NW side of the trial area. This may also partially explain why despite a higher stocking rate in the HSR than in the VAR (4 vs. 5.77 ha/AE), LWG was higher in the HSR than in the latter treatment (106 vs. 98 kg). The relatively good LWG in the HSR may also be due to the combined effects of good rainfall on a shorter pasture with a greater proportion of 2-P (Fig. 4) and annual grasses, giving a significantly higher diet quality. However, this can only be confirmed when 2009/10 NIRS diet quality data is available.



Plate 2. Although pasture yields were far less in the heavy stocking rate (right) than in the R/Spell (left), weight gains were still good because the pasture was short and green.

Carcass value

At the end of the 2009/10 grazing year 112 number 7 steers were sent to the meatworks. The price received per kg (Fig. 9) was markedly lower in the HSR (\$2.75/kg) than in the remaining treatments (mean: \$2.81/kg). Treatment effects on total carcass price were more pronounced with price being highest in the SOI (\$899), followed by the R/Spell, MSR and VAR strategies (mean: \$849). Carcass price was by far the lowest in the HSR (\$749). The lower carcass price in the HSR reflects a combination of a lighter carcass weight, a slightly lower dressing percentage (50 % vs. 51-52 %) and fat thickness from 1 to 4 mm less than the other treatments.

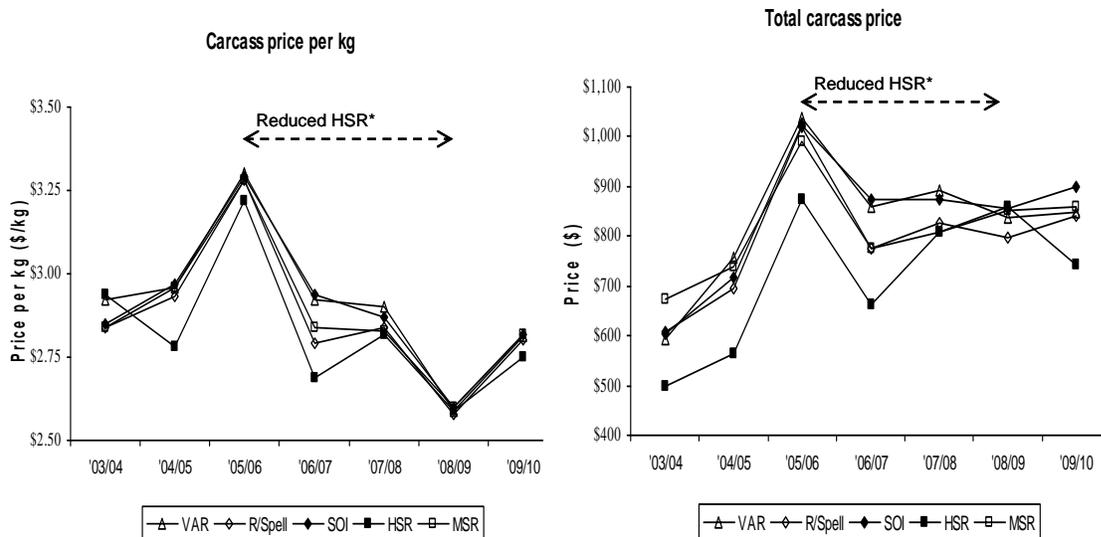


Figure 9. Rainfall and price per kg (left) and price per carcass (right) for meatworks steers from 2003/04 to 2009/10.

4.5.2 Production per unit area

Mean LWG per unit area (LWG/ha) in 2009/10 (16 kg/ha) was similar to that recorded in most previous years (Fig. 10). As before (O'Reagain *et al.* 2009), there were marked treatment differences with LWG/ha in the HSR (26 kg/ha) being double that in the MSR, SOI and R/Spell (mean: 14 kg/ha). This is logical given the significantly higher stocking rate in the HSR. The

magnitude of the difference between the HSR (26 kg/ha) and the VAR (16 kg/ha) is again unexpected i.e. given their relative stocking rates their LWG/ha might have been expected to be a bit closer, but obviously reflects the lower individual LWG in the VAR strategy.

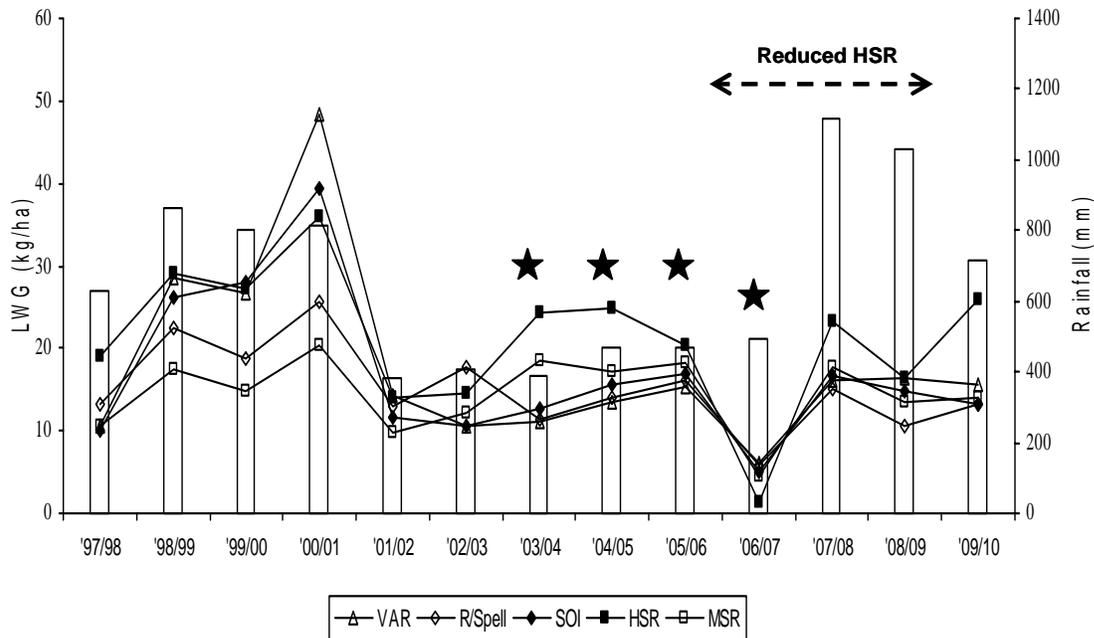


Figure 10. Annual rainfall and live weight gain (LWG/ha) per hectare for different grazing strategies at the Wambiana trial between 1997/98 and 2009/10. Stars=years when M8U fed to HSR- see text for details. NB: The 217 mm that fell in June 2007 has been added to the 2007/08 total. Treatment abbreviations as before.

4.6 Economic performance of different strategies

4.6.1 Gross margins

As in the previous two good years, gross margins (GMs) in the HSR in 2009/10 were again positive (\$875/100 ha). Nevertheless, GMs in the HSR were from \$164 to \$232/100 ha lower than the other strategies (Fig. 11). This undoubtedly resulted from the effects of the increased stocking rate in this treatment in increasing livestock interest costs and reducing meatworks prices. Going on previous performance, it is unlikely that these positive GMs in the HSR will be maintained with a transition to below average rainfall years.

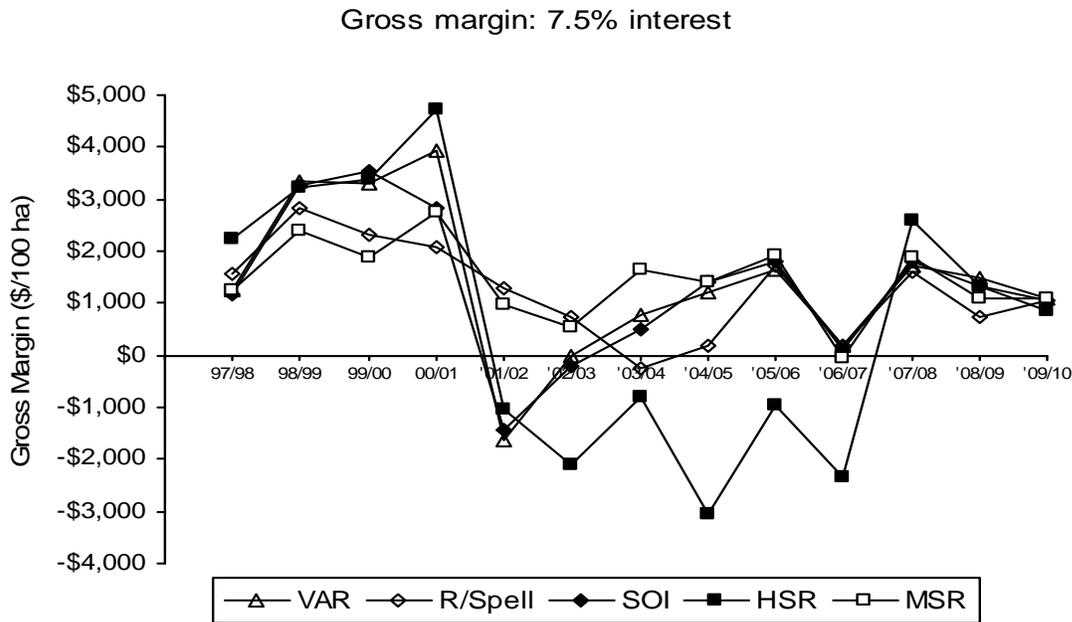


Figure 11. Gross margin (\$) per 100 ha for five grazing strategies at Wambiana from 1997/98 to 2009/10. Interest at 7.5 % and price differential based on condition score.

4.6.2 Accumulated gross margin

Despite the profitability of the HSR in the last 3 years, after 13 years the HSR is still \$9,500 to \$13,000/100 ha behind the remaining strategies in terms of accumulated gross margin (Fig. 12). Scaled upwards to an average property size of 20 000 ha, this equates to an economic advantage of about \$2.4 million over 13 years in favour of the other strategies relative to heavy stocking.

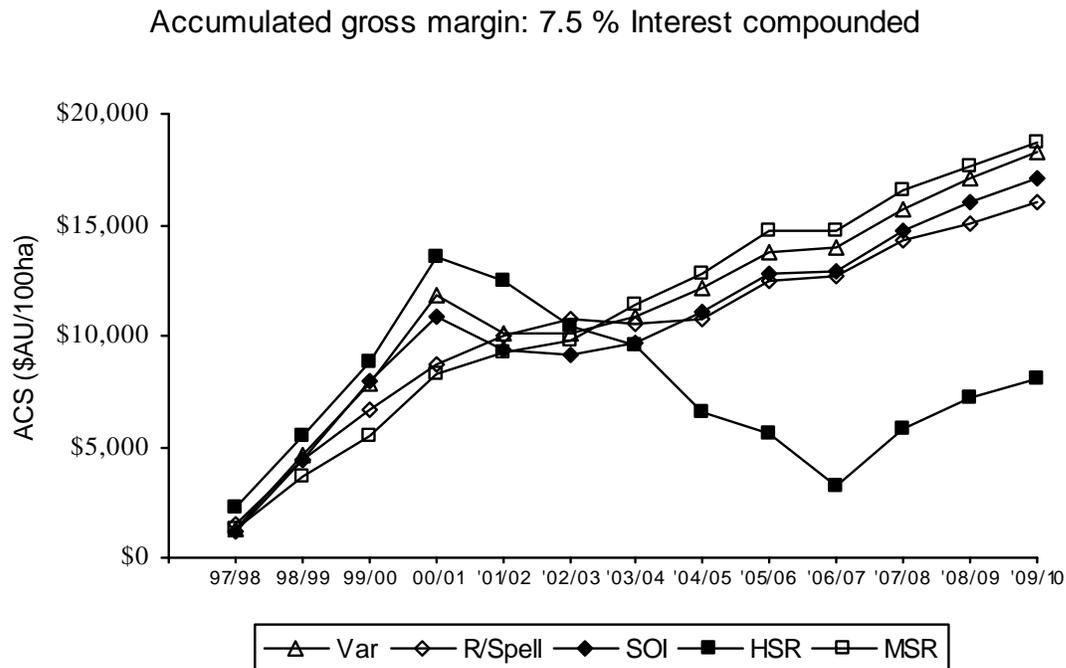


Figure 12. Accumulated gross margin (AGM) for five grazing strategies at the Wambiana grazing trial from 1997/98 to 2009/10.

5 Updated key findings

The past years results have not changed the studies key findings detailed in the 2009 report. These are as follows: N.B: Highlighted sentences indicate 2009 updates to the 2008 key findings.

5.1 Moderate stocking

Moderate stocking (MSR) at or near Long Term Carrying Capacity (LTCC) was a profitable and sustainable strategy for managing climate variability.

Moderate stocking maintained pasture in B condition despite severe drought, and resulted in the best pasture condition in terms of 3-P tussock density and species composition. Long-term carrying capacity was also maintained and runoff and sediment loss minimised.

Moderate stocking on B condition pastures gave far better individual animal performance than heavy stocking in all years of the trial. Although LWG/ha was generally lower than under heavy stocking, long term profitability was far greater due to lower costs and the price premiums received at the meatworks for better condition animals.

5.2 Heavy stocking

Heavy stocking (HSR) at twice the LTCC was generally not profitable (except in wet years), caused pasture degradation from B to C condition pastures and was not sustainable. Applying a HSR also reduced options (marketing, pasture management) and required far greater management inputs (drought feeding, reduced SR) than MSR. Heavy stocking also resulted in an increase in the frequency and intensity of runoff events through reduced ground cover and reduced soil health.

Heavy stocking on B condition pastures in conjunction with low rainfall led to a decline in land condition to C- as shown by reduced 3-P tussock density, lower cover and inferior pasture species composition. Recovery to B condition did not occur in subsequent seasons despite markedly greater rainfall and a c. 30% reduction in stocking rates.

Heavy stocking on B condition pastures gave lower individual LWG/hd but gave superior LWG/ha compared to moderate stocking in both good and poor rainfall years. However, drought feeding was essential to avoid mortality in dry years.

Moderate-heavy stocking (HSR*) on C condition pastures gave very good LWG/hd and LWG/ha in high rainfall years due to the abundance of short, higher quality annual grasses, forbs and legumes. However, in dry years, animal production was extremely low or even collapsed due to the low yields of the annuals and less resilient species common on C condition pastures.

Moderate-heavy stocking on C- condition pastures appears to result in a cycle of 'boom and bust' in productivity and profitability, with 'busts' probably being more common due to the greater preponderance of dry years.

5.3 Variable stocking

Varying stock numbers to track annual variation in pasture TSDM (with or without use of the SOI) was far more profitable than heavy stocking because the costs of overstocking in dry years were largely avoided. Variable stocking was no more profitable than moderate stocking because its higher

profitability in wet years was negated by the economic losses incurred through forced sales and reduced animal production in the change from good to poor rainfall years.

After 13 years, pasture condition under variable stocking (B-) was superior to that under heavy stocking (C-) but was lower relative to the moderate stocking (B+) and rotational wet season spelling strategies. Very heavy stocking rates in the Variable strategy preceding or going into the drought led to long-term pasture damage; recovery in subsequent years has occurred but has been relatively slow despite lower stocking rates and good rainfall.

Alternative ways of implementing variable stocking may avoid these issues but were not tested.

5.4 Wet season spelling

Moderate to light stocking in conjunction with rotational wet season spelling was sustainable, profitable and resulted in good pasture condition (B+). *However, moderate stocking and wet season spelling coupled with frequent fire was not sustainable because of poor post-fire recover in dry years.* Wet season spelling, as applied here, did not appear to buffer the effects of increased utilisation rates on pasture condition.

Wet season spelling increased pasture TSDM and ground cover in spelled sections, especially in wet years like 2008/09. In the longer term, wet season spelling also improved species composition in terms of the frequency and density of 3-P grasses and had a lower intensity and frequency of runoff events relative to heavy stocking. The effects of wet season spelling on pasture condition were negligible in dry years with the greatest improvements in condition apparently occurring in wet years.

5.5 Dietary quality

Diet quality is a major determinant of animal production in low fertility environments with small differences in quality resulting in major differences in LWG. Diet quality is primarily determined by rainfall but management is also important through its effects on stocking rate, land condition and sward structure.

On B condition pastures, dietary quality is nearly always greater under moderate stocking due to a higher % of non-grass (probably legumes and forbs) in the diet.

On C condition pastures and in good years, dietary quality is generally higher under heavy stocking, particularly early in the season, due to the short green grass and relative abundance of higher quality annuals and forbs. In dry years however, diet quality would be expected to be far poorer due to extremely low pasture availability.

5.6 Pasture change

Rainfall was the major driver of pasture composition and condition but this effect was strongly mediated by pasture utilisation rate and in particular, its timing in relation to climate. Constant high utilisation rates combined with low rainfall led to a decline from B to C condition. High pasture utilisation rates prior to and leading into drought also had an adverse effect on pasture condition. Low utilisation rates largely maintained pastures in B condition despite an extended run of very poor seasons.

The effects of management and drought on pasture condition were persistent and recovery of degraded pastures was slow or almost non-existent despite reduced stocking rates and good seasons.

5.7 Runoff and water quality

Heavy pasture utilisation rates reduce rainfall infiltration and hence increase the intensity and frequency of runoff events especially from early storms. This increased runoff is likely to impact directly upon animal performance because of its occurrence in the late dry season when forage is usually scarce and of poor quality. Heavy utilisation rates also increase sediment and nutrient losses from grazing lands with obvious impacts upon water quality and pasture productivity. These changes arise from the effects of utilisation rate on pasture condition, cover, pasture TSDM and importantly, soil health and surface condition.

5.8 Fire effects

Fire had little effect on woody plant density with mortality rates ranging from 3 % to 18 %, but in the longer term, the accumulated effects of regular fires (at the prescribed frequency) would be important in controlling tree densities. Fire caused a significant shift in woodland structure from large to smaller size classes. These effects were relatively short term however, with rapid regrowth over the 10 years post-fire.

The effects of fire on pasture composition were variable and strongly dependent upon the interacting effects of rainfall, soil type and probably, fire frequency. While pasture recovery in the good seasons following the 1999 fire was rapid on all land types, a second fire in 2001 combined with poor follow-up rains resulted in severe damage to pasture condition on Ironbark soils.

5.9 Carissa

Fire caused extensive top-kill of *Carissa* but no actual plant mortality was observed. Although fire caused a significant reduction in *Carissa* canopy cover, good seasons ensured rapid recovery in subsequent years. A long-term burning program appears to be essential for controlling this species.

Carissa cover increased by c. 10 % in all grazing treatments over a 10-year monitoring period, indicating that grazing strategy had no impact upon the rate of expansion of an established population. Further work is required to determine how grazing management effects initial *Carissa* establishment and the subsequent expansion of *Carissa* patches.

5.10 Sustainable management

Insights and trends observed through the trial indicate that sustainable and profitable grazing management will involve all of the following elements:

1. Use of LTCC (based on 25 % utilisation of average pasture growth) as guidelines for setting sustainable stocking rates for different landtypes.
2. Flexible stocking rates with numbers adjusted in a risk-averse manner in line with forage availability, expected seasonal conditions and possibly, climate forecasts.
3. Rotational wet season spelling of priority areas, preferably for a full wet season.
4. The appropriate use of fire that takes into account time since last burning, the resilience of the landtype and climate forecasts for the approaching wet season.

6 Success in Achieving Objectives

Maintained the integrity of treatments at the trial site, and collected critical data sets, during 2007-08, 2008-09 and 2009-10.

The integrity of the Wambiana trial site has been maintained and all critical data sets collected and processed. This data includes animal weight gains, carcass values, pasture TSDM, ground cover and species frequency. NIRS analysis of faecal samples is still being conducted.

Provided a concise final report, including data from 07-08, 08-09 and 09-10, with updating of key data sets and discussion of changes, or otherwise, in performance of the grazing strategies.

This report includes the 2009-10 data and updates the September 2009 report.

Produced a series of Tips and Tools that capture the key grazing management messages for industry benefit.

A draft '*Tips and tools*' document has been completed and submitted to MLA for assessment.

In cooperation with GLM workshop delivery staff and other extension officers, developed and implemented a strategy to effectively communicate project outputs and to ensure their full integration with the GLM workshop, the StockTake workshop and other relevant extension activities.

A communication strategy was developed and submitted to MLA. Progress against this report was subsequently reported on with most objectives being achieved. Integration of trial findings with *Stocktake* has proceeded slowly due to staff shortages in both projects.

Contributed to the bio-economic analysis of pasture-based production systems of northern Australia, leading to recommendations for on-going experimentation at Wambiana.

Extensive input and feedback has been made to the NGS project. A technical meeting held at Wambiana in November 2009 has made recommendations for treatment changes to the trial. These changes will be implemented in late 2010 before the start of the wet season.

7 Impact on Meat and Livestock Industry – now & in five years time

Live weight gain and carcass values can be significantly improved by applying moderate stocking rates along with appropriate supplementation and HGPs. Application of sustainable stocking strategies reduces production inputs in terms of drought feeding, supplementation and the interest costs on livestock capital. With faster growth rates, animals also reach target weights sooner for marketing or breeding, potentially increasing animal turnover.

Sustainable grazing strategies improve or at least maintain land condition, improve rainfall use efficiency and reduce the frequency and intensity of runoff events. Data from the trial also indicates shows an eventual drop in carrying capacity under heavy stocking. Although some apparent recovery may occur in very good seasons, this is probably temporary with both carrying capacity and animal production likely to plummet with a return to below average rainfall conditions.

The present study has also clearly shown the economic benefits of moderate and/or variable stocking. Adoption of such strategies would not only increase profitability but also reduce drought risk by eliminating management induced droughts, avoiding the costs of drought feeding, minimising

the decline in animal production and increasing the resilience of both the business and the environment to natural climate variability.

8 Conclusions and Recommendations

The Wambiana trial has delivered important evidence-based principles, guidelines and tools for sustainable and profitable management in northern Australia. The trial will be continued, but with some of the treatments modified from October 2010 onwards to include current key management recommendations.

The treatments applied will be as follows:

- Heavy stocking (*no change*)
- Moderate stocking (*no change*)
- Moderate stocking with rotational wet season spelling in a 6-paddock system– (*previously rotational spelling (R/Spell) in a 3 paddock system*)
- Flexible, moderate stocking - (*previously variable (VAR) stocking*)
- Flexible, moderate stocking with rotational wet season spelling in a 6-paddock system – (*previously SOI-variable stocking*).

Notes:

1. *Spelling* – 6 paddock wet season spelling, with the proportion spelled (1,2 or 3 paddocks) varying with the type of year and pasture condition.
2. *Flexible stocking* will incorporate 3 decision points (May, Nov/Dec & March) for stocking rate changes within the bounds set around long-term carrying capacity.

9 References

O'Reagain P.J., Bushell J.J., Holloway C.H. 2008. *'Final report: B.NBP.0379. Testing and developing grazing principles and management guidelines for the seasonably variable tropical savannas.'* Meat and Livestock Australia, Sydney, 266 pp.

O'Reagain P, Bushell J, Holloway, C & 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.J. & Bushell J.J., 2009. *'Final report: B.NBP.0379. Wambiana grazing trial extension: Testing and developing grazing principles and management guidelines for the seasonably variable tropical savannas.'* Meat and Livestock Australia, Sydney, 29 pp.

10 Appendices

10.1 Appendix 1 - Scientific and popular publications

Scientific (Submitted)

O'Reagain PJ, Bushell JJ & Holmes W. 2010. Managing for rainfall variability: Long-term profitability of different grazing strategies in a north Australian tropical savanna.

Popular publications

- *Stocking rate balancing act*. MLA Frontier Magazine, Autumn 2009.
- *Perennial grasses; the key to profitable cattle production*. Northern Muster, Spring 2009.
- *Grazing land management: dry times are when perennials keep business going*. Townsville Bulletin, 14 Dec 2009.
- *Good rainfall or not – it doesn't pay to overstock*. Northern Muster, Autumn 2010.
- *Good rainfall or not – it doesn't pay to overstock*. Handout: AgForce Grazing industry field days in the Burdekin catchment re: Reef Regulations and ERMPs (5 meeting locations).

10.2 Appendix 2 - Presentations and site visits

Site visits (number of people in brackets)

- Assoc. Prof. Peter Scogings, University Kwazulu-Natal, South Africa, 26 August 2009, (1).
- Dr. Marcello Benvenuti (UQ/CSIRO) & Peter Isherwood (UQ), September 2009, (2).
- MLA technical group meeting for Wambiana trial:, 27 October 2009, (8).
- Dr. Jerome Bindelle (CSIRO/UQ) & Peter Isherwood (UQ), March 2010, (2).
- Paddock to Reef modelling/monitoring project: Mark Silburn DERM, Rachel Bryan FBA, Tessa Chamberlain, DERM, Diana O'Donnell NQDT, 13 Mar 2010, (3).
- Wambiana schools EXPO, 10 May 2010, (approx. 30 students).
- International Beef Agri-Benchmarking Conference, 20 June 2010, (20).
- JCU 5th year vet students, 29 July 2010, (11).

10.3 Appendix 3 – Newsletter article

Good rainfall or not it doesn't pay to overstock (*Northern Muster March 2010*)

In December 1997 we started a long term grazing trial on the Lyons family property 'Wambiana' near Charters Towers, comparing the profitability and sustainability of different stocking strategies. In this article we present some results from the heavy stocking rate (HSR) treatment (4 ha/animal equivalent (AE)) and the moderate stocking rate (MSR: 8 ha/AE). Results from the rotational wet season spell and the two variable stocking strategies will be presented in a later article.

The first 10 years of trial results showed that heavy stocking led to pasture degradation and was unprofitable in the longer term. The stocking rate in the HSR also had to be reduced by about 30 % in 2005 due to reduced carrying capacity. Moderate stocking in contrast, was sustainable, maintained pasture condition and ensured long-term profitability.

These results were however from 1998 to 2007 which included six consecutive below-average rainfall years. With the good rainfall in recent seasons do these conclusions still apply?

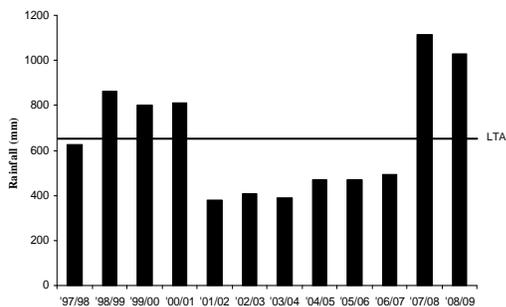


Fig. 1. Annual rainfall between 1997/98 and 2008/09 at the Wambiana grazing trial and long term average rainfall (LTA).

The very good rains in 2007/08 and 2008/09 allowed pasture cover and productivity to rebound significantly in the HSR. Animal performance was also very good and individual animal production in the HSR was higher than the MSR for the first time in 12 years. This occurred because of the extended wet season and short, high quality

pasture in the HSR. Gross margins also recovered strongly in these wet years and in 2007/08 the gross margin in the HSR was the highest of all treatments. This is a dramatic change given that the HSR had run at a net loss for the previous six years.

This recovery is impressive, but does not alter the conclusions reached previously. First, after 12 years the HSR is still \$9000 to \$10 000 per 100 ha in accumulated cash surplus behind the MSR. Assuming a property size of 20 000 ha, this equates to an advantage of more than \$1 million in favour of the MSR relative to heavy stocking.

Second, the density of 3-P (palatable, perennial and productive) grasses in the MSR is still 3 to 4 times greater than in the HSR. This suggests that the increased production and profitability in the HSR reflects the recent good seasons and the flush of short, annual pastures and will not continue in the longer term.

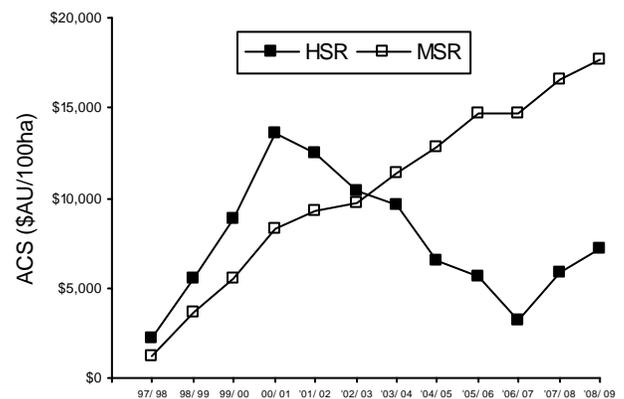


Fig. 2. Accumulated cash surplus (ACS) at the Wambiana trial from 1997/98 to 2008/09. HSR=heavy stocking rate, MSR= moderate stocking rate.

After 12 years and some very good seasons, it may thus still be concluded that:

- (1) Moderate stocking is sustainable, profitable and maintains pasture condition.

(2) Heavy stocking is generally not profitable, is unsustainable and leads to pasture degradation.

Results from the other treatments at the trial will be presented in more detail at a later date, but briefly, both the variable and rotational spell strategies performed substantially better than the HSR.

The Wambiana trial will be continued with ongoing MLA funding. In this new phase, the heavy and moderate stocking treatments will remain unchanged but some modification to the

variable stocking and spelling treatments will occur. We look forward to sharing these results with the grazing industry both in future editions of the Northern Muster and in field days at the site.

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