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Managing for rainfall variability: long-term profitability of different grazing strategies in a northern Australian tropical savanna

Peter O'Reagain[A,C], *John Bushell*[A] *and Bill Holmes*[B]

[A]Department of Employment, Economic Development and Innovation, PO Box 976, Charters Towers, Qld 4820, Australia.

[B]Department of Employment, Economic Development and Innovation, PO Box 1085, Townsville, Qld 4810, Australia.

[C]Corresponding author. Email: peter.o'reagain@deedi.qld.gov.au

Abstract. Several grazing strategies are recommended to manage sustainably for rainfall variability in northern Australia, but there is little objective data on their profitability relative to less sustainable management systems such as heavy stocking. In 1997, a large cattle grazing trial was initiated in northern Queensland to quantify the relative performance of a range of grazing strategies in a variable climate. These strategies were (i) moderate stocking (MSR) stocked at the calculated long-term carrying capacity (LTCC), (ii) heavy stocking (HSR) at twice LTCC, (iii) rotational wet-season spelling (R/Spell) at 1.5 LTCC, (iv) variable stocking (VAR), with stocking rates adjusted in May based on available forage and (v) a southern oscillation index (SOI)-variable strategy, with stocking rates adjusted in November based on available forage and SOI-based seasonal forecasts.

Rainfall varied over the 12-year trial period, with sequences of dry and wet years. Gross margins (GM) in the HSR were initially high but collapsed in drier years due to high costs and reduced product value. GMs only recovered in later years with a reduced stocking rate and increased rainfall. The VAR and SOI were also initially very profitable, but GMs plunged as rainfall declined due to reduced animal performance and the sale of poor-condition cattle. This sharp cut in stocking rates nevertheless allowed GMs to recover well in subsequent years. In the MSR, GMs remained relatively constant across most years due to low costs and a higher product value. The R/Spell also performed relatively well despite being compromised by an ill-timed fire, drought and the subsequent sale of poor-condition cattle.

Net present value (NPV) after 12 years was highest in the VAR ($11 962/100 ha), followed by the MSR ($11 873/100 ha), the SOI ($11 167/100 ha) and the R/Spell ($10 665/100 ha). NPV was by far the lowest in the HSR ($6930/100 ha). Profitability also varied the most in the HSR, with a negative GM in 6 of the 12 years. Incorporating the costs of natural resource decline would further reinforce the case against heavy stocking. These results challenge the assumption that sustainable management in a variable environment is unprofitable.

Additional keywords: economic performance, pasture spelling, southern oscillation index, stocking rate, sustainability, variable stocking.

Introduction

Rainfall variability is a major management challenge to sustainability and profitability in many semiarid grazing systems. The extensive pastoral areas of northern Australia are no exception (Scanlan *et al*. 1994), with rainfall varying at annual, decadal and generational time scales (McKeon *et al*. 1998). In these environments, annual forage production can vary five to six fold or more, causing major fluctuations in short-term carrying capacity. Under these variable conditions, stocking rates based on 'average' rainfall could easily cause overgrazing, economic loss and resource degradation in a drought year. Historically, periodic droughts combined with unsustainable grazing management, particularly overstocking, have resulted in major episodes of economic loss and land degradation in Australia (McKeon *et al*. 2004). Climate change is likely to amplify the challenges of managing in a variable environment due to expected increases in drought intensity and frequency (McKeon *et al*. 2009).

Three main grazing strategies are commonly recommended to manage sustainably and profitably in these variable environments (Ash *et al*. 2000). First, 'conservative' or 'moderate stocking' aims to utilise some 'safe' amount of forage, usually 20–25% of long-term average annual pasture growth (Johnston *et al*. 2000), to avoid overgrazing in most years and maintain land condition. Second, 'variable stocking' involves varying stocking rates with available forage to take advantage of wetter years but avoid overgrazing in dry years (Perry 1977; Wilson *et al*.

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1984; Pressland *et al*. 1988). In northern Australia, the obvious time to adjust stock numbers is at the end of the wet season in May or June (Ebersohn 1973). Seasonal climate forecasts such as the southern oscillation index might also be used proactively to guide stocking rate adjustments (McKeon *et al*. 1990; O'Reagain *et al*. 2003). Third, 'pasture spelling' or 'resting' may be used to buffer fodder shortages in poor years (Danckwerts *et al*. 1993; Muller *et al*. 2007) and may also ameliorate the effects of increased utilisation rates on pasture condition (Ash *et al*. 2001).

Despite major extension efforts by government agencies and community groups such as Landcare, there appears to have been only moderate adoption of these strategies. Assessments of land condition show significant areas of degradation (De Corte *et al*. 1991; Tothill and Gillies 1992; Karfs *et al*. 2009), indicating that unsustainable practices, such as overstocking and/or delaying destocking decisions until droughts are well advanced, continue. Aside from directly reducing the productivity of these grazing lands, these practices also increase soil erosion and runoff with obvious implications for water quality and downstream systems such as the Great Barrier Reef Lagoon (e.g. Furnas 2003).

Managers who overstock and/or only respond to droughts in a delayed, reactive fashion can also suffer significant financial losses through the costs of drought feeding, forced sale of poor-condition cattle and animal mortality. These losses can seriously affect long-term business performance, and ultimately jeopardise the survival of the enterprise (Hinton 1993; O'Meagher 2003).

The reasons for the non-adoption of more sustainable management practices such as lighter stocking are complex and the subject of ongoing investigations (e.g. Pannell *et al*. 2006). One major adoption constraint is the belief that 'sustainable' management is not profitable and that heavier stocking rates maximise economic returns (Stockwell *et al*. 1991; Lawrence *et al*. 1994), at least in the short to medium term.

Unfortunately, until fairly recently (Burrows *et al*. 2010), there has been little objective data available on the longer-term profitability and sustainability of recommended strategies relative to existing systems, such as constant heavy stocking. Previous grazing research in northern Australia largely focussed on introduced pastures (Eyles *et al*. 1985) or did not directly quantify the productivity or profitability of different grazing systems (e.g. McIvor and Gardner 1995; Ash *et al*. 2001). Importantly, most previous trials focussed on stocking rate *per se* (e.g. Gillard 1979; MacLeod and McIntyre 1997; Burrows *et al*. 2010) and not on managing for climate variability.

Case studies of managers successfully applying conservative stocking, variable stocking and/or rotational spelling (e.g. Mann 1993; Landsberg *et al*. 1998; Muller *et al*. 2007) are valuable but invariably confounded with the managers' circumstances and/or abilities (Briske *et al*. 2008). Linked biophysical and economic simulation models, such as GRASP and *Enterprise*, are also valuable (McKeon *et al*. 2000, 2004; Stafford-Smith *et al*. 2000); however, their effectiveness as a tool to facilitate adoption is limited. For land managers, it is the physical encounter, the power of 'seeing is believing' through research and demonstration (Nicholson *et al*. 2003), that is the key element in adoption.

In summary, as noted by Stockwell *et al*. (1991), 'there are few hard data to convince graziers that the conventional wisdom that more cattle means more money is not necessarily correct', and many managers persist with conventional, less sustainable forms of management.

To address this problem a large cattle-grazing trial was initiated in 1997 in northern Queensland, Australia. Its specific objective was to quantify the relative ability of different grazing strategies to cope with climate variability in terms of their effects on animal production, economic performance and resource condition. A critical criterion for the work was that it be conducted at a scale and in a manner of direct relevance to the grazing industry.

The current paper presents 12 years of results on the economic performance of the different grazing strategies from this ongoing trial. It follows a previous paper detailing animal production in the different strategies (O'Reagain *et al*. 2009). Preliminary papers (O'Reagain *et al*. 2005; O'Reagain and Bushell 2008) and two reports (O'Reagain *et al*. 2008; O'Reagain 2009) on the effects of the strategies on pasture condition and runoff have also been published.

Materials and methods

The trial is located on 'Wambiana' (20°34′S, 146°07′E), a commercial cattle property ~70 km SW of Charters Towers, northern Queensland, Australia. Long-term (100 year) mean annual rainfall for 'Trafalgar', 17 km NW of the study area is 643 mm (CV = 39%), with a historical range of 207–1409 mm. Most rain (70%) falls in a relatively well defined wet season between December and March (Clewett *et al*. 2003). Mean maximum temperatures for January and July are 33.5°C and 24.4°C respectively. The vegetation, termed the *Aristida–Bothriochloa* pasture community (Tothill and Gillies 1992), is an open *Eucalyptus* savanna with smaller areas of *Acacia harpophylla* F.Muell. ex Benth. woodland, overlying tropical C_4 grasses on relatively infertile kandosol, vertosol and sodosol soils (De Corte *et al*. 1991; Isbell 1996). Land and pasture condition of the site was moderate to very good (A or B condition; Chilcott *et al*. 2003) at the start of the trial in 1997 (O'Reagain 2009).

The experimental site is 1041 ha; there are 10 experimental paddocks of 93–117 ha in size, in a randomised block design, with two blocks of five treatments. To simulate paddocks on commercial properties, trial paddocks were laid out to contain a mixture of soil types (O'Reagain *et al*. 2009).

Grazing strategies

Five grazing strategies that are used by graziers in the district and/or are recommended to manage for climate variability (e.g. McKeon *et al.* 1993) were selected for testing. Importantly, all were practical management options for a region characterised by large paddocks and limited labour and infrastructure. Stocking rates were selected based on the limited available data (McIvor and Gardner 1995), local knowledge and the advice of the Wambiana trial Grazier Advisory Committee (O'Reagain *et al*. 2009). All stocking rates fell within the range used in the district.

Target stocking rates for each paddock in each grazing year (~1 June to 31 May the following year) were set based on the expected mean weight of steers over the next 12 months, i.e. starting weight + 0.5 × expected weight gain. Expected

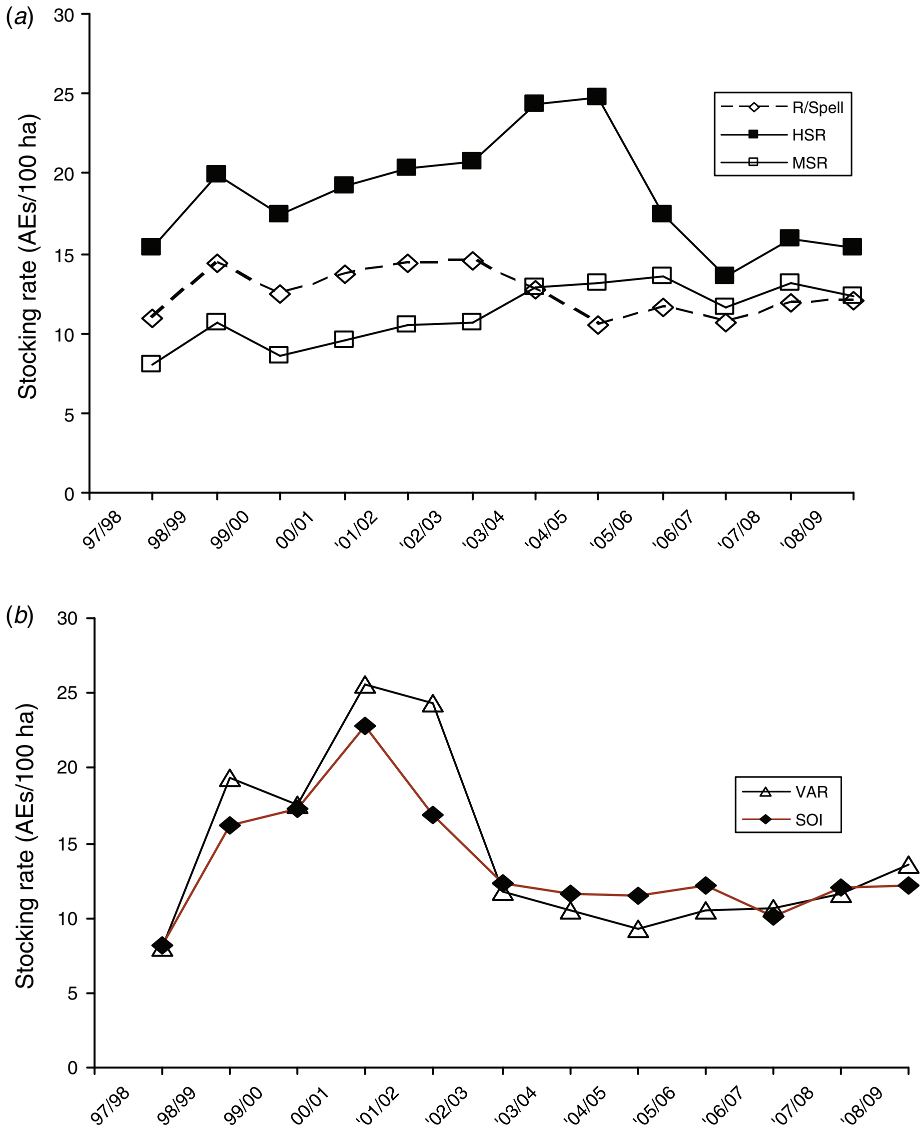

Fig. 1. Annual stocking rate expressed as animal equivalents (AEs) per 100 ha from 1997–98 to 2008–09 for (*a*) the heavy stocking rate (HSR), rotational spell (R/Spell) and moderate stocking rate (MSR) strategies and (*b*) the variable (VAR) and southern oscillation index-variable (SOI) strategies.

gain was assumed to be 100 kg in all years. In practice, the *actual* stocking rates achieved sometimes varied from the target rates because of differences between actual and expected weight gains and the practical difficulties of achieving exact stocking rates with large animals in relatively small paddocks.

The grazing strategies and their nominal stocking rates through the years of the trial are as follows [see O'Reagain *et al*. (2009) for more detail]:

(1) *Moderate stocking rate* (*MSR*) – moderate stocking (previously termed 'light' stocking by O'Reagain *et al.* 2009) at the estimated long-term carrying capacity (LTCC) of the site, i.e. 25% utilisation of the average long-term pasture production expected for the land types in question (e.g. McKeon *et al*. 2009). The MSR was initially stocked at ~10 ha per animal equivalent (AE, defined as a 450 kg steer) between 1997–1998 and 2000–2001, and at ~8 ha/AE thereafter (Fig. 1). This 20% increase in stocking rate in the MSR (as well as the HSR and R/Spell; see below) in May 2001 was implemented because the initial LTCC for the site appeared to have been underestimated and treatments appeared understocked.

(2) *Heavy stocking rate* (*HSR*) – heavy stocking at about twice the LTCC, i.e. ~50% utilisation of the average long-term pasture production. The HSR was stocked at ~5 ha/AE between 1997–98 and 2000–01, and at ~4 ha/AE thereafter, as paddocks were considered to be understocked. In May 2005, the stocking rate was cut to ~6 ha/AE and maintained at this level until May 2009 because of the ongoing scarcity of forage in this treatment.

(3) *Variable stocking rate* (*VAR*) – stocking rates adjusted annually at the end of the wet season (May) based on pasture total standing dry matter (TSDM), as described by O'Reagain *et al*. (2009). Briefly, available forage was calculated from paddock TSDM, discounted for wastage and a minimum residue to prevent soil erosion. Stocking rate was calculated from the estimated daily dry matter intake per animal of 2% of expected average bodyweight and the number of days to the expected start of the wet season, as indicated from historical rainfall data (Clewett *et al*. 2003).
(4) *Southern oscillation index* (*SOI*) – *variable strategy* – stocking rates adjusted annually in November as described above for the VAR, but based on available forage at the end of the dry season and SOI phase-based (Stone *et al*. 1996) climate forecasts for the next wet season (O'Reagain *et al*. 2009), on the Queensland Climate Change Centre of Excellence 'Long paddock' website (Anonymous 2008*b*). Initially, animal numbers were adjusted to a pre-set stocking rate based on broad classes of pasture TSDM and SOI values in November. However, from November 2002 onwards, stocking rates were set based on both the available forage for the rest of the dry season and the predicted wet season pasture growth expected in 75% of years with the prevailing SOI value (O'Reagain *et al*. 2009).
(5) *Rotational spelling* (*R/Spell*) – rotational wet season spelling applied in a three-paddock system, with a different paddock spelled annually. The R/Spell was stocked at ~8 ha/AE between 1997–98 and 2000–01, and at ~6 ha/AE up to November 2003 (O'Reagain *et al*. 2009). Thereafter, stocking rates were reduced to ~8–9 ha/AE to allow recovery from the effects of drought and an ill-timed fire in November 2001 (O'Reagain *et al*. 2009).

Fire management

The trial site was burnt on 11 October 1999 to remove moribund grass and control woody species, and then wet-season spelled until 12 January 2000 to allow pasture recovery. Animals grazed together during this period on a nearby area, before returning to their respective treatment paddocks. The weight gains through this period were included in the economic analysis described below, but no cost was allocated to this grazing agistment.

Experimental animals and animal husbandry

Paddocks were stocked with 11–35 Brahman-cross steers to achieve the appropriate stocking rate in each treatment. Up until the end of 2000–01, steers were all about 2 years of age and were replaced annually at the end of each grazing year in late May. From May 2001 onwards, paddocks contained two similar-sized groups of 2- and 3-year-old steers, with the older cohort being replaced annually by new, younger animals, i.e. animals remained on the trial for two full years. This change occurred to allow a longer period for treatment effects to emerge. Older, heavier animals could also be sent directly to the meatworks and carcass grades and values assessed (O'Reagain *et al*. 2009).

Animals were weighed and condition scored at the start and end of the grazing year (O'Reagain *et al*. 2009). Total annual liveweight gain (LWG) per paddock was calculated as the difference between the total fasted start- and end-weights of all animals in a paddock, standardised to 100 ha to facilitate strategy comparisons.

All husbandry actions were based on the advice of the Wambiana grazier advisory committee and were normal industry practice (Bortolussi *et al*. 2005*a*, 2005*b*). Cattle were initially unsupplemented but were given a commercial dry-season urea lick from May 2003, and wet season phosphorous from December 2004 onwards (Appendix 1). Starting in May 2005, steers were implanted annually with hormonal growth promotants (Compudose 400, Elanco Animal Health, Sydney, Australia). Animals were inoculated annually for botulism and against bovine ephemeral fever in 2007–08 and 2008–09.

Extra feeding had to be provided to animals with very poor body condition on three occasions. First, due to very low dry-season forage quality in November 2001, some poor-condition cattle (numbers in parentheses) in the SOI (20), VAR (6) and HSR (1) strategies had to be removed for ~8 weeks and fed a commercial weaner supplement to halt weight loss. Second, molasses and 8% urea (M8U) drought feeding had to be provided to the HSR in the late dry seasons of 2003–04, 2004–05, 2005–06 and 2006–07. On two or three occasions when animals were under extreme stress, a small amount of cottonseed meal was also provided with the M8U. Third, in November 2004, cattle had to be removed from one replicate of the HSR and fed with *Chloris gayana* hay and M8U for 10 weeks (O'Reagain *et al*. 2009) due to the complete absence of forage in these paddocks.

Marketing

From 1999 to May 2003, animals leaving the trial were sold locally or sent elsewhere. However, from May 2004 onwards, those leaving the trial, i.e. the older cohort, generally went directly to the meatworks, whereas lighter and/or poorer-condition animals were sold locally (O'Reagain *et al*. 2009). In May 2004, the % in each strategy that went to the meatworks was: MSR (94%), SOI and R/Spell (67%), VAR (47%) and HSR (5%). In May 2005, 75% of steers in the HSR went to the meatworks compared with 100% in the other four strategies. From 2006 onwards, all animals went to the meatworks.

Value of beef produced

Australian meatworks cattle are priced according to weight-for-age, fat depth and butt shape (Anonymous 2008*a*). The beef produced per treatment, i.e. total LWG per annum, was valued based on the April or May 2004–09, and January 2010 price grids from the Townsville, Mackay and Rockhampton meatworks, the main destinations for district slaughter cattle. Based on animal production data (O'Reagain *et al*. 2009) and meatworks feedback sheets for the trial, the following two 'typical' carcass types for trial animals were selected: (1) *good-condition steer* – carcass weight of >280 kg, fat depth 7–22 mm, 0–6 teeth, average grid price $2.76/kg and (2) *poorer-condition steer* – carcass weight of 240–280 kg, fat depth 3–22 mm, 0–6 teeth, average grid price $2.57/kg. Based on a lower dressing percentage for lighter, poorer-condition steers (50% *v*. 55%), these prices approximate to $1.50/kg and $1.30/kg liveweight for good and poorer-condition steers, respectively. Trial data also indicate a meatworks premium of about \$0.20/kg liveweight for heavier, better-condition animals (O'Reagain *et al*. 2009).

At the start of the grazing year (1 June), animals were valued at \$1.50/kg because of the premium that younger steers typically attract due to their growth potential. At the end of each grazing year (31 May), all animals in a treatment were valued at either \$1.50/kg ('good-condition steer') or \$1.30/kg ('poor-condition steer'), depending on condition score and weight gain, and after 2004, meatworks feedback sheets (Appendix 2). These values were used irrespective of whether animals had gone to the meatworks that year (older cohort) or whether they still had another year on the trial (younger cohort). Cattle removed in the late-dry season, as happened in the SOI strategy in November 2001 or the R/Spell in late 2003 (see below), were valued at \$1.30/kg due to their poor condition.

Variable and interest costs

Variable costs were the actual supplement, vaccination and implant costs per strategy, adjusted to January 2010 prices at Charters Towers. Supplement prices (GST and transport inclusive; labour costs excluded) were molasses and urea (\$0.26/kg), cottonseed meal (\$0.76/kg), weaner supplement (\$0.60/kg), dry season urea lick (\$0.81/kg) and wet season lick (\$1.21/kg). Hay feeding in droughts is impractical on large cattle properties, so for the purposes of the present analysis, the current agistment cost for the district of \$2.75/steer per week (M. Lyons, pers. comm., Wambiana Station, Charters Towers) was substituted for the costs of hay fed in the HSR in late 2004.

Interest costs on livestock capital were based on the total value of livestock in a paddock at the start of the season, i.e. $Mass_{\text{In}} \times$ \$1.50/kg, using a real interest rate of 7.5%. Real interest rates are used to calculate the opportunity cost of capital invested in livestock and to calculate the net present value, while prices and costs are in constant 2010 values. Real interest rate is the nominal rate less inflation.

Economic analysis

All costs and benefits were expressed in 2010 values. Treatments were compared using gross margins (GM) and net present value (NPV), which is the sum of discounted future benefits and costs.

Gross margin and net present value analysis

GMs per paddock were calculated as:

$$GM = Mass_{\text{Out}} \times \text{value} - \text{variable costs} - \text{interest costs} - Mass_{\text{In}} \times \text{value},$$

where $Mass_{\text{In}}$ and $Mass_{\text{Out}}$ are the total mass of all animals in a paddock at the start and end of a grazing year, respectively, value is price of beef in \$/kg, variable costs are all supplement and inoculation costs and interest costs reflect interest on livestock capital calculated at 7.5%.

Accumulated GM (AGM) was calculated as the sum of paddock GMs for successive years, compounded annually at a rate of 7.5%.

Net present value (NPV) for each strategy after 12 years was computed as:

$$\text{NPV} = \sum_{t=0}^{t} \frac{(Bt - Ct)}{(1+r)^t},$$

where B denotes the dollar benefits received in any year, C refers to the costs incurred in any year, r is the discount rate and where t refers to the year (Sinden and Thampapillai 1995).

Annualised NPV (ANPV) was calculated as follows:

$$\text{ANPV} = \text{NPV} \times [r \times (1+r)^t]/[(1+r)^t - 1]$$

where r is the discount rate and t is the period in years (Chisholm and Dillon 1966).

NPV was calculated from annual GMs by using a 7.5% interest rate. A sensitivity analysis was also conducted at rates either side of this, using, in each instance, the same interest on livestock capital and in the NPV calculation. In the present NPV analysis, AGMs serve as a proxy for cash flow. In using the GM rather than the purchase and sale transactions, this NPV calculation misses the capital tied up in stock purchase. To account for this, NPV is calculated on GM (less interest paid on livestock capital). The alternative, but more complex, method would be to calculate NPV on monthly cash flows but for simplicity, we pick up the cost of livestock capital flows by working on annual GMs, as defined previously.

Marginal analysis of increasing stocking rates

Marginal analysis was used to determine if it was profitable to increase stocking rates from 'moderate' to 'high' by setting the extra GM against the extra stock (and thus extra capital) in the high stocking rate. Marginal analysis of the extra financial return from HSR relative to MSR was conducted across all years as follows: the increase in GM after interest for the HSR versus the MSR was calculated as the value of beef produced less variable costs from HSR, less the same calculation from MSR. The extra GM was then divided by the additional adult equivalents in the HSR relative to the MSR to give the marginal return per AE from the increased stocking rate.

Sensitivity analysis

A sensitivity analysis of the effects of different interest rates on livestock capital- and condition-based price premiums for marketed cattle was conducted on the marginal returns of running extra AEs in the HSR relative to the MSR. The default interest rate was 7.5%, and rates of 0 and 15% were also considered for comparison (Fig. 2). Simulations were run for a range of scenarios involving all combinations of interest rate (0%, 7.5% and 15%) and price premium (0–\$0.30/kg). Results for different scenarios are presented as the margin per AE averaged across all years, as well as separately for wet (1997–98 to 2001–02, 2007–08 and 2008–09) and dry years (2002–03 to 2006–07).

Statistical analysis

Statistical analyses were undertaken using the GENSTAT 9 statistical package (VSN International Ltd, Hemel Hempstead, UK). The effect of grazing strategy on GM, variable costs and livestock interest costs was analysed separately for each year using an analysis of variance. The experimental unit was the 'paddock', i.e. there were two replications for each strategy. Normality assumptions were assessed using standardised normal plots of residuals. Pair-wise comparisons between strategies were made using protected least-squares significant differences.

Results

Rainfall

Rainfall was generally above average and well distributed over the first 4 years of the trial (Fig. 3). Thereafter, rainfall declined, with the years between 2001–02 and 2006–07 amongst the lowest 20–30% of rainfall years on record (Clewett *et al*. 2003). With the exception of 2005–06, rainfall in these years was also poorly distributed. Rainfall in 2007–08 (1116 mm) and 2008–09 (1030 mm) was exceptional, with these years being the 4th and 5th wettest respectively on record (Clewett *et al*. 2003).

Stocking rates

The initial high stocking rates (4–5 ha/AE) in the HSR could only be maintained until May 2005 (Fig. 1) when they had to be cut by 30% due to ongoing forage deficits, the repeated need for dry season drought feeding and an obvious decline in carrying capacity. In contrast, MSR stocking rates remained relatively constant, with adequate forage available in all years. In the R/Spell, the initial moderate stocking rate (6 ha/AE) had to be reduced in April 2003 due to the after-effects of an ill-timed fire in October 2001 and poor follow-up rains (O'Reagain *et al*. 2009).

VAR stocking rates started at moderate levels in 1997–98, but thereafter were increased rapidly to very high levels (~4 ha/AE) to take advantage of the high pasture TSDM (3000–5000 kg/ha). Stocking rates in the VAR were halved in May 2002 in response

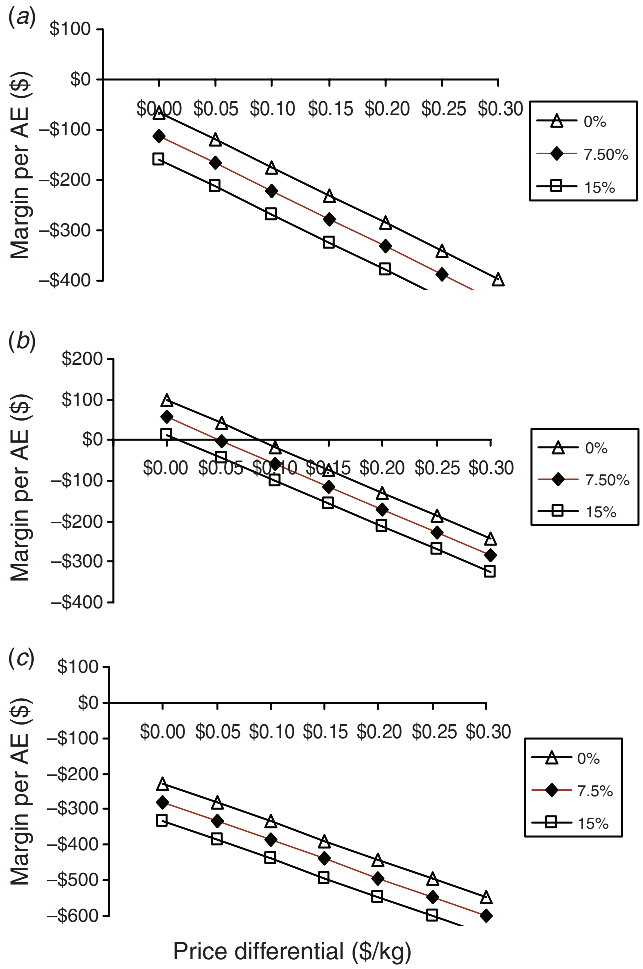

Fig. 2. Marginal return per extra animal equivalent (AE) per 100 ha for heavy *v.* moderate stocking over different interest rate and product price scenarios for (*a*) all, (*b*) wet and (*c*) dry years.

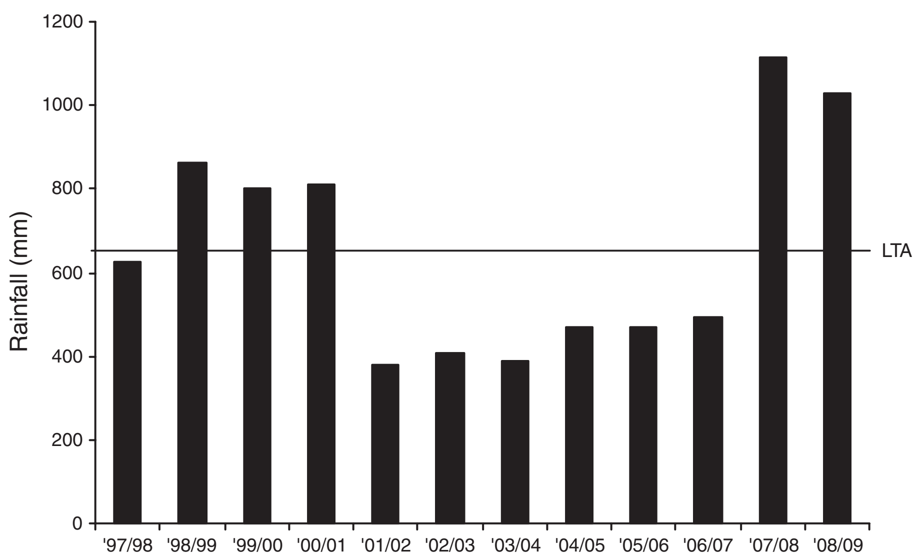

Fig. 3. Annual rainfall (July–June) from 1997–98 to 2008–09 at the Wambiana grazing trail and long-term average rainfall (LTA) for the area.

to the sharp drop in TSDM, and then progressively reduced below those in the MSR (O'Reagain *et al.* 2009). SOI stocking rates were also initially increased to high levels in early years, due to the high pasture TSDM and positive SOI outlooks (Anonymous 2008*b*). Stocking rates were then cut in October 2001 due to declining TSDM and the negative/neutral SOI, i.e. use of the SOI resulted in stocking rates being cut 6 months earlier than in the VAR. Stocking rates in both the VAR and SOI gradually increased again after 2006–07 as rainfall and pasture yields improved (Fig. 1).

Gross margins of different grazing strategies

Annual GMs varied widely from between \$2000/100 ha and \$4700/100 ha in the best rainfall years (2000–01) to losses in some strategies of more than –\$1000/100 ha in the driest years (Fig. 4). Margins in 2006–07 were also very low due to the short wet season, but rebounded in 2007–08 and 2008–09 with the good, well distributed rainfall.

The grazing strategy applied significantly ($P < 0.05$) affected GM in 8 of the 12 years (Table 1). In the earlier, wetter years (1997–2001), heavily stocked strategies such as the HSR, VAR and SOI had substantially higher GMs than did the R/Spell or MSR. This was particularly marked ($P < 0.05$) in 1999–00 and 2000–01, with e.g. the HSR earning from \$1400/100 ha to \$1900/100 ha more per annum than the MSR. However, with the onset of the dry years in 2001–02, GMs in these heavier-stocked strategies plummeted to a net loss of about –\$1000/100 ha. In contrast, the decline was relatively minor in the R/Spell and MSR (Fig. 4), with positive GMs maintained. Thereafter, the MSR consistently delivered GMs as good as or far better (2003/04) than the other strategies.

GMs in the SOI and VAR strategies recovered strongly in 2002–03 in response to reduced stocking rates, and improved thereafter to approach those in the MSR. Conversely, maintenance of high stocking rates in the HSR gave a consistently negative GM between 2001–02 and 2006–07. This effect persisted despite the reduction in HSR stocking rates in 2005. Nevertheless, with good rainfall, the GM in the HSR (stocked at the reduced rate) rebounded sharply and was the highest of all strategies in 2007–2008 and the second highest in 2008–09 (Fig. 4). In the R/Spell, GMs in the dry years were initially relatively high, but complications arising from the 2001 fire precipitated a temporary drop in GM due to the forced sale of relatively poor-condition animals in November 2003.

In summary, at an assumed interest rate of 7.5%, the HSR had a negative GM in 6 of 12 years, with the other strategies negative in only 1 (MSR & R/Spell) or 2 (VAR & SOI) of 12 years (Table 1). The magnitude of this loss varied widely among the latter group, however, with the losses in the VAR (–\$1648/100 ha) and SOI (–\$1448/100 ha) in 2001–02 being far higher than those in the R/Spell (–\$255/100 ha) in 2002–03 or those in the MSR (–\$58/100 ha) in 2006–07.

Accumulated gross margin

In the earlier wetter years, AGM increased rapidly in the heavier-stocked strategies, with the HSR, for example, having an AGM nearly \$4500/100 ha greater than the MSR by 2000–01 (Fig. 5). Thereafter however, AGM steadily declined in the HSR as the strategy ran at a consistent loss through the dry years. In contrast, in the VAR and SOI, after an initial loss in the first dry year, the reduced stocking rate allowed AGM to recover and continue to grow thereafter in both strategies (Fig. 5). In the MSR and R/Spell, AGM grew steadily and by 2003–04 both strategies equalled, and then exceeded, the HSR. After 12 years, AGM was highest in the MSR (\$28 279/100 ha) and VAR (\$28 490/100 ha) and lowest in the HSR (\$16 505/100 ha). AGMs in the SOI (\$26 596/100ha) and R/Spell (\$25 402/100ha) were somewhat (~\$2500) lower than those in the MSR and VAR, but still far ahead of the HSR (Fig. 5).

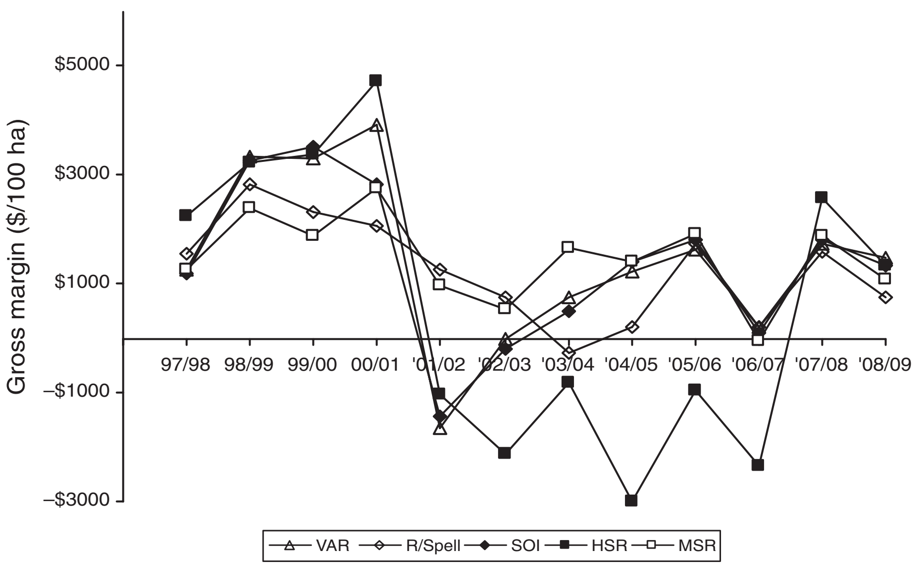

Fig. 4. Gross margin (\$) per 100 ha from 1997–98 to 2008–09, using an interest rate of 7.5% and a condition-based price premium for the variable (VAR), rotational spell (R/Spell), southern oscillation index-variable (SOI), heavy stocking rate (HSR) and moderate stocking rate (MSR) strategies. See text for details.

Table 1. Mean gross margin, variable costs and interest on livestock capital for five grazing strategies at the Wambiana grazing trial
F-probabilities are for overall treatments differences in the same year. HSR, heavy stocking rate; MSR, moderate stocking rate; R/Spell, rotational spelling; SED, standard error of a difference within a year; SOI, southern oscillation index-variable; VAR, variable. Within a year, means for the same variable with the same letter do not differ significantly at $P = 0.05$. Significant values are in italic

Grazing strategy	Year 1997–98[A]	1998–99	1999–2000[B]	2000–01	2001–02	2002–03	2003–04	2004–05	2005–06	2006–07	2007–08	2008–09
					Net gross margin ($/100 ha)							
VAR	1260	3333	3291a	3922b	–1648b	–27b	761	1217	1643a	191a	1724	1468a
R/Spell	1553	2812	2314b	2081d	1275a	754a	–254	202	1725a	201a	1601	736c
SOI	1174	3281	3520a	2832c	–1448b	–206b	486	1393	1804a	89a	1796	1323a
HSR	2233	3237	3365a	4718a	–1037b	–2110c	–803	–3035	–960b	–2348b	2584	1331a
MSR	1262	2393	1878b	2744cd	959a	522a	1647	1421	1909a	–58a	1871	1080b
F-value	0.122	0.086	*0.008*	*0.002*	*0.004*	*<0.001*	0.070	*<0.001*	*0.001*	*<0.001*	0.075	0.004
SED	325.3	267.3	245.0	242.2	391.5	100.0	585.5	169.1	241.3	130.0	245.6	77.6
					Variable costs ($/100 ha)							
VAR	12c	22a	24a	31a	172b	1100	444c	448b	201c	274b	170	369a
R/Spell	16b	16b	17b	17c	17b	1304	607bc	417b	195c	200b	148	292b
SOI	12c	22a	24a	30a	488a	1072	443c	499b	227bc	205b	187	343a
HSR	23a	23a	24a	24b	50b	1405	1182a	3189a	1582a	682a	218	380a
MSR	11c	11c	11c	11d	12b	856	620b	588b	258b	246b	204	347a
F-value	*<0.001*	*0.004*	*<0.001*	*<0.001*	*0.032*	0.111	*0.001*	*<0.001*	*<0.001*	*0.001*	0.205	*0.036*
SED	0.712	1.415	0.908	0.942	98.0	155.1	62.6	67.1	16.74	43.5	25.11	17.32
					Interest on livestock capital ($/100 ha)							
VAR	297c	771a	698a	821a	1201a	509bc	459b	380d	440c	469	522b	615b
R/Spell	414b	547b	492b	447c	657cd	610b	538b	435c	500bc	482	522b	558b
SOI	304c	578b	674a	744a	806bc	535bc	471b	451c	498bc	441	526b	559b
HSR	575a	795a	691a	636b	1012ab	938a	1006a	1110a	730a	658	685a	742a
MSR	299c	395c	329c	306d	482d	445c	507b	556b	560b	508	567b	591b
F-value	*<0.001*	*0.003*	*0.002*	*<0.001*	*0.010*	*0.002*	*<0.001*	*<0.001*	*0.005*	0.160	*0.023*	*0.038*
SED	15.86	43.3	39.9	33.2	101.4	44.5	40.0	17.17	32.8	70.4	31.4	39.0

[A]Based on 6 months of data from 19 December 2007 to June 1998.
[B]In 1999–2000, all animals were agisted together for 15 weeks after the trial was burnt – see text for details.

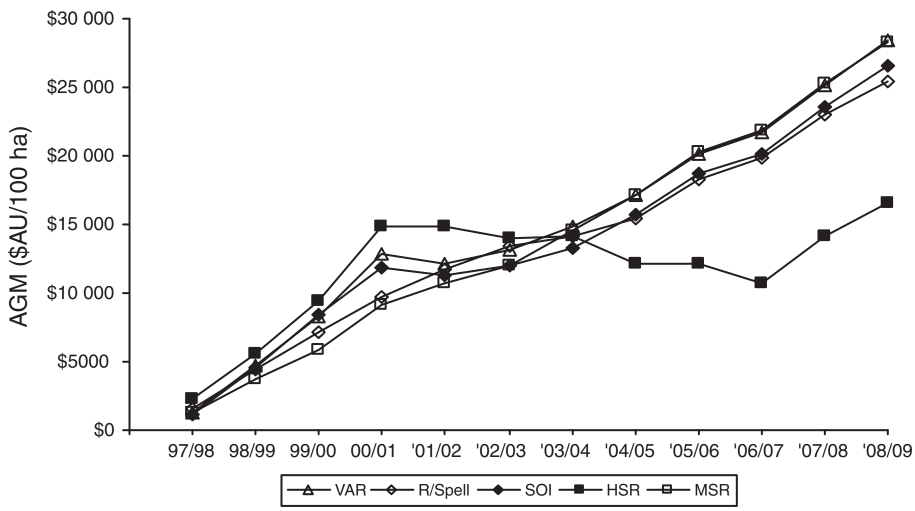

Fig. 5. Accumulated gross margin (AGM) per 100 ha, with interest compounded at 7.5% for the variable (VAR), rotational spell (R/Spell), southern oscillation index-variable (SOI), heavy stocking rate (HSR) and moderate stocking rate (MSR) strategies from 1997–98 to 2008–09. See text for details.

Net present value

In all NPV comparisons, the most profitable strategy over the 12 years was either the VAR or the MSR, followed relatively closely by the SOI and R/Spell strategies (Table 2). At all discount by interest rate combinations, the HSR was by far the least profitable strategy. In general, the relative profitability of the HSR declined

Table 2. Net present value and annualised net present value after 12 years for five grazing strategies at the Wambiana grazing trial for interest and discount rates of 5, 7.5 and 10%

HSR, heavy stocking rate; MSR, moderate stocking rate; R/Spell, rotational spelling; SOI, southern oscillation index-variable; VAR, variable

Grazing strategy	Rate 5%	7.5%	10%
	Net present value ($/100 ha)		
VAR	$15 143	$11 962	$9418
R/Spell	$13 363	$10 665	$8516
SOI	$14 100	$11 167	$8834
HSR	$9378	$6930	$5021
MSR	$14 738	$11 873	$9613
	Annualised net present value ($/100 ha)		
VAR	$1709	$1546	$1382
R/Spell	$1508	$1379	$1250
SOI	$1591	$1444	$1297
HSR	$1058	$896	$737
MSR	$1663	$1535	$1411

as the interest rate on livestock capital and discount rate increased (Table 2).

In terms of annualised NPV, treatments performed in a similar order (Table 2). For example, at an interest and discount rate of 7.5%, annualised NPV was highest for the VAR ($1546/100 ha) and the MSR ($1535/100 ha), followed by the SOI ($1444/100 ha) and the R/Spell ($1379/100 ha), but by far the lowest for the HSR ($896/100 ha).

Marginal analysis of high v. *low stocking rates*

There was a clear financial advantage to the HSR in the first 4 years, with estimated margins of ~$156/100 ha per extra AE above those run in the MSR (Fig. 6). The advent of drier years in 2001–02, however, saw a sharp drop in marginal returns with estimated losses of about –$200/100 ha for each extra AE. These negative margins continued and averaged about –$280/100 ha over the next 3 years, before dropping even further to –$1100/100 ha per extra AE in 2006–07. Nevertheless, with better rainfall, margins rebounded sharply to about $260/100 ha in 2007–08 and $90/100ha in 2008–09 for each extra AE (Fig. 6).

Sensitivity of marginal analysis to different interest rates and price differentials

Averaged over all years, heavy stocking resulted in a negative margin for each extra AE added over those in the MSR, i.e. there was no financial advantage to running extra animals over and above those in the MSR (Fig. 2). Even at a 0% interest and no price premium for better-condition animals, each extra AE in the HSR above those in the MSR diminished the potential total GM by about $70/100 ha. These negative margins increased as interest rates rose and the market price differential for better-condition animals widened. In dry years, margins per extra AE were also always negative, irrespective of interest rate or price differential. The only conditions where stocking rates above those in the MSR paid were in wet years, when (1) interest rates were <7.5% and the price differential for better-condition cattle was <$0.06/kg or, (2) when interest rates were zero and the price differential was ≤$0.10/kg.

These marginal relationships may obviously shift in future, due to changes in pasture composition and productive capacity. For example, with a change to an annual dominated pasture, running extra stock above those in the MSR in dry years may become even more unprofitable because of the poorer rainfall-use efficiency of such landscapes. Conversely, in very wet years, the relationships might shift upwards, i.e. carrying extra stock becomes more profitable because of the higher forage quality of annual dominated pastures (Ash and McIvor 1995).

Discussion

These results challenge the assertion that sustainable management is not profitable and the perception that 'more

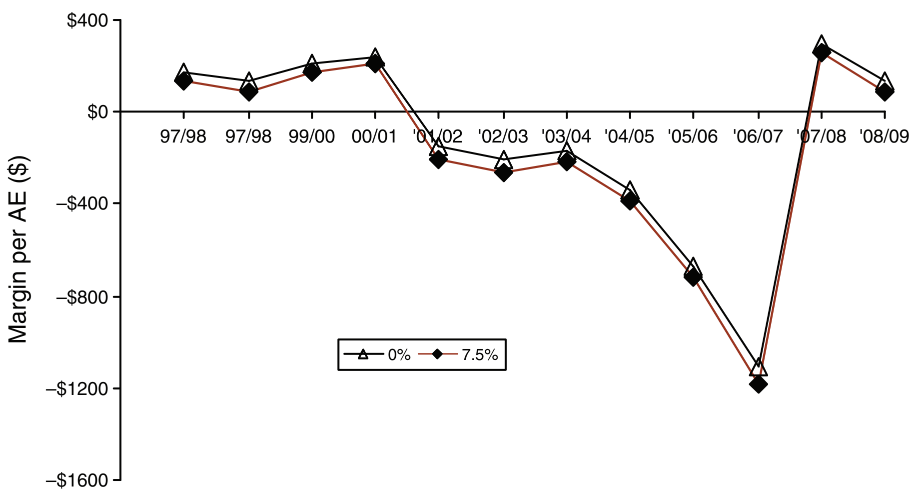

Fig. 6. Marginal return per extra animal equivalent (AE) per 100 ha from 1997–98 to 2008–09 for heavy *v.* moderate stocking at 0% and 7.5% interest rates on livestock capital.

cattle equal more money' (Stockwell *et al*. 1991). They provide the first long-term empirical evidence to show that recommended grazing strategies such as moderate or variable stocking can be just as, if not considerably more, profitable than heavy stocking. Profitability in the HSR after 12 years was not only the lowest compared with other strategies, income variability and the risk of incurring a negative GM were far greater. GMs in the HSR were only positive in wetter years when drought feeding was not required and price penalties for poor-condition animals were not incurred.

Initially, the HSR and the heavily stocked VAR and SOI strategies had higher GMs than the more lightly stocked MSR and R/Spell. Although individual animal production was lower and interest costs far higher in the former heavier-stocked strategies, total GM was boosted by the much greater production per area (O'Reagain *et al*. 2009). Good rainfall in these years allowed heavy stocking without incurring drought feeding costs or a price penalty for reduced animal condition. This suggests that heavy stocking can, initially at least, be very profitable under certain conditions. However, this period was exceptional in terms of both rainfall and the unbroken sequence of these wetter years. This initial profitability was also undoubtedly subsidised by the relatively good starting pasture condition and its delayed response to the grazing treatments (O'Reagain *et al*. 2008). Simulations run with data from southern Queensland (MacLeod *et al*. 2004) yielded similar results, with GMs increasing with stocking rate on good- (State 1) but not poorer-condition (States 2 or 3) pastures.

With the inevitable drier years, however, GMs of the heavier-stocked strategies plummeted due to price penalties for poorer animal condition, a relatively large drop in beef production/area (O'Reagain *et al*. 2009) and the ongoing high interest costs on livestock capital (Table 1). As the dry years continued, HSR profitability was further eroded by the drought feeding costs (Table 1) required to maintain high stocking rates, giving negative GMs for the next 5 years (Fig. 4).

The HSR (at a reduced stocking rate) returned to positive GMs only in later years when above-average, well distributed rainfall gave exceptionally good animal performance on the resultant short, green grass in this strategy (O'Reagain and Bushell 2008). Given the greater relative frequency of average and below-average rainfall years (Clewett *et al*. 2003), it is unlikely the longer-term profitability of the HSR will ever fully recover. Animal production and GMs are rather likely to decline further in future dry years due to the significantly lower density of perennial grasses in this treatment (O'Reagain and Bushell 2008).

While the GM of the MSR appeared relatively modest in the early good seasons, this GM was largely sustained through the dry years, ensuring a positive GM in 11 of the 12 years. This reflected the relatively low variable costs, particularly the avoidance of drought feeding, and lower interest costs on livestock capital. Good individual animal performance in the MSR also increased product value through condition- and weight-based market premiums (O'Reagain *et al*. 2009). This supports the view that profitability under moderate stocking is favoured by price premiums and lower costs (e.g. Wilson and Macleod 1991; Landsberg *et al*. 1998).

The SOI and VAR strategies also had a substantially negative GM in the first dry year (Fig. 4). But in contrast to the HSR, cutting stocking rates in response to declining forage availability (VAR) and deteriorating seasonal climate forecasts (SOI) avoided the expense of drought feeding and substantially reduced interest costs. Lower stocking rates also improved individual animal production and product value (O'Reagain *et al*. 2009), allowing a return to positive GMs that were maintained through later, dry years. Varying stocking rates with changing seasonal conditions thus ensured that the VAR and SOI were far more profitable over the longer term than constant heavy stocking.

The forced reduction in stocking rates in the HSR in May 2005 might also have been expected to reduce costs and improve animal performance, allowing GMs to recover. However, profitability continued to be adversely affected by drought feeding costs, price penalties and reduced production per unit area, despite a stocking rate only about a third heavier than the MSR. GMs were also probably undermined by the decline in land condition observed in this strategy (O'Reagain and Bushell 2008).

Despite the positive GMs in 2007–08 and 2008–09, overall profitability in the HSR after 12 years was still far lower than the other strategies, particularly the VAR and MSR (Table 2). If these results are extrapolated upwards to a 20 000-ha property, at an interest rate of 7.5% over 12 years, a manager applying moderate stocking would have made an extra $2.5 million in AGM or $988 600 in NPV compared with heavy stocking. This is obviously a very simplistic analysis, sensitive to assumptions about interest rates on livestock capital but indicates the potential magnitude of property-level benefits that might occur with more sustainable grazing management.

In marked contrast to the present results, profitability was greatest at the heaviest stocking rate in a 13-year grazing trial in central Queensland (Burrows *et al*. 2010). Aside from differences in rainfall, soils, pasture composition and grazing resilience between the study areas, this discrepancy may be attributed to two main factors. First, in contrast to the present study where only the HSR received (and required) drought feeding, in dry years Burrows *et al*. (2010) provided drought feeding to all treatments irrespective of stocking rate. Second, no price premium was given for animal condition, with animals in the optimum weight ranges receiving only an extra $0.04/kg (Burrows *et al*. 2010). This is far lower than the $0.20/kg premium given to 'good-condition steers' in our economic analysis. Both of these factors would have removed or minimised the economic advantages that normally accrue to lighter or more moderate stocking rates through lower variable costs and superior product prices.

In the present study, it is significant that varying stocking rates in response to seasonal conditions was no more profitable than simply stocking at long-term carrying capacity. Indeed, based on inter-annual variability in GM, the SOI and VAR strategies achieved a similar outcome to moderate stocking but at a far greater level of risk. Although high stocking rates were initially financially advantageous, this was largely negated by losses incurred by reduced animal performance and forced sales at the beginning of the dry years.

Importantly, the high stocking rates in the variable strategies leading into the dry years also significantly damaged pasture condition. Despite significant recovery in later years, in 2009 the density of perennial grasses in the SOI and VAR was still lower than in the MSR and R/Spell (O'Reagain 2009). A major risk of variable stocking is thus that of being overstocked running into dry years, potentially leading to overgrazing, financial loss and resource degradation. As noted by Higgins *et al*. (2007), while variable or opportunistic strategies are 'intuitively appealing', they are not necessarily optimal relative to more conservative strategies such as constant moderate stocking.

The profitability of the VAR and SOI were possibly unfairly penalised by two factors. First, animal performance in both strategies was particularly poor in 2001–02 due to the combination of heavy stocking and low-quality, dry season forage (O'Reagain *et al*. 2009), a problem that might have been avoided with urea supplementation. Second, the heavy stocking rates applied in the early wet years were probably excessive and, as indicated, had an ongoing adverse effect on pasture condition and, possibly, animal production (O'Reagain *et al*. 2008). A risk-averse variable strategy with more conservative increases in stocking rate in wet years, coupled with sharper reductions in drier years, might avoid these problems and still increase profitability relative to constant moderate stocking.

The SOI strategy was also penalised by the sale of poor-condition animals at a net loss in November 2001 in the late dry season. Again, with urea supplementation, these cattle may have maintained weight better, possibly reducing the financial loss. Nevertheless, the issue of late-dry season (November) stocking rate adjustments highlights the fact that the current 3-month lead-time for SOI forecasts (Stone and de Hoedt 2000) limits its utility as a tool for managing climate variability.

While not advocating an extreme 'trader' strategy involving major fluctuations in stocking rate (Foran and Stafford-Smith 1991), the performance of both variable strategies could be improved with better guidelines for adjusting stock numbers with changing conditions. Although decision tools such as Stocktake (Aisthorpe *et al*. 2004) for forage budgeting and BREEDCOW (Holmes 2006) for herd dynamics are available, significant practical problems remain in implementing variable stocking with breeding animals (e.g. Diaz-Solis *et al*. 2009), particularly on extensive properties (Smith 2000).

The slightly lower profitability of the R/Spell relative to the MSR, VAR and SOI is unexpected; light–moderate stocking with wet season spelling should improve pasture condition (Ash *et al*. 2001), presumably increasing animal production and profitability. As indicated, the R/Spell was severely compromised by the 2001 fire, the subsequent drought and the forced sale of poor-condition animals. Despite this, the R/Spell was still far more profitable than the HSR. A key factor in the recovery of the R/Spell was the 2003 reduction in stocking rates which, despite the short-term drop in GM, allowed reasonable animal performance and substantial pasture recovery in later years (O'Reagain *et al*. 2008).

In any economic analysis, the underlying assumptions obviously significantly affect the final outcome. The present analysis was very sensitive to interest rate assumptions on livestock capital; lower interest rates improved profitability in all strategies and, in particular, reduced the number of years at which the HSR recorded a loss. That aside, lowering interest rates from 7.5% to 5% had little effect on the relative performance of the different strategies. Irrespective of the interest rate, the key point is that all of the more 'sustainable' strategies were at the very worst as, if not considerably more, profitable than heavy stocking.

The choice of discount rate in NPV analyses is also crucial and identifying the most appropriate rate is problematic (Campbell *et al*. 2006). In the present study, the relative profitability of the HSR improved as discount rate increased, reflecting the initial good seasons and the time taken for the effects of heavy stocking on pasture condition to emerge. The sequence of profit and loss is also important in any NPV analysis (Campbell *et al*. 2006); again, the early gains of the VAR in the initial wet years probably account for it having a slightly greater NPV than the MSR.

Assumptions on livestock value are also critical. First, the condition-based market premium undoubtedly favoured treatments with good individual animal performance, such as moderate stocking (O'Reagain *et al*. 2009). This premium is a reality for meatworks cattle, but is probably of lesser importance for the finishing market, and of little or no importance for the live-export cattle market. Second, the purchase and sale price of animals has a major impact on profitability. In particular, the fall in stock prices with declining rainfall, followed by a rebound at the end of drought (e.g. Diaz-Solis *et al*. 2009), would profoundly affect the profitability of any variable stocking strategy.

Importantly, the economic value of the observed differences in land condition between strategies (O'Reagain and Bushell 2008) were not included in the present analysis. Any land condition decline would reduce future profitability via lower carrying capacity, reduced animal performance in most years and the increased probability of feed deficits. The direct costs of restoring condition are also substantial (MacLeod and McIvor 2008; Teague *et al*. 2009). Other indirect but important environmental costs are the reduction in ecosystem services, including declines in biodiversity, water quality and soil carbon sequestration (e.g. Liebig *et al*. 2010).

Inclusion of these costs in the analysis would reduce the relative profitability of the HSR even further. Similarly, accounting for the slightly better land condition in the MSR and R/Spell (O'Reagain and Bushell 2008) would also improve their profitability relative to the VAR and the SOI strategies.

Further limitations of the present study must also be recognised. First, the trial period of 12 years is relatively short compared with longer-term climate variation and the rates of change in vegetation and ecosystem function. Given a different sequence of rainfall years, the relative profitability of the different strategies might also have been different. The VAR and SOI, for example, might have performed relatively poorly if the sequence of good and poor years had been more disjointed than those encountered.

Second, the work was conducted with non-reproductive animals and conventional wisdom is that breeder performance is less sensitive to stocking rate than steers (Ash and Stafford-Smith 1996; Smith 2000). Theoretically, there is no *a priori* reason why strategies such as moderate stocking that are sustainable, profitable and give good animal production should not do the same with breeders. Nevertheless, with a majority of northern Queensland properties having large breeder herds (Bortolussi *et al*. 2005*a*), it will be critical to test how the present strategies affect the profitability of such operations.

An important next step will be to investigate how these different grazing strategies affect enterprise-level economic performance and land condition using linked biophysical and economic models (e.g. MacLeod *et al*. 2004). Long-term simulations need to be run with breeding animals and steers at the property level under a range of market price, debt level and rainfall sequence scenarios (e.g. Stafford-Smith *et al*. 2000). Property case studies with participating producers in different areas (e.g. Buxton and Stafford-Smith 1996) would also provide strong evidence on the relative benefits of sustainable grazing strategies and assist in adoption.

Management implications

The present analysis indicates that contrary to conventional wisdom, heavy stocking rates are likely to be uneconomic in the medium to long term, with profitability eroded by high costs and reduced product value in most years. Moderate stocking at long-term carrying capacity is likely to be more profitable because of lower costs, increased product value and, probably, improved management flexibility. Rotational spelling with light to moderate stocking rates will also be more profitable than heavy stocking and, in the longer term, is likely to result in the best land condition. Varying stock numbers based on forage availability and, if appropriate, seasonal climate forecasts, will also be more profitable than heavy stocking because drought feeding costs are largely avoided and product value is maintained in drier years at low stocking rates. However, the management expertise required, as well as the associated economic and environmental risks, are likely to be higher than under constant moderate stocking. In summary, constant heavy stocking will be by far the least profitable of all stocking strategies in a variable climate. Incorporating the direct costs of declining resource condition, as well as any indirect societal costs via off-site impacts, further reinforces the case against this strategy.

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Appendix 1. Animal husbandry actions and the strategies involved for cattle on the Wambiana grazing trial between 1997–98 and 2008–09
BEFV, bovine ephemeral fever vaccination; BOT, botulism vaccination; DS-urea, dry-season urea supplementation; HGP, hormone growth promotants; M8U, molasses and urea drought feeding; WS-P, wet-season P supplementation; WS, weaner supplement. Strategies involved indicated as follows: ✓, applied to all strategies; –, not applied to any strategies; HSR, applied to heavy stocking rate; SOI, applied to southern oscillation index; VAR, applied to variable stocking rate

Treatment	Year											
	1997–98	1998–99	1999–2000	2000–01	2001–02	2002–03	2003–04	2004–05	2005–06	2006–07	2007–08	2008–09
HGP	–	–	–	–	–	–	–	✓	✓	✓	✓	✓
DS-urea	–	–	–	–	–	✓	✓	✓	✓	✓	✓	✓
WS-P	–	–	–	–	–	–	–	✓	✓	✓	✓	✓
M8U	–	–	–	–	–	–	HSR	HSR	HSR	HSR	–	–
BOT	✓	–	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
BEFV	–	–	–	–	–	–	–	–	–	–	✓	✓
WS	–	–	–	–	SOI/VAR/HSR	–	–	–	–	–	–	–

Appendix 2. Prices per kg (liveweight) from 1997–98 to 2008–09 used in the economic analysis for the five grazing strategies at the Wambiana grazing trial
HSR, heavy stocking rate; MSR, moderate stocking rate; R/Spell, rotational spelling; SOI, southern oscillation index-variable; VAR, variable

Grazing	Price per kg liveweight ($/kg)											
strategy	1997–98	1998–99	1999–2000	2000–01	2001–02	2002–03	2003–04	2004–05	2005–06	2006–07	2007–08	2008–09
VAR	$1.50	$1.50	$1.50	$1.30	$1.30	$1.50	$1.50	$1.50	$1.50	$1.50	$1.50	$1.50
R/Spell	$1.50	$1.50	$1.50	$1.30	$1.50	$1.50	$1.50	$1.30	$1.50	$1.50	$1.50	$1.50
SOI	$1.50	$1.50	$1.50	$1.30	$1.50	$1.50	$1.50	$1.50	$1.50	$1.50	$1.50	$1.50
HSR	$1.50	$1.50	$1.50	$1.50	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30	$1.50	$1.50
MSR	$1.50	$1.50	$1.50	$1.50	$1.50	$1.50	$1.50	$1.50	$1.50	$1.50	$1.50	$1.50