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Extensive beef stocking rate strategies for coping with rainfall variability

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Abstract

This simulation study compared the cattle productivity and sustainability of fixed stocking with that of 55 flexible stocking strategies at 28 locations across Queensland and the Northern Territory which differed in rainfall amount and variability. Flexible stocking strategies differed markedly in the extent they could increase or decrease stocking rates in response to the amount of forage available at the end of each pasture growing season.

Relative to fixed stocking at the mesic locations (>700mm mean annual rainfall), flexible stocking caused a small decline in pasture condition while offering only a small gain in LWG/ha, and thus does not perform better than fixed stocking. At all other arid and semi-arid locations, cattle productivity was maximised by strategies which increased and decreased stocking rates markedly after good and poor growing seasons respectively. This was particularly evident at the most arid locations, where these strategies achieved LWG/ha double to triple that of fixed stocking. However, this was not sustainable. In comparison, flexible strategies with 20 or 30% limits for annual increases and an 80% limit for annual decreases in stocking rate achieved 10-70% higher LWG/ha than fixed stocking with only a small decline in pasture condition. While these highly flexible strategies perform well, they are unlikely to be practical. More practical is constrained flexibility with a 10% annual increase and 20% annual decrease in stocking rate. At the majority of locations, this strategy achieved 5-25% higher LWG/ha than fixed stocking whilst maintaining pasture condition.

Introduction

Rainfall across northern Australia varies enormously in amount and reliability. To adapt to high variability in inter-annual rainfall and forage supply, many cattle producers maintain a relatively constant and conservative stocking rate from year-to-year (fixed stocking), while others vary stocking rates considerably between years (flexible stocking). Several simulation studies conclude that flexible stocking is more sustainable and profitable (e.g. Torell *et al.* 2010), but this often required perfect climate forecasts and multiple annual adjustments in stocking rates. Given these requirements are rarely met in northern Australia, fixed stocking at close to the long-term carrying capacity appears to be the preferred approach.

The objective of this simulation study was to determine if some degree of flexible stocking would achieve better cattle productivity and/or pasture condition than fixed stocking, and whether the relative performance of these approaches was influenced by differences in rainfall.

Methods

The outcomes of 56 stocking rate strategies were simulated using the GRASP model at 28 locations in Queensland and the Northern Territory. Locations were selected so that all combinations of BOM (2013) zones of annual mean rainfall and rainfall variability were represented. When locations were ranked from lowest to highest for median – standard deviation (SD) annual rainfall, Ghan in the Northern Territory (arid with high inter-annual variability) had the lowest value of 12mm, Dirranbandi in Queensland (semi-arid with moderate inter-annual variability) had the mid-value of 268mm, and Heathlands in Queensland (mesic with low inter-annual variability) had the highest value of 1235mm. Two pasture condition states (excellent with 88% perennial grasses and moderate with 60% perennials) of a box woodland land type were used in simulations at all locations.

All stocking rate strategies commenced with what is referred to here as the maintenance stocking rate, being the maximum fixed stocking rate which maintained an average of either 88% or 60% perennials for each simulation period at each location (see Scanlan *et al.* 2010). The fixed stocking strategy was simulated with the maintenance stocking rate in every year of each simulation period. The remaining strategies differed in the extent stocking rates could be adjusted annually in response to changes in the amount of forage (herbaceous standing dry matter) available at the end of May. The most flexible strategy, full flexibility, allowed unlimited adjustments in stocking rate to achieve 30% consumption of the pasture present at the end of May, over the following 12 months. A further 54 strategies with lower flexibility were simulated. This included six core strategies which set different limits (5, 10, 20, 30, 50 and 70%) to the extent stocking rates could be increased annually. Each of these core strategies were simulated with different limits to the extent stocking rates could be decreased annually (5, 10, 20, 30, 40, 50, 60, 70 and 80%).

Stocking rate strategies were simulated for 10 separate 30-year simulation periods between 1894 and 2012 at each location. The simulated annual outputs used in this study were kilograms of cattle live-weight gain per hectare (LWG/ha) and the percent of pastures that were perennial grasses (%PG, an index of pasture condition). These were the averages for the 10 by 30-year simulation periods at each location.

Results

The %PG achieved by a number of stocking rate strategies at the three locations representing the range in median-SD rainfall are shown in Fig. 1. For example, the line with the solid square markers is the %PG achieved by strategies with a 5% limit for annual increases and various limits for annual decreases in stocking rate. Generally, the %PG increased with rises in the limits for annual decreases in stocking rate, and fell as the limits for annual increases in stocking rate rose.

The median-SD rainfall of locations influenced the %PG that could be achieved by strategies. With high reliable rainfall (Heathlands), there was little difference in the performance of flexible strategies, and they mostly achieved lower %PG than fixed stocking. The impact of different rates of increase and decrease in stocking rates on %PG was much greater at the drier and more variable rainfall locations.

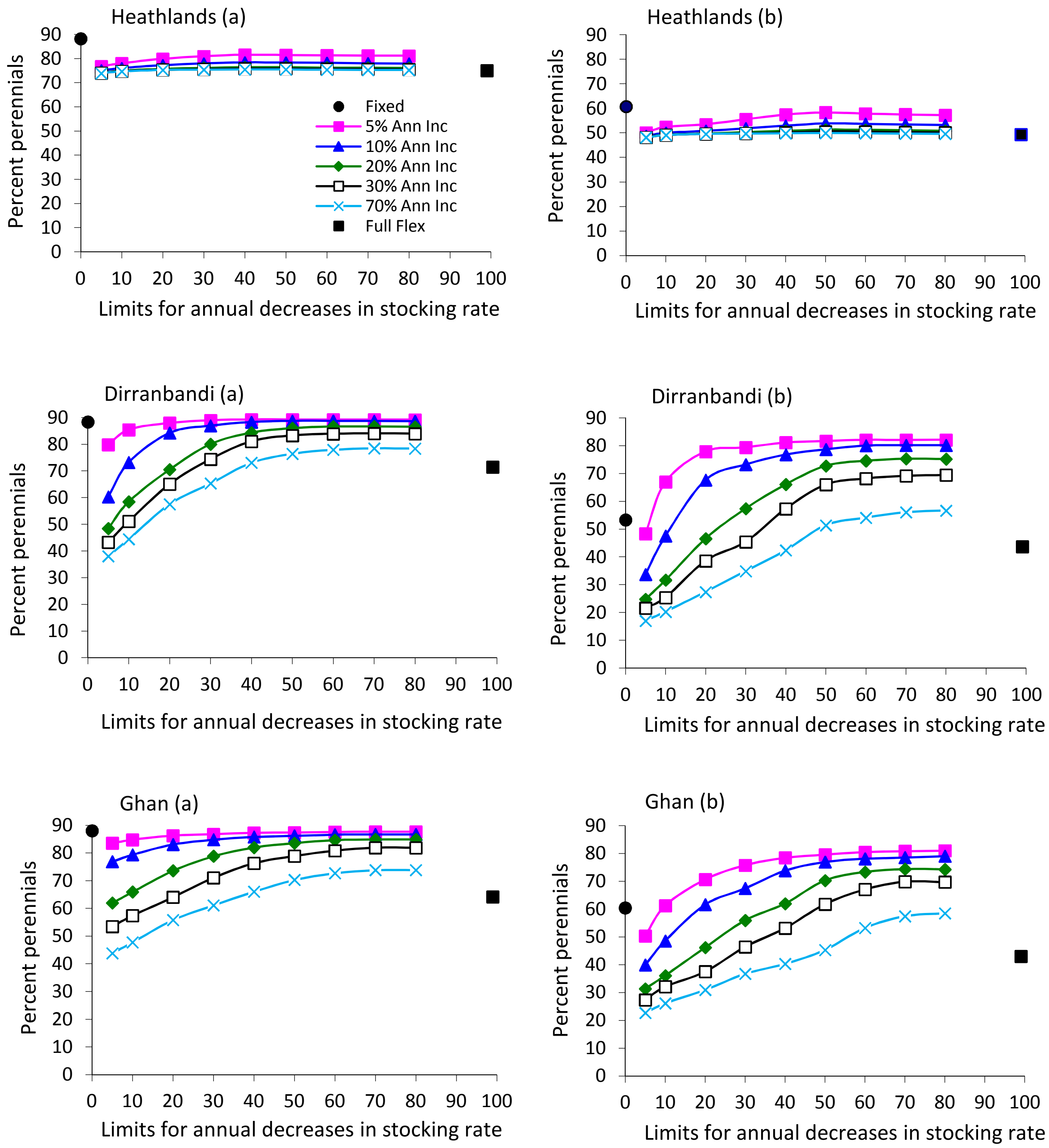

Fig. 1. The average %PG achieved by fixed and flexible stocking strategies at Heathlands, Dirranbandi and Ghan, when start pasture condition was excellent (a) and moderate (b).

For the drier locations, when start pasture condition was excellent (Fig. 1a), only strategies with 5% annual increases and high annual decreases in stocking rates achieved a %PG similar to fixed stocking. However, when start pasture condition was moderate (Fig. 1b), strategies with 5, 10 and 20% annual increases and high annual decreases in stocking rate often achieved higher %PG than fixed stocking.

As for %PG, all flexible strategies achieved similar LWG/ha at the small number of locations with the highest rainfall, such as Heathlands, and differed little to fixed stocking (Fig. 2). At these locations, strategies with only a 5% annual increase in stocking rates achieved the highest LWG/ha. At all other locations, where median-SD rainfall < 660mm, full flexibility and other highly flexible strategies achieved the highest LWG/ha.

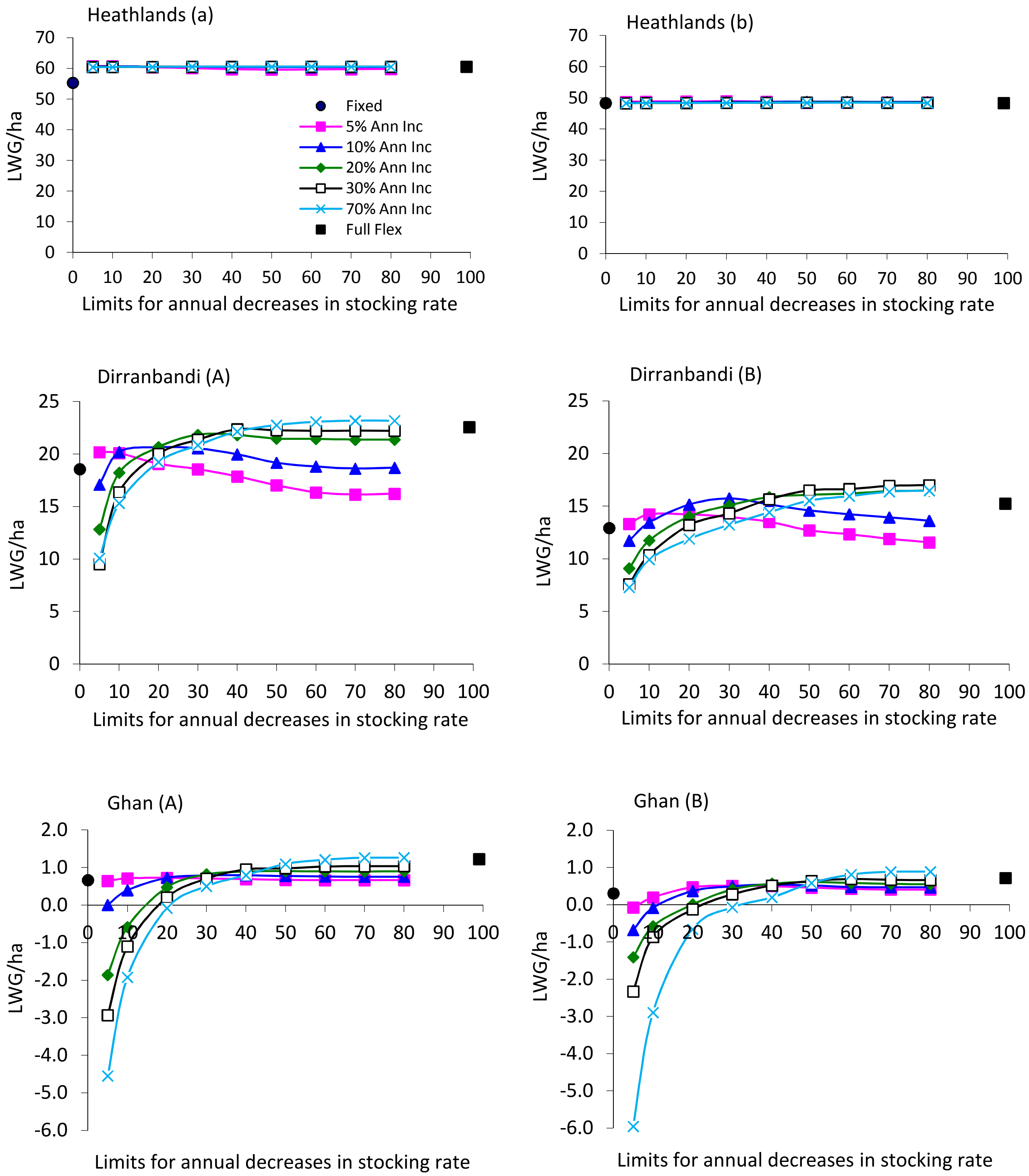

Fig. 2. The average LWG/ha achieved by fixed and flexible stocking strategies at Heathlands, Dirranbandi and Ghan, when start pasture condition was excellent (a) and moderate (b).

The proportional increase in LWG/ha that flexible strategies achieved above fixed stocking increased with decreases in median-SD rainfall (Fig. 3). Depending on the median-SD rainfall of locations and start pasture condition, flexible strategies achieved LWG/ha that was 1 to 244% higher than fixed stocking. Relative to fixed stocking, flexible strategies also achieved much higher LWG/ha when start pasture condition was moderate rather than excellent.

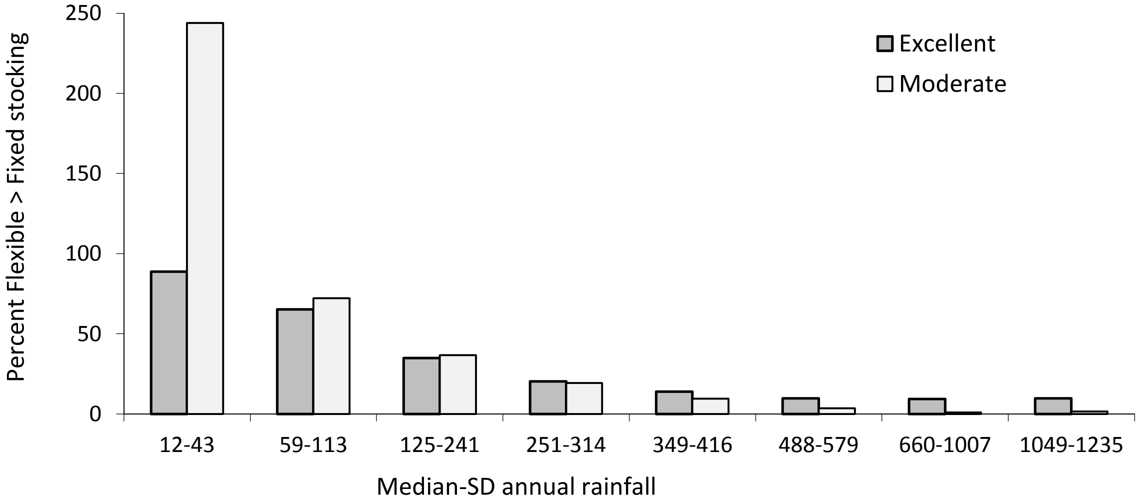

Fig. 3. Percent difference in the LWG/ha achieved by flexible stocking relative to fixed stocking at locations which varied in the median-SD annual rainfall, when start pasture condition was excellent and moderate. (The flexible strategy chosen for each category of rainfall was that which achieved the highest LWG/ha.)

While strategies in Fig. 3 achieved higher LWG/ha than fixed stocking, they often caused a decline in pasture condition (Fig. 4). Overall, the decline relative to fixed stocking was greatest when start pasture condition was excellent and at locations with low rainfall (<251mm). At all other locations, the decline in pasture condition was less, or improved when start pasture condition was moderate.

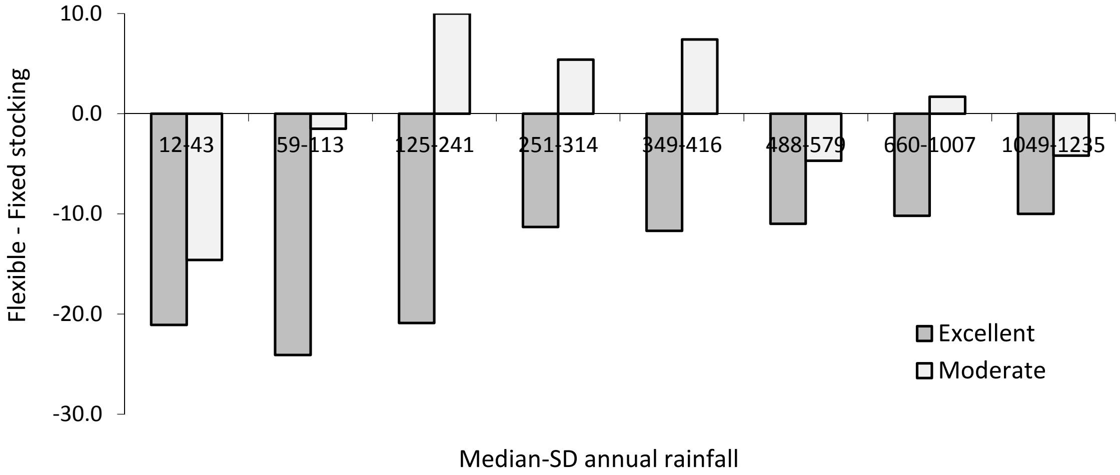

Fig. 4. Differences in percent perennials between flexible and fixed stocking at locations which varied in the median-SD annual rainfall, when start pasture condition was excellent and moderate.

Conclusions

At the wetter locations (median-SD ≥488mm), flexible stocking with a 5% annual increase in stocking rates offers up to a 10% gain in LWG/ha relative to fixed stocking, but causes up to an 11% decline in %PG, and thus does not perform better than fixed stocking. At all other drier locations (19 of 28), cattle productivity was maximised by strategies which increase and decrease stocking rates markedly after good and poor growing seasons respectively. However, at the driest locations (median-SD <125mm) this was not sustainable. While highly flexible strategies perform well at most locations, they are unlikely to be practical. More practical is constrained flexibility with a 10% limit for annual increases and a 20% limit for annual decreases in stocking rate. At the majority of locations, this strategy achieved 5-25% higher LWG/ha than fixed stocking whilst maintaining pasture condition.

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