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The economics of safe stocking rates in Central Australia

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Abstract

In the semi-arid rangelands of Central Australia, research undertaken at the Old Man Plain Research Station (OMP) has shown that managing stocking rate at a safe utilisation level allows land condition improvement given two La Niña years in a row. The first year provides a high rate of vegetation growth and consequent seed and the second-year results in a recruitment event from the first year's seed bank. The aim of this paper is to contrast the economics of OMP grazing strategies to an industry business-as-usual scenario. A bioeconomic model has been developed which encompasses a pasture growth model; the GRASs Production (GRASP) model linked to herd structure modelling using Breedcow and Dynama. The herd performance and other baseline data was derived from industry consultation, whereas the OMP data was derived from published data from the research station.

The analysis shows that there are economic incentives to run safe stocking rates. Besides the unequivocal environmental (land condition) benefits of running a safe stocking rate, the economic benefits are dependent on the initial status of the station and how it transitions to a safe stocking rate. The analysis concludes that there are economic benefits of running safe stocking rates, however implementation should be carefully managed by pastoralists to maintain a positive cash flow.

Introduction

Researchers have described key strategies for maintaining productivity in Northern Territory's rangelands (Walsh et al., 2014; Walsh and Cowley, 2016). One of the main principles is rigorous control over total grazing pressure by controlling animals' access to water supplies through self-mustering yards (SMY) and other infrastructure. This principle permits stocking rate adjustments in response to seasonal conditions, and most significantly, implementation of safe stocking rates (SSR). A safe stocking rate (SSR) is described as the stocking rate that allows for land condition maintenance or improvement over time. Usually, the SSR is calculated as the safe utilisation of median long term pasture growth / intake (Johnston *et al.* 1996).

The Northern Territory Department of Agriculture and Forestry (NT DAF) have been testing the application of SSR on Old Man Plains Research Station (OMP), near Alice Springs, Australia, over the last 15 years. Applying safe stocking rates has facilitated land condition improvement at OMP (Materne and Cowley 2023), increasing the cover of forage across the landscape (Bastin et al. 2024). The application of a SSR on OMP has resulted in livestock performance that is consistently higher than other properties in the region (Materne et al 2021). Properties in the Alice Springs region are typically large (average 3799km^2) and poorly developed with an average 28 watering points per station (Conradie 2014). The result of this underdevelopment leads to only 50% of the average station being within a 4km radius from water (watered area) where cattle usually graze (Hodder and Low 1978). This leads to uneven grazing pressure across the landscape and high grazing pressure surrounding waters, thus investment is infrastructure is key to further spread and control the grazing pressure

The economics of applying SSR on a commercial station has not been yet investigated. The present study aims to evaluate the economic and environmental benefits of implementing self-mustering yards (which provide control over total grazing pressure via controlling animals access to water), while running a SSR. These interventions are expected to permit pastoralists to manage stocking rates more efficiently, reduce overgrazing, and help ensure sustainable beef production in Central Australia.

Methods

In this study we applied a two-step modelling approach given the complexity of integrating the models. Firstly, pasture growth and Total Standing Dry Matter (TSDM) when grazed by cattle was modelled using the GRASP model (GRASs Production; McKeon et al. 2000; Rickert et al. 2000) which has been calibrated by NT DAF to OMP land types and land condition (Materne and Cowley 2023). The pasture growth modelling results of the land conditions and stocking rates on OMP encompassed 100-year data sets using Alice Springs Airport rainfall (LongPaddock, 2024). The modelling considered 2 land conditions (B and C – see Walsh et al. 2014) with three different management scenarios (Table 1) and 7 different constant stocking rates from 0.5 to 12 adult equivalents (AE - McLennan et al. 2020) per km^2. This provides 42 x 100-years results.

Secondly, a herd bioeconomic model has been developed which uses the relevant modelled pasture availability from the different scenarios noted above. Given the herd modelling results, the model selects the pasture growth jumping from one of the 100-year results to the most appropriate one, given the modelled land condition and stocking rate. The herd structure modelling is based on Breedcow and Dynama (Holmes et al. 2017) which were modified to allow for herd variations and un-mustered cattle (i.e. phantom herd) (d'Abbadie et al. 2024).

An initial herd and station condition was developed after discussions with both NT DAF experts and pastoralists. From the initial condition, three scenarios have been run: (a) BAU: This scenario performs as the contrafactual in which the station's business as usual (BAU) has developed across time with almost no adoption of practice change. The objective of this scenario is to reflect current poor-performing practices. This scenario was contrasted with two improved management practices, T and TS. (b) T: This scenario builds on the BAU scenario and includes the development of a network of SMY which enables a higher mustering efficiency and better herd management. (c) TS: This scenario builds on the T scenario and runs with a SSR in the watered area. The lower stocking rates will reduce pasture utilisation, improve land condition and increase animal performance.

Table 4: Main variables considered in the modelling for the initial condition and the three scenarios considered: business-as-usual (BAU), self-mustering yard development (T) and self-mustering yard development and safe stocking rate (TS)

Variables	**Initial Condition**	**Expected status after 20-years**		
		BAU	**T**	**TS**
Herd numbers mustered (AE)	5000	5000	5000	2213 - 3218
Target Stocking Rate (AE/km^2)	5	5 with destocking	5 with destocking	2.2 + 1
Weaning Rate (%)	50%	60%	70%	83.50%
Mortality rate (%)	10%	5%	5%	0.50%
Annual LWG steers (kg)	110	110	130	150
% turnoff females	15%	15%	37%	50%
% turnoff males	85%	85%	63%	50%
Land Condition	C	Maintained	Maintained	Improved to B
% water points with self-mustering yard	20%	50%	100%	100%
Mustering Efficiency	50%	80%	95%	95%
Phantom herd	50%	20%	5%	5%

The simulated station is located in Alice Springs region and was assumed to be in poor condition (land condition C- see Walsh et al. 2014) and has 1006 km^2 of watered area. It was assumed that the land condition improvement will occur when there is both a double La Niña event as the station is carrying a safe stocking rate within the watered area, so that the stocking rate increases by 1 AE per km^2 (Bastin et al. 2024). The model encompassed 20 consecutive rainfall years for each scenario, with the initial year varied from 1987 to 2004 to assess sensitivity. The model used the last 20-year average South Australian cattle prices (MLA 2024), and variable costs were discussed with pastoralists. Droughts were assumed to have no effect on prices. Fixed costs were based on current benchmarks for the region (McLean et al. 2024) and remained constant throughout the modelling. Infrastructure costs were set at $30,000 per SMY. Each scenario included an infrastructure development plan implemented in year one to understand the economic merits of infrastructure development. Scenarios were compared using net margin and net present values (NPV) with a 10% discount rate.

Results

Figure 1 shows the carried cattle for the 17 runs for each scenario. Both the BAU and T scenarios maintain a stable stocking rate over time. In the T scenario, the stocking rate stabilizes after five years due to the improved mustering efficiency from the SMY network, which helps to both control the herd and reduce numbers to desired levels. Additionally, the T scenario exhibits lower variability compared to the BAU scenario. In the TS scenario significant destocking occurs during the first five years, followed by an increase in carried cattle as land condition improves, typically after ten years on average. This improvement can occur between five to thirteen years, depending on the occurrence of a double La Niña event.

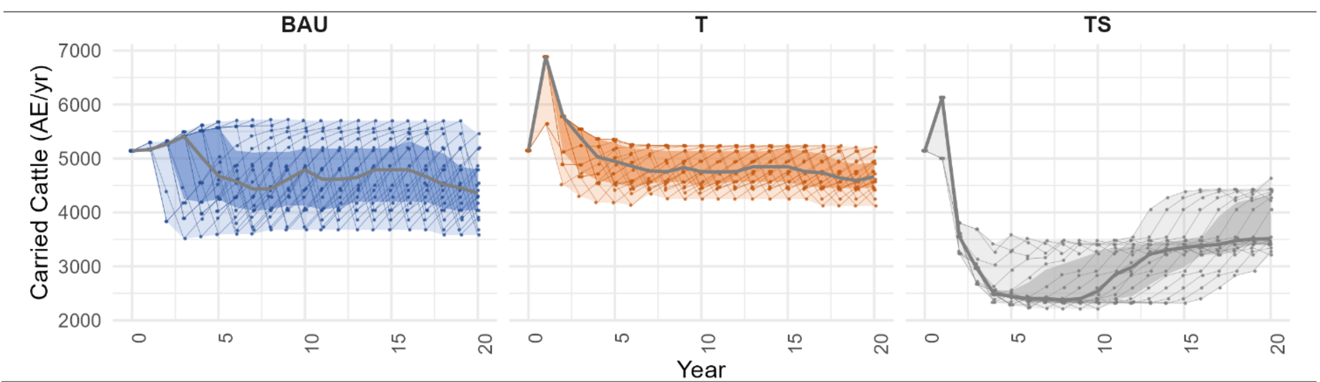

Figure 1: Yearly herd size (without considering phantom herd) for the business-as-usual (BAU), self-mustering yard development (T) and self-mustering yard development and safe stocking rate (TS) scenarios considering the

median in black and the 50% confidence interval in dark shaded colour. All 17 simulations with different starting years shown for each scenario.

The BAU scenario shows the largest variability in net margins over time (Figure 2), from the need to destock during prolonged droughts. Despite occasional highs from destocking during droughts, the overall net margin remains negative. A limitation of all scenarios is the fixed costs, which remain constant and do not adjust seasonally or in response to cash flow constraints.

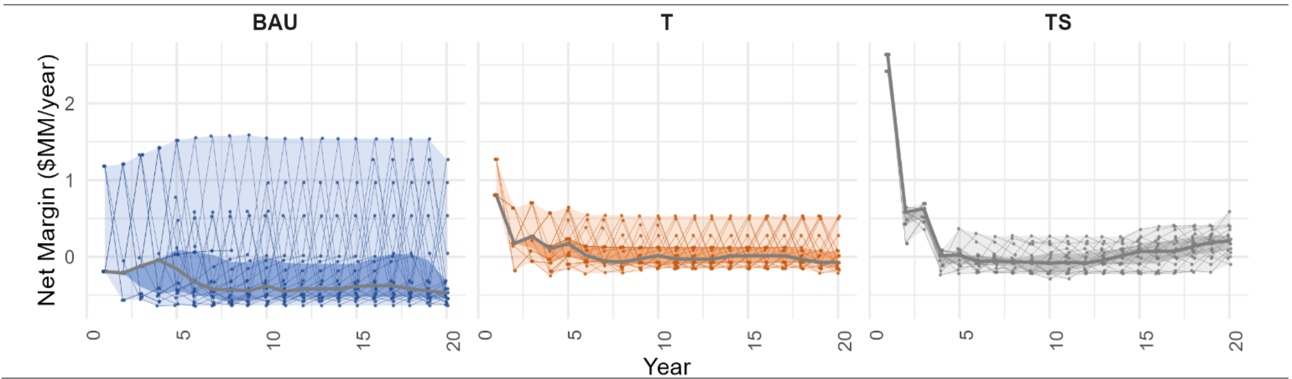

Figure 2: Yearly net margin for the business-as-usual (BAU), self-mustering yard development (T) and self-mustering yard development and safe stocking rate (TS) scenarios considering the median in black and the 50% confidence interval in dark shaded colour. All 17 simulations with different starting years shown for each scenario.

The T scenario is profitable in the first five years, with destocking of the phantom herd funding the trapyard developments. This scenario also requires destocking during droughts. After year five, cash flow averages around zero. Compared to the BAU scenario, the T scenario generates approximately $2.27 million extra in NPV (at 10% discount rate) over 20 years, with a return on the investment required to install the self-mustering yards of around 474%. In the TS scenario, peak cash flow occurs in the initial years due to destocking, which funds the self-mustering yards. From years five to thirteen, cash flow remains around zero. When the double recruitment event occurs, net margin increases as more cattle can be carried. Implementing safe stocking rates alone adds approximately $1.44 million in value, assuming the SMY are already in place.

Discussion

The results indicate that implementing SSR offers long-term economic benefits by reducing pasture utilization and eventually improving land condition, pasture growth, and animal performance. However, adopting SSR can lead to poor cash flow from the 5 to 10 years following the income gained from destocking and gaining control over total grazing pressure (TGP). This "valley of death" may deter pastoralists from adopting this strategy. To navigate this period, financing options could include the cash income from destocking, which could be deposited in banks to earn interest or used as needed. Additional income sources might include carbon credits, biodiversity credits, or investments from public donors interested in supporting enterprises that enhance and maintain land condition and biodiversity. Future research should explore additional infrastructure developments, such as more water points, and analyse the sensitivity of these interventions to varying initial conditions in this environment.

The results also highlight the benefits of investing in infrastructure such as SMY in that it improves TGP management, allowing for greater control over animal performance and significantly increases mustering efficiency. This presents an opportunity for pastoralists to leverage infrastructure development to better manage grazing pressure and potentially spread cattle with new or redeveloped water points. Consequently, the more cattle on the property, the greater the opportunity to capitalize on those above-SSR numbers. It is important to note that the BAU scenario's economics are poor, with net margins consistently below zero. A limitation of this modelling is the lack of tactical adjustments to fixed costs in response to extended dry periods. As a result, costs remain unchanged regardless of income levels, leading to negative cash flows, and as such alternative sources of income are likely to be required in order to implement the proposed changes.

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