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Assessing trigger points for flexible livestock management decisions in rangelands

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Abstract

Making management decisions (e.g. livestock sales and feeding) that involve predicting future weather conditions is difficult, especially in variable climates like the southern Australian rangelands. This project assessed tactical management options and trigger points using modelling to inform flexible stocking decisions. The study focused on a lamb production system on chenopod shrubland at Balranald, NSW Australia. A focus group of producers held in March 2019, during a lengthy drought, identified August as a key decision point for adjusting ewe numbers based on available feed. The SGS pasture model was validated for this location against historic vegetation and animal data from grazing studies, the GRASP model and producer experience of feeding periods between 2016 and 2020. Five different grazing systems were modelled. A base system of Merino ewes with lambs sold on 1 November that were containment fed with grain during periods of feed deficit was compared with two flexible options that adjusted livestock numbers in relation to available feed. The first was to reduce ewe numbers by half when green herbage mass was <0.7 t DM/ha in August (Flex ewe). The second was to retain lambs to 50 kg if green herbage mass in October was either > 1.2 t DM/ha (Flex lamb – 1.2) or >0.5 t DM/ha (Flex lamb – 0.5). The fifth system was to retain lambs to 50kg regardless of available feed (50kg lamb). The flexible ewe sale strategy reduced gross margin by 11% from $23.04 to $20.55 (per DSE; based on the long-term carrying capacity), due to lower income in the recovery years. The flexible lamb sale strategies (Flex – 1.2 – $26.76 and Flex – 0.5 – $33.30) were also lower than retaining lambs to 50 kg ($35.84). While modelling suggested lower returns from adjusting stock numbers in relation to trigger points identified by producers, other practical considerations such as experience with supplementary feeding also need to be considered.

Introduction

Livestock production in the southern Australian rangelands faces the difficult challenge of reconciling the dynamic nature of forage availability with relatively stable feed demands from domestic livestock. The region is characterised by high seasonal and annual fluctuations in vegetation growth, primarily driven by climate variability and its consequent impact on soil moisture. While livestock populations remain relatively constant, the underlying feed resources can vary dramatically—sometimes changing by orders of magnitude within a single growing season or across different years. Further, producers may only have contact with livestock 3-4 times per year so have limited opportunities to make and act on decisions.

These environmental uncertainties create significant management challenges for producers. This inherent unpredictability is typically managed by adopting conservative stocking strategies and maintaining lower herbage utilisation rates (Godde *et al.* 2019). This approach helps mitigate risks associated with potential feed shortages, such as the need for expensive supplementary feeding or forced destocking and prevents long-term environmental degradation of rangeland ecosystems (Hacker and McDonald 2021).

However, such conservative management strategies come with substantial economic trade-offs. By limiting stocking rates and forage utilisation, producers potentially sacrifice productive potential and economic returns. The critical question emerges: Can more adaptive management approaches be developed that balance economic efficiency with environmental sustainability and decrease risk?

This research project was designed to address this fundamental challenge in southern Australian rangelands. Its primary objective was to assess tactical decision-making frameworks that could help producers optimise their management strategies to maintain their feedbase whilst maximising economic return. The central hypothesis proposed that introducing more flexible management systems would yield improved financial outcomes while maintaining ecological integrity.

Methods

This study examined different flexible decisions and trigger points to make decisions for a sheep production system at Balranald (34.64 °S, 143.56 °E, average annual rainfall of 317 mm), NSW Australia.

Producer consultation

In March 2019, during an extended drought period, researchers conducted a focus group with local producers to explore their decision-making processes regarding livestock destocking and feeding under variable seasonal conditions. The consultation revealed that August was a critical trigger point for adjusting ewe numbers, with numbers often reduced by half when feed is limited. One producer illustrated this approach, stating, "Rainfall at the end of the winter growth period is the trigger point. Last winter [we] went from 3000 to 1500 ewes because of the rainfall deficit." The discussion also revealed considerable variation in lamb sale strategies, with some producers incorporating regular supplementary feeding while others did not, highlighting the variation in rangeland livestock management in response to environmental uncertainties.

Modelling

The SGS pasture model was used to simulate the rangeland grazing systems. The model has four main modules (water, nutrients, pastures and animals) that are interconnected. The model is hierarchical in structure and most processes are described in terms of a series of fluxes (or, more specifically, flux densities) that have dimensions of amount per unit area per time step (for details see Johnson et al. 2003).

The livestock system modelled was Merino ewes (60 kg reference weight) joined to a terminal sire with lambing on the 1 June and lambs sold on the 1 November or at 50 kg and run at a stocking rate of 0.1 ewes/ha. The pasture in the model was a C4 native grass and subclover (representing naturalised/native annual grasses and forbs) that had been calibrated to be slightly higher than ground level herbage to account for browse from perennial shrubs (e.g. *Atriplex spp.*; based on data from Wilson *et al.* 1969). The soil used had low hydraulic conductivity and low organic matter. Long Paddock weather data were used for Balranald (https://www.longpaddock.qld.gov.au/silo/). Since this area has a low level of trees, the tree level was set at 30% to account for the natural patchiness of semi-arid rangelands, which concentrate and retain resources in fertile patches that are interspersed with bare areas. Further validation of seasonal conditions was achieved using GRASP (Rickert *et al.* 2000), a pasture growth model commonly used in rangelands. Model output from 2016 to 2020 was presented to producers to confirm that predicted feeding periods matched their experience. The simulation was run for the 1910 to 2019 production years.

Flexible decisions

The base system was as described above, with all ewes retained and supplemented with grain as required in a drought feedlot. Two flexible decision scenarios were simulated; 1) adjusting ewe numbers, with half ewes sold when green herbage mass in August is <0.7 t DM/ha (flex ewe) and 2) adjusting sale time of lambs in the base system, by retaining lambs to 50 kg when green herbage mass in October is >1.2 t DM/ha (flex lamb – 1.2) or is >0.5 t DM/ha (flex lamb – 0.5) or selling on 1 November when not. A final scenario retained lambs until 50 kg regardless of herbage mass (50kg lamb).

Gross margin and analysis

A gross margin analysis was undertaken using the biophysical model output with costs and prices from NSW DPI 2020 gross margins (https://www.dpi.nsw.gov.au/agriculture/budgets/livestock). The sheep prices and feed grain prices were assessed against High, Medium and Low CPI-adjusted prices for the last 20 years. The sheep meat and the feed grain prices were based approximately on the 9th decile (High; lamb AUS\$7.20 /kg cwt), average (Medium; lamb AUS\$5.00 /kg cwt) and 1st decile (Low; lamb AUS\$3.00 /kg cwt) years. The gross margins per DSE are reported, based on the long-term average DSE capacity of the system (rather than DSEs in a particular year). As the model feeds to meet animal requirements, differences in profitability are primarily driven by the cost of supplementary feeding rather than production differences. All analyses were performed using ANOVA in Genstat (22nd edition).

Results

Developing trigger points

The number of days of confinement feeding that occurred from 1 August onwards for 12 months was assessed against average green herbage mass in August (Fig. 1a). In 9% of instances there was feeding for >150 days and this always occurred when green herbage mass was below 0.7 t DM/ha in August. There was also a relationship between average October green herbage mass and average per head supplement intake, with high levels of feeding only occurring below 1.2 t green DM/ha (Fig. 1b).

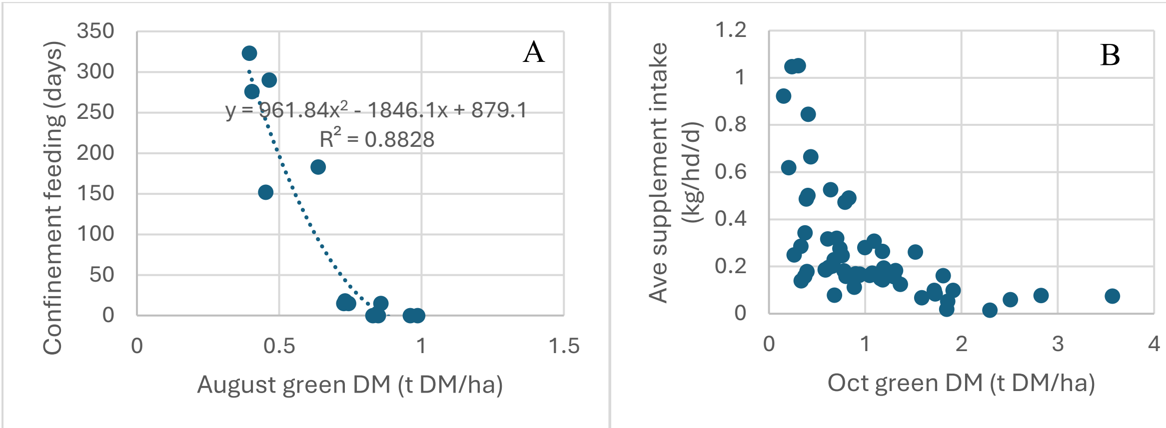

Figure 1. a) The green herbage mass in August (instances where green herbage mass was < 1 t DM/ha) compared to the average days of confinement feeding over the following 12 months. b) October green herbage mass and average per head supplement intake.

Flexible decisions

Flexible ewe numbers did not greatly influence gross margin compared to the base system. On average the base system was $2.49/DSE more profitable ($P < 0.001$; Table 1) with a lower CV (90% v 113%). There was an interaction between sheep price and the difference between the flex ewe and base system gross margins ($P < 0.001$). At a moderate sheep price there was no difference between selling or retaining ewes, while there were benefits to the base system at the high and low sheep prices.

In the year the flex ewes were destocked there was no difference in gross margin when compared with the base system, but in the following year there was a higher gross margin for the base system than for the flex ewe system ($P<0.001$).

Under all price and feed scenarios, the more often lambs could be retained to 50 kg, the greater the average profitability (Table 1) and the lower the CV (Flex lamb - 1.2 – 89% Flex lamb - 0.5 – 78% 50 kg lamb – 69%). Even with significantly increased supplementary feeding below 0.5 t DM/ha of green herbage mass, there was still an advantage in retaining lambs to 50 kg as supplementary feeding was required for a relatively short period of time (2 months) and increased the value of lambs.

Discussion

The research revealed nuanced complexities in livestock management strategies during poor seasonal conditions. Reducing ewe numbers did not consistently provide the expected financial advantages initially anticipated by producers. While selling ewes generated additional income and reduced feeding costs in the first year, the strategy's effectiveness was compromised by instances where ewes were purchased back within a month, negatively impacting overall profitability. Even excluding these short-term repurchases, the financial benefits remained marginal. In the second year, the flexible ewe sale approach encountered increased repurchase costs and lower lambing rates due to delayed rejoining, further diminishing its comparative advantage. The analysis suggested that a more gradual, staged approach to selling ewes might offer greater operational flexibility.

Many rangeland livestock producers lack experience, specialised infrastructure or labour resources for confinement feeding. In these instances, selling livestock may be a seemingly lower risk management option, despite generating slightly lower returns. The modelling, while quantifying risks, potentially underestimated complexities such as animal health considerations associated with prolonged feeding. The research also identified an alternative adaptation strategy: growing lambs to heavier weights when feed was adequate, which could help offset increased drought-related expenses and price differentials. Confinement feeding to the target sale weight of 50kg was the most profitable strategy and had the lowest risk.

The study's assumptions included access to confinement feeding infrastructure, recognising that paddock feeding could cause significant vegetation damage. Any substantial infrastructure investment would require a thorough return-on-investment assessment. Moreover, the researchers acknowledged the model's limitations, emphasising that the identified herbage mass thresholds would likely vary across individual farms, particularly in rangeland systems where saltbush browsing contributes significantly to feed availability under low rainfall conditions.

This study reveals that while flexible decision-making strategies may appear promising, their advantages were not conclusively demonstrated under the cost and price assumptions examined. The economic benefits of flexible decision making may have been understated without considering the potential additional labour and infrastructure costs associated with confinement feeding. Recognizing that modelling inherently simplifies complex real-world scenarios, the nuanced insights of experienced managers could potentially reveal subtleties and opportunities that were not captured by this analysis. Nevertheless, the research identified a clear advantage in strategically feeding lambs to a target weight across all seasonal conditions, which consistently demonstrated improved economic returns, with lowered risk.

Table 1. Average gross margin per DSE (long-term average) for different management treatments, sheep prices and grain prices. The management treatments included: 1) Base system - all ewes retained, lambs sold 1 November; 2) Flex ewe – ewes reduced by half when August green DM <0.7 t DM/ha, lambs sold on 1 November; 3) Flex lamb - 1.2 - all ewes retained, lambs retained to 50 kg when October green DM >1.2 t/ha; 4) Flex lamb – 0.5 - all ewes retained, lambs retained to 50 kg when October green DM >0.5 t/ha; and 5) 50 kg lamb: all ewes retained and lambs retained to 50 kg. High (9th decile; or based on 2020), Medium (average) and Low (1st decile) sheep prices CPI adjusted over 20 years. High (9th decile; or based on 2020), Medium (average) and Low 1st decile) feed grain prices CPI adjusted over 20 years. P values and least significant difference (P<0.05) are presented.

System		Treatments					lsd	P-value
		Base	*Flex ewe*	*Flex lamb - 1.2*	*Flex lamb - 0.5*	*50kg lamb*		
Management		$23.04	$20.55	$26.76	$33.30	$35.84	$0.51	P<0.001
		High		*Medium*		*Low*		
	Sheep price	$48.82		$26.63		$8.24	$0.40	P<0.001
		High		*Medium*		*Low*		
	Feed grain	$21.34		$28.29		$30.36	$0.40	P<0.001
Management	**Sheep price**	*Base*	*Flex ewe*	*Flex lamb - 1.2*	*Flex lamb - 0.5*	*50kg lamb*		
	High	$41.34	$40.00	$46.64	$56.09	$60.02	$0.89	P<0.001
	Medium	$21.52	$21.05	$25.13	$31.50	$33.95		
	Low	$6.27	$0.61	$8.49	$12.31	$13.54		

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