Predicting pasture production from November temperatures

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Abstract: *In response to seasonal conditions, tactical decisions made on stocking rate, supplementary feeding and the timing of livestock sale can improve the profitability of a livestock system. Currently there are few objective benchmarks or indicators to help producers make tactical decisions. The SGS pasture model was used to predict the variability of pasture production over 104 years for the Panuara EverGraze experimental site south of Orange. The variability in pasture production was used to examine the probability of forage production meeting animal demands through summer and autumn, where feed deficits often occur. Average maximum November temperature (Tmax) was found to best predict forage availability over the subsequent 6 month period (R^2 = 0.42). In years where November Tmax exceeded the median there was a 77% chance pasture production would not meet animal requirements, but when Tmax was less than median there was only a 25% chance this would occur.*

Introduction

Rainfall and pasture production can fluctuate significantly within and between years in south-eastern Australia. Traditionally extensive livestock grazing systems have been run conservatively to ensure pasture production meets animal requirements through most years. Even with this conservative approach often there are seasonal deficits where pasture growth does not meet animal demands, which limit production (Moore *et al.* 2009). Tactical decisions made on stocking rate, supplementary feeding and the timing of livestock sale can improve the profitability of a livestock system, but benchmarks and triggers are needed to determine when to make these decisions early, rather than after significant expense in feeding has already occurred or animals have lost condition and decreased in value.

This paper examines the variability in pasture production simulated from long-term climatic data for a typical native pasture on the Central Tablelands of NSW and examines several factors, which have the potential to predict pasture production over the summer and autumn period.

Methods

The EverGraze Proof site located at Panuara 25 km south of Orange (33˚27'S, 154˚56'E) was selected as the focus for simulations of a representative native pasture for the Central Tablelands of NSW to aid in the stocking rate decision making process. Long-term climatic data was downloaded from Datadrill for 1901 to 2005 (Jeffery *et al.* 2001) and used to simulate pasture growth, forage and supplementary concentrate consumption of sheep with the SGS pasture model (Johnson *et al.* 2003). The livestock system under investigation was merino ewes, lambing in mid August with lambs sold in mid December, at a stocking rate of 5 ewes/ha. The pasture was a C3 native perennial pasture (*Microlaena stipoides* and *Austrodanthonia* spp.) with annual ryegrass and subterranean clover. The amount of concentrate fed per head was used as a surrogate to estimate when pasture growth did not meet animal demands. The total amount of concentrate fed per head was determined for 6 month periods following the months of October, November and December for each year of the simulation. Linear regression was used to determine the relationship between concentrated fed per head and total rainfall or average maximum temperature (Tmax) for that month. The probability of concentrate being fed was determined for all years, when Tmax was greater than median and when Tmax was less than median.

Results

The long-term average rainfall (1901 to 2004) for Panuara was 805mm, with considerable variation between years (Fig 1). The rainfall was substantially lower for the first half of last centenary with the average rainfall of 718 mm from 1901 to 1949 and 894 mm from 1950 to 2004.

From the simulation the herbage mass ranged from 6.6 to 0.1 t/ha (Fig 2). There was a step shift in climate that occurred around 1949 and after this point pasture growth was substantially higher. The average herbage mass was 1.1 t/ha from 1901 to 1949 and was 1.8 t/ha from 1950 to 2000. Over the same period another simulation was used where stocking rates were adjusted to maintain a minimum herbage mass of 1.5 t/ha. There was an average of 4.1 DSE/ha from 1901 to 1949 and 7.4 DSE/ha from 1950 to 2000.

Tmax had a better linear relationship with the amount of concentrate fed over the following 6 months than rainfall (Table 1). Of the 3 months examined November better predicted the amount of concentrate fed than October or December. November Tmax was therefore used as a factor to predict feeding for summer and autumn.

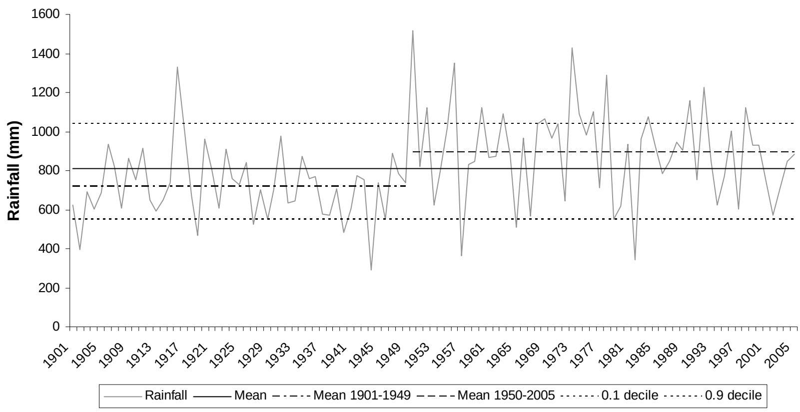

Figure 1. Average annual rainfall for Panuara from 1901 to 2004. The mean rainfall for 1901 to 2004, 1901 to 1949 and 1950 to 2004 are shown. The 0.1 and 0.9 decile average annual rainfall are featured.

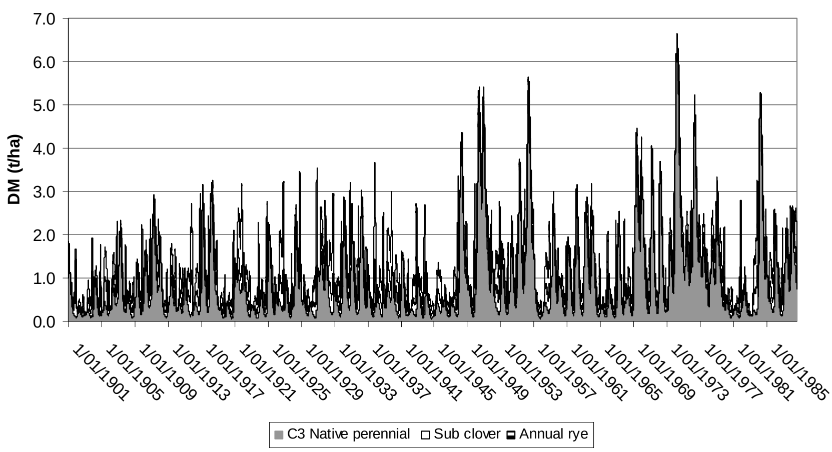

Figure 2. Pasture herbage mass (kg/ha) for Panuara from 1901 to 2000.

Table 1. R^2 for linear regression between concentrated fed per head (kg/head) and average Tmax and total rainfall for October, November and December between 1901 and 2004 at Panuara.

Month	Tmax	Rainfall
October	0.176	0.145
November	0.423	0.282
December	0.317	0.144

Using all years of data there was a 50% chance of having to feed >5kg/head of concentrate through summer and autumn (Fig 3). In years where November Tmax was greater than median there was a 77% chance of having to feed >5kg/head. If November Tmax was less than median there was a 25% chance of having to feed >5kg/head of concentrate. There was little difference between using November Tmax or rainfall (data not presented) to predict the feeding of concentrate (77% v 75% >median and 25% v 29% <median).

Discussion

In approximately half of the years examined some feeding was simulated to be required to maintain production when ewe numbers were kept constant. When November temperature was greater than median, the probability of pasture production not meeting animal demands was 77%. This finding has significant implications as above median temperatures can be used as a guide to help make early destocking decisions. Alternatively, when November temperature was below median values, there was only a 25% chance that pasture production would not meet animal demands, and decisions could be made to maintain ewes, retain lambs for longer or use short-term feeding to overcome seasonal deficits.

While Tmax and rainfall also predicted the amount of concentrate fed per head in October and December the relationships were not as strong as in November. The predictive power out to 6 months and beyond (9 months R^2 = 0.35 and 12 months R^2 = 0.21), suggest that this measure does not only identify conditions of immediate soil moisture deficit, but also larger seasonal patterns that influence rainfall in the coming months. The negative phase of the Southern Oscillation Index (SOI) is also used as an indicator of poor rainfall (Stone *et al.* 1996). It was also examined as a factor in this analysis (data not presented) but did not predict deficits in pasture production as consistently as November Tmax and rainfall.

This analysis was completed for only one site and further investigations are needed to determine whether similar patterns occur at other locations where the critical time of the season may vary,

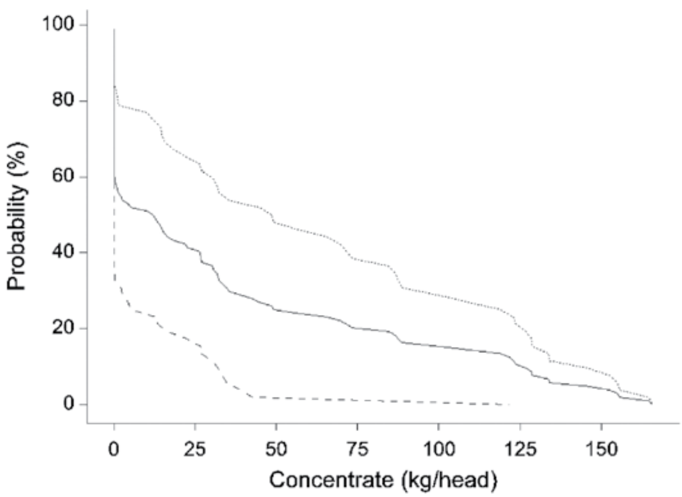

Figure 3. The probability of feeding concentrate (kg/head) through summer and autumn for all years (solid line), November Tmax>median (dotted line), and November Tmax<median (dashed line).

i.e. in the slopes region it could be in October or September. The animal demands peaked in December before lambs were sold for the livestock system under investigation. With other production systems a different pattern of animal demands throughout the year may also change the critical time of the year. Moreover, climate change is likely to alter rainfall patterns to a greater summer dominance in this region (Hennessy *et al.* 2008), which will alter the pattern of forage growth and hence historic conditions may not be as powerful at predicting future conditions. However, seasonal variability is likely to have a greater influence on pasture intake of sheep than climate change (Lodge *et al.* 2009) and these trigger points may still be relevant.

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