Sheep production in a puccinellia-dominant pasture with or without balansa clover is highly profitable on moderately saline, waterlogging prone saltland

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Introduction

Work by Edwards *et al.* (2008) has confirmed the suitability of puccinellia (*Puccinellia ciliata*)-based pastures for the moderately saline, waterlogging prone areas of the Upper South East of South Australia. It also provided robust pasture production and botanical composition data to demonstrate that puccinellia-dominant pastures with nitrogen inputs from applied nitrogen or from fixation by balansa clover (*Trifolium michelianum*) are the most productive pasture systems. The increased production is due to greater growth of the puccinellia and puccinellia/balansa clover pastures relative to unimproved sea barley grass (*Hordeum marinum*)-dominant pastures. In this second paper we present data to benchmark animal productivity in the same range of 'improved' saltland pastures against the same unimproved control. These data are also used in a whole-farm optimisation model (MIDAS) to provide an assessment of the profitability of a number of saltland pasture options and production scenarios for the region.

Materials and methods

Site and pasture treatment details were as for Edwards *et al.* (2008).

One hundred and eighty 1.5-2 year old Merino wethers were allocated to treatments in June 2003, within 2 weeks of shearing. Separate groups were also allocated in January 2004 and 2005, approximately 4 weeks off shears. A minimum of 10 'core' animals were allocated to each plot and additional animals were added (or subsequently subtracted) depending on expected carrying capacity and actual pasture growth measured by the methods described by Edwards *et al*. (2008). Sheep were supplemented with whole lupins (*Lupinus angustifolius)* or faba beans (*Vicia faba)* in early 2004 and 2005 to meet maintenance requirements when pasture mass and quality were insufficient to support liveweight maintenance of the core animals in a treatment. Pasture mass was reassessed monthly by calibrated visual assessment and feeding level adjusted based on GrazFeed (Horizon Agriculture Pty Ltd, Roseville, NSW) recommendations. Liveweight and fat score were measured monthly and also used in determining stocking and supplementation rates.

Annual wool production was determined from fleece weights recorded at shearing in December each year and the effect of each treatment on wool quality was determined by collection and measurement of wool samples from the mid-side of core animals from each treatment. Fibre diameter, staple strength, yield, staple length and position of break were measured using standard methods (Australian Wool Testing Authority Pty Ltd, North Melbourne, Victoria).

Economic analyses were conducted for a farm representative of the Upper South region using the whole farm optimisation model, MIDAS, adapted specifically for this analysis (see Bathgate *et al*., 2008 for details). The representative farm was 2000 hectares, with 70% of the annual average rainfall of 450mm falling in the growing season between early May and early November. Soils were of low fertility and situated in a landscape with little relief. Drainage was consequently very poor, despite the presence of drainage channels constructed to limit the effect of waterlogging on production. The model farm had three soil types: deep sand and sand over clay, covering 30% of the property each and shallow sand over clay on the remaining 40% of the farm. Lucerne (*Medicago sativa*) was allocated to grow on the deep sand, and be re-established every 10 years. Tall wheat grass (*Thinopyrim ponticum*) was allocated as the dominant species on the sand over clay and was re-established every 20 years. Both pastures were top dressed with 75kg per hectare of superphosphate annually. Growth rates for lucerne and tall wheat grass for the model were estimated using previous studies (eg G. Auricht, pers. comm.) and local experience. The shallow sand over clay soils were subject to a rising water table and consequent waterlogging, highly saline groundwater and dryland salinity. Simulations assessed the production and quality of two puccinellia-based pastures on these saline soils, in comparison to unimproved pasture consisting mainly of sea barley grass. Growth rates of the puccinellia-based pastures were estimated using the Grassgro pasture simulation model (Horizon Agriculture Pty Ltd, Roseville, NSW) and adjusted to reflect growth measured by Edwards *et al*. (2008). Nutritive values of all three pasture types in 10 periods of the year were also estimated using local experience and data generated by Edwards *et al.* (2008).

Four treatments applied in the grazing experiment were compared in the economic analysis:

1. Unimproved pasture – sea barley grass-dominant, low growth rate, poor quality
2. Improved puccinellia pasture – puccinellia dominant, high growth rate, moderate quality
3. Improved puccinellia pasture + nitrogen – puccinellia dominant, high growth, good quality
4. Improved puccinellia pasture + balansa clover – puccinellia dominant, high growth, good quality

Differences in pasture growth rate and quality in each of the aforementioned periods and costs of management were modelled to represent each treatment. The model was run assuming different areas of shallow sand over clay (i.e. saline land) and wool price.

Results and discussion

Puccinellia-dominant pasture oversown with balansa clover outperformed all except the similar treatment with applied nitrogen in lieu of balansa clover for nitrogen fixation in terms of liveweight gain per hectare (Fig. 1). As alluded to in Edwards *et al.* (2008), this is likely to be a combination of both an increase in pasture growth and higher nutritive value of the balansa clover that made up a significant proportion (27.5%) of the sward. In contrast, unimproved pasture resulted in the lowest liveweight gain of all the treatments (Fig. 1), due to a combination of the lower pasture growth and nutritive value of the sea barley grass-dominant sward in this treatment. It is noteworthy that the puccinellia only and puccinellia-dominant pasture with added superphosphate treatments were not significantly different to each other in terms of pasture growth (see Fig. 2 in Edwards *et al*., 2008) or liveweight gain (Fig. 1), indicating that the extra superphosphate applied to the latter treatment did not result in a pasture or an animal liveweight response. This is most likely a result of the relatively strong superphosphate history of the property and the fact that soil tests from a number of pits dug at the site indicated low soil surface Colwell P levels (typically 6-10 mg/kg), but much higher levels at 25-40 cm (26-28 mg/kg).

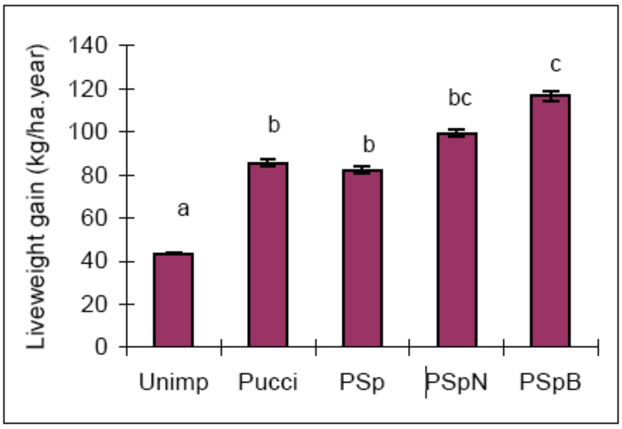

Figure 1: Average liveweight gain per year achieved over 2004 and 2005 for unimproved (Unimp), puccinellia only (Pucci), puccinellia + superphosphate (PSp), puccinellia + super + nitrogen (PSpN) and puccinellia + super + balansa clover (PSpB) treatments. Columns with

Wool production results largely mirror the liveweight gains - greasy and clean fleece weights per hectare were significantly higher when balansa clover was a significant component of the pasture (PSpB in Fig. 2) than when puccinellia-dominant pasture was top dressed with nitrogen, which in turn was higher than the puccinellia and puccinellia-dominant pasture with applied superphosphate treatments. The 'unimproved' pasture treatment produced the lowest clean fleece weights per hectare (Fig. 2) and the same trends were also seen in greasy fleece weight (data not shown). Similar effects were evident for coefficient of variation of fibre diameter (Unimp > PSpN > Pucci = PSp = PSpB) and length to point of break (Unimp < PSpN< Pucci = PSp < PSpB), but no significant differences were found in yield, percentage of mid-point breaks, staple strength, staple length or fibre diameter.

Interestingly both measures of sheep production were significantly different between years of the experiment, highlighting some of the between season variability encountered in this environment.

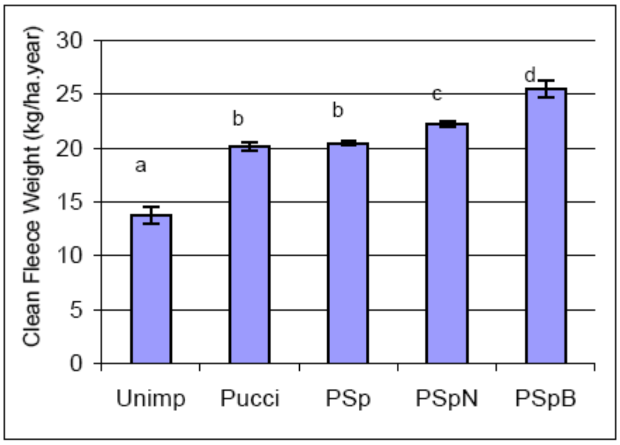

Figure 2: Clean fleece weights per hectare per year for unimproved (Unimp), puccinellia only (Pucci), puccinellia + superphosphate (PSp), puccinellia + super + nitrogen (PSpN) and puccinellia + super + balansa clover (PSpB) treatments. Columns with different letters are significantly different at P=0.05.

When these animal production results and the pasture data from Edwards *et al*. (2008) were used to model a typical farm with saltland for the region, a puccinellia-dominant pasture with a strong balansa clover component on the salt affected land was the most profitable (equivalent to PSpB in the field-measured results). This treatment produced the best animal growth rate and wool quality at a relatively low cost. For the standard assumptions used in the model (see Bathgate *et al*., 2008), profit was increased by around $40 per hectare per annum under this scenario, compared with around $10 per hectare for saltland growing only puccinellia and a $17 per hectare loss for puccinellia pasture with annual topdressing of nitrogenous fertiliser (equivalent to the PSpN treatment). This loss was brought about primarily by the high cost of applied nitrogen, compared to the relatively low cost of re-seeding balansa clover every 5 years. Further analysis indicated minimal reduction in profit if seasonal conditions and management strategies led to a reduced density of balansa clover necessitating resowing every 3 years (~$2/ha.year reduction), but the difference between this and the applied nitrogen treatment would most likely be even greater now that urea prices are approaching $900/tonne. The main reason for the lowered profitability of the puccinelliaonly saltland farm compared to one with puccinellia and balansa clover was the lower pasture quality. Over the growing season the quality of the pasture without balansa clover was assumed to be two percentage points lower in digestible dry matter and one percentage point lower during the drier months. The difference in profitability therefore is due mainly to the additional production that can be achieved with better pasture quality. It is worth noting the observation by Edwards *et al.* (2007) that maximum profitability for the model farm was dependant on achieving near maximal pasture and animal production for any particular system, indicating the importance of pasture improvement and good pasture management on saline soils.

The price received for wool from the modelled sheep flocks had significant effects on profitability for all of the saltland pastures. Furthermore, a puccinellia treatment oversown with balansa clover remained profitable down to about 475c/kg clean, whereas the puccinellia-only treatment started to run at a loss at about 620c/kg and the puccinellia with applied nitrogen treatment did not result in a positive change in profit until wool price reached about 800c/kg due largely to the relatively high cost of purchasing and applying nitrogenous fertiliser. This further highlights the robustness of the puccinellia/balansa clover pasture system on saltland in this region.

When the area of saline land was modelled for the 2,000ha property, the increase in profit per hectare rose as the area of saline land sown to puccinellia with balansa clover increased (Fig. 3). However, the increase in per hectare profit declined with increasing area when the saline pastures were puccinellia-only (Fig. 3). This is because the increase in production from puccinellia-only saltland could only be capitalised upon if supplementary feeding also increased to maintain stock numbers over summer and utilise the additional pasture grown. While more pasture was also grown in the puccinellia with balansa clover treatment, its higher nutritive value negated some of the additional supplement requirement. This increased requirement for supplementary feed as pasture was improved was also observed in the grazing experiment (data not shown).

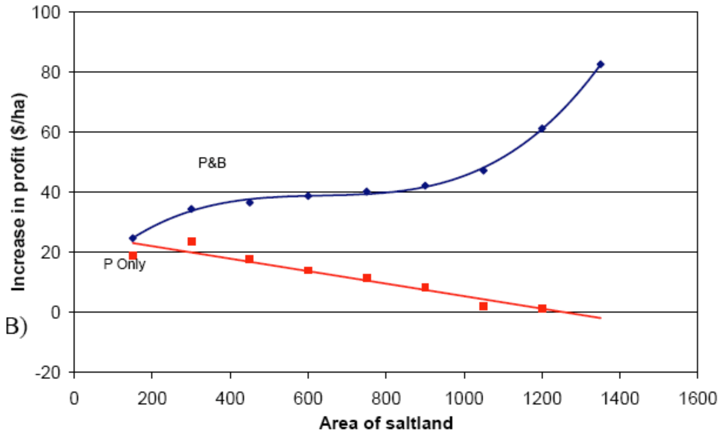

Figure 3: Increase in profit per hectare modelled for puccinellia-only (P only) and puccinellia + balansa clover (P&B) treatments at different areas of saltland (10-65% of the model farm).

Conclusions

Animal production, in terms of both liveweight gain and wool production per hectare, was highest in treatments incorporating puccinellia-dominant pasture oversown with balansa clover, due to a combination of increased pasture growth and increased nutritive value of these pastures. In contrast, unimproved pastures dominated by sea barley grass had the lowest liveweight and wool production performance, whilst treatments dominated by just puccinellia (with or without superphosphate) were intermediate.

Puccinellia-dominant pastures oversown with balansa clover were also the most profitable of the pasture systems considered when analysed on a whole farm basis, confirming the initial hypothesis for the experiment that this would be the ‘best-bet’ pasture system for saltland in the region. As was the case for the experimental results, this modelled finding resulted from the improved quality of the feed at relatively low cost (i.e. sowing a nitrogen fixing legume vs annual applications of nitrogen). For localised areas where salinity levels are unfavourable for the establishment and/or persistence of balansa clover, the analyses indicate that although puccinellia-dominant pastures were a less profitable option they should still be sufficiently attractive to encourage farmers to renovate areas currently dominated by sea barley grass.

Acknowledgments

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