Systems simulation assists land capability estimation in Australia's temperate grasslands

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Introduction Intensification of production in the water-limited grasslands of temperate Australia has increased the need to quantify their sustainable carrying capacity. Empirical rainfall-based rules for estimating stocking rate fail when used in districts with differing weather patterns, or when soil and pasture resources limit the utilisation of rainfall. Grazing systems simulation should help to overcome these problems because local conditions can be taken into account. This study investigated the impact of soil resources on potential stocking rate, profitability and production risk in a local climatic area of the southern tablelands of NSW, Australia.

Materials and methods The GrassGro decision support tool (Moore *et al*., 1997) was used to simulate Merino wethers continuously grazing pasture at Bookham, NSW (rainfall 775±206 mm/year, mean±sd). Pasture mass was measured at a reference farm ("Kia-Ora"; 34°48.2'S, 148°34.9'E) at monthly intervals (1998-2003) and the data were used to test model predictions. Inputs to simulations included daily weather records, soil physical properties and a description of the sheep genotype. Sheep were fed for maintenance whenever liveweight declined below a threshold. Pasture was simulated as dominantly annual grass-*Trifolium subterraneum*. Subsequently, GrassGro was used to explore the impact of soil fertility at the farm and to simulate alternative scenarios at high soil fertility, in which the plant-available water holding capacity (PAW) was varied to reflect different soils in the area. All other inputs were kept constant. Relative profitability was determined from simulations (1965-2003) that used costs and prices suitable for 2004. Optimum stocking rate was defined as the lowest stocking rate that achieved the "best" combination of high median annual profit and low below-median variation in profits. Production risk was defined as the proportion of years with profit <$100/ha.

Results The test simulation explained 80% of the variation in available green pasture at the reference farm (regression analysis n=63; one outlying point excluded). Mean annual pasture yield was predicted to be 5.3 t DM /ha for unfertilised paddocks (6 wethers/ha) but increased to 10.5 t DM/ha for paddocks simulated to reflect field applications of P, S, K and Mo (18 wethers/ha). A survey of ten paddocks across the district (~1,800 km^2) showed that soils varied independently in depth, PAW and root depth (root zone PAW range: 64–128 mm). Variations in soil properties of this magnitude may occur within a single farm. Skeletal soils also occur, but in relatively small areas and were not encountered in the survey. Carrying capacity of paddocks at high fertility was examined by assessing productivity relative to root zone PAW. For this climate, there was a critical PAW (~45 mm) below which production and profitability declined and production risk increased markedly (Figure 1).

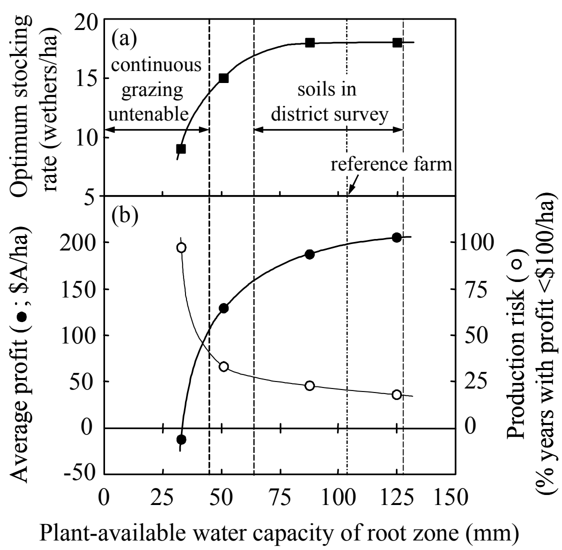

Figure 1 Stocking rate, profit and risk in relation to root zone PAW (from simulations: 1965-2003)

Conclusions Continuous grazing appeared to be unsustainable on soils with <45 mm PAW. The soils in the survey were predicted to carry 17-18 wethers/ha with similar, low production risk. However, substantial differences in relative profitability were predicted with the highest PAW paddock returning 28% more profit than the lowest paddock. The optimum stocking rate is not achieved on all farms experiencing similar climate. It was concluded that differences in fertiliser management, rather than soil characteristics were the likely cause.

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Reference

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