Simulation of pasture phase options for mixed livestock and cropping enterprises

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Introduction In southern Australia, 50% of grain-producing farms also run beef and/or sheep enterprises. Legume pasture leys are used to replace soil nitrogen and manage crop disease risks. Deep-rooted perennials, predominantly lucerne (*Medicago sativa*), are replacing annual *Trifolium subterraneum*-based leys to increase pasture production. They also have the environmental benefits of limiting soil acidity, rising water tables and dryland salinity. After recent droughts depletion of soil water by lucerne has penalised wheat yields. Decision support tools can help farmers evaluate the long-term effects of grazed annual and perennial leys on animal and crop production at the whole farm level.

Materials and methods FarmWi$e, a modular decision support tool (Moore 2001) was used to simulate wheat yield, pasture production and animal production in rotations of 3 years of wheat and 3 years of either lucerne or self-regenerating sub clover at Lockhart, NSW (mean annual rainfall 500mm). The water balance model used in the simulations was an updated version of that described by Moore *et al.,* (1997). Continuous simulations from 1954-2003 used daily weather records and a description of a Red Dermosol soil from the region. The management module of FarmWi$e was used to simulate the recommended practices of undersowing lucerne in the 3rd year of wheat, lucerne removal in mid-October of the 3rd year of the pasture phase and residue cultivation prior to sowing wheat. Simulations assumed maximum root depths in this soil of 0.7m for sub clover, 1.3m for wheat, 2.4m for lucerne and that soil nitrogen and disease did not limit pasture or crop growth. The effects of each pasture type on water balance were modelled but any differences in the effect of lucerne and sub clover on soil structure or soil nutrient dynamics were not. In each system the pasture phase was grazed by weaned 30 kg 4 month-old Border Leicester × Merino sheep to achieve a live weight of 45 kg. Six simulations of each of the rotations were run, each commencing in a different year of the rotation. The difference in wheat yield for the two pasture rotations was calculated for the each of the 50 years simulated (1954-2003).

Results Average wheat yields over 50 years of 3.90 and 3.75 t/ha for the sub clover and lucerne wheat rotations, respectively, agree with district performance. However yield differences between rotation types depended on the year of the crop phase (Figure 1). In Year 1 of the wheat phase, yields from crops sown after lucerne were, on average, 0.14 t/ha greater than crops sown after sub clover but were similar in Year 2 and 0.56 t/ha less in Year 3. Lucerne removed more water from the soil profile than sub clover but summer rainfall during the long fallow period before the first wheat crop often replenished the soil profile. In Year 3, wheat yields in lucerne rotations were penalised by competition from the undersown lucerne. Distributions of yield differences show that in 2% of years the penalty in Year 1 of the wheat phase after lucerne exceeded 1.2 t/ha. These years were the severe droughts of 2002 and 2003; the recent bad experiences of local farmers are therefore exceptional and are not necessarily a sound basis on which to choose pasture species.

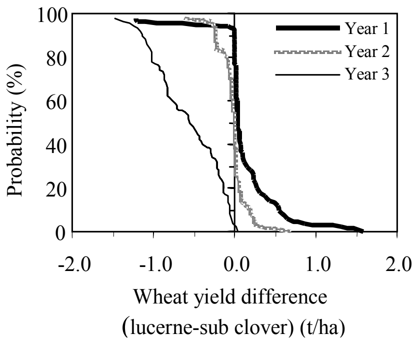

Figure 1 Distribution of differences between simulated lucerne and sub clover rotations in wheat yields for each year of the wheat phase

Conclusions Decision support tools enable a whole farm approach to assess the relative benefit of lucerne to both crop and livestock enterprises on farms and environmental sustainability.

References

Moore, A.D. (2001). FarmWi$e: a flexible decision support tool for grazing systems management. In: Gomide, J.A., W.R.S. Mattos & S.C. da Silva (eds.), *Proceedings of the Nineteenth International Grassland Congress*, Sao Pedro, Brazil. FEALQ, Sao Pedro, Brazil, pp. 1045-1046.

Moore A.D., J.R. Donnelly & M. Freer (1997). GRAZPLAN: decision support systems for Australian grazing enterprises. III. Pasture growth and soil moisture submodels, and the GrassGro DSS. *Agricultural Systems* 55, 535-582.