Evaluation with simulation of lucerne-based cropping systems to combat dryland salinity in Australia

W. Chen[1], M.J. Robertson[2] and W.D. Bellotti[1]
[1]*School of Agriculture & Wine, The University of Adelaide, Roseworthy Campus SA 5371 Australia, Email: wen.chen@adelaide.edu.au,* [2]*CSIRO Sustainable Ecosystems, St Lucia Qld 4067 Australia*

Keywords: APSIM simulation, phase cropping, companion cropping, dryland salinity, drainage, lucerne

Introduction Dryland salinity is one of the most significant forms of land degradation that farmers face in Australia. There are currently 2.5 million ha affected by dryland salinity in Australia, and this may rise to 15 million ha over the next 30 to 100 years if no action is taken. National field experiments suggest that adoption of cropping systems that integrate deep-rooted perennials, such as lucerne, are important to reduce dryland salinity. This paper reports simulation results with APSIM (The Agricultural Production Systems Simulator), that have been used to explore climate, soil and agronomic factors affecting effectiveness of lucerne-based phase and companion cropping systems in sustaining crop yield and reducing deep-water drainage in South Australia.

Materials and methods The APSIM farming system simulator has been developed in Australia to facilitate analysis of complex production and sustainability issues of agricultural systems (Keating *et al*., 2003). Simulations were conducted for Roseworthy, South Australia, with annual rainfall of 436 mm, 65% of which falls in the winter. The soil type is a red-brown earth with a soil texture of sandy loam in the top over clay to heavy clay in subsoil. The maximum effective rooting depth and plant-available water capacity were estimated respectively to be 1.8m, and 173mm for lucerne, and 1.6m and 143mm for wheat. The simulations were run from 1950 to 2000 with APSIM version 2.1. The simulated cropping systems were continuous wheat (CW), lucerne-based phase (LW-phase, terminated early E or late L) and companion (LW-companion) cropping. See footnote to table for further details of treatments.

Results Simulated drainage in LW-phase and LW-companion systems was much lower than in CW (continuous wheat) (Table 1). Compared with lucerne-based cropping systems, drainage in CW system occurred more frequently over the simulated period (Figure1). Although annual drainage in LW-companion was reduced significantly (below national target of 10mm or 1% of annual rainfall), reduction in wheat yield compared with CW system was high. The LW-phase systems seemed to provide the best balance of sustaining wheat yield and effectively reducing annual drainage in this environment, although there was some yield loss when lucerne stands were terminated late (LW-phase-L).

Table 1 Summary of simulated average wheat yield and annual deep drainage (% of annual rainfall in parentheses) in different cropping systems

Cropping systems[1]	Yield (kg/ha)	Annual drainage (mm)
CW	3,206	13 (3%)
LW-phase-E	3,350	8 (2%)
LW-phase-L	2,679	4 (0.9%)
LW-companion	1,706	2 (0.4)

[1]Continuous wheat (CW). Wheat was sown following three years lucerne, when lucerne stands being terminated in Nov. (LW-phase-E) and April (LW-phase-L). Wheat was sown into established lucerne stands (LW-companion).

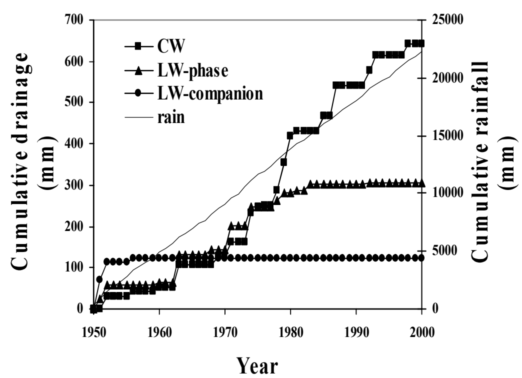

Figure 1 Simulated drainage in different systems

Conclusions Lucerne-based phase cropping systems appear promising in the Roseworthy environment, combining reduced deep drainage with acceptable grain yield. For LW-companion system, further experimentation is required on agronomic options for suppressing lucerne growth, enhancing crop competitiveness and thus reducing crop yield loss. This location-specific analysis needs to be extended to additional locations and the whole farm economics of changing from annual crop and pasture systems to a perennial forage based farming system needs to be considered.

Reference

Keating, B.A. *et al*. (2003). An overview of APSIM, a model designed for farming systems simulation. *European Journal of Agronomy*, 18, 267-288.