Simulating historic cropping systems to understand the interaction between crop choice and deep drainage.

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Abstract

Salt and water have moved below the cropping root zone since the clearing of Brigalow scrub on the western downs of south east Queensland. The movement of salt has improved the PAWC of these soils, but the loss of water below the root zone is seen as a wasted resource and potential environmental hazard. Detailed paddock histories from the time of clearing until now, describing crops, yields, cultivation and management techniques were collected for five farms in the Condamine Moonie catchment areas. The detailed histories provided the input parameters for an APSIM simulation that used the water balance at each site to identify periods of drainage and enabled the assessment of farm management and crop selection with respect to drainage. Deep drainage and runoff were higher in traditional long fallow winter crop dominated cropping sequences compared with more modern no-till opportunity cropping sequences. The inclusion of summer crops significantly reduced water loss below the root zone and in combination with optimal winter crop sowing, reduced the loss of water below the root zone by 50%. Deep drainage and the mobilisation of salt are serious concerns for farmers in the Moonie and Condamine catchments. However, by maximising production using summer cropping, opportunity cropping and no-till management techniques potential drainage can be significantly reduced.

Key words

Participation, on-farm research, salinity

Introduction

In the early 1950s large areas of southern Queensland and smaller areas of northern NSW were dominated by brigalow scrub (*Acacia harpophylla*). The predominant soil under brigalow is classified as a Grey Vertosol with melonhole (gilgai) micro relief and high depositional salt in the upper layers (Isbell, 1962, 1996, Dalal *et al*. 2002). These soils are fertile, have a plant available water capacity (PAWC) of about 190 mm and are recognised as productive cropping soils (Hochman, 2001, Dalal *et al.*2002).

In response to the release of the southeast Queensland salinity hazard map (NRM 2002) and discussions about potential deep drainage values predicted by simulation models, two farmer groups joined with researchers from the GRDC Eastern Farming Systems project to investigate possible implications of deep drainage and salt mobilization within the Moonie, Condamine regions of southeast Queensland (French *et al.* 2006). The aim of this paper is to describe interactive simulation studies that were used to identify the frequency of drainage events and if farming sequence selection could be used to manage deep drainage.

Methods

Detailed paddock histories were collected from 5 participating farmers. Paddock records detailing crop type and variety, sowing rate, fertilizer additions and fallow management, had been maintained for the 40 years since clearing. These records along with rainfall and climate records were used to run the APSIM farming systems simulation model (Keating *et al*., 2002) to simulate crop production, water use and drainage for each site.

To confirm drainage rates the simulated drainage outputs were compared with chloride transient mass balance modelling (Rose, 1979) as described by French *et al.* (2006).

Modelling results were discussed in a group situation and compared simulated yields and long-term averages to farm records for each paddock. The frequency of drainage events was related to farmer rainfall records and memorable rainfall periods.

A hind-cast simulation used current farm management knowledge to develop new cropping these simulations were run for the same period and the annual drainage figures compared.

Results

The paddock histories from the 5 sites highlighted changes in farm management over time. In general the cropping sequence between 1960 and 1990 was continuous wheat interspersed with irregular lucerne leys; however from the early to mid 1990s summer crops became common and the use of non-cereal winter crops increased.

Yield simulations of the historic cropping sequence were similar to those recorded by the farmers. Differences occurred within particular seasons, but the farm average wheat yield was not significantly different from the average simulated yield.

Drainage figures for the APSIM simulations were similar to those calculated using the chloride mass balance technique. On average about 8 mm/annum was calculated to drain below the crop root zone using the chloride method while APSIM predicted an average drainage rate of 10 mm/annum. The simulation modelling highlighted the episodic nature of deep drainage, which generally occurred when heavy rains coincided with a fully wet soil profile. Major simulated drainage events coincided with memorable wet seasons such as 1983 and 1998.

Stubble retention reduced runoff, but allowed a higher frequency of cropping. The inclusion of opportunity cropping and summer crops in the hind-cast simulations significantly reduced drainage by 50 % compared with the original cropping sequence (5mm/ annum).

Discussion

The paddock histories highlight changes in farming practice over time. Since the 1990s an emphasis on summer cropping and opportunity cropping has occurred; however, this change in crop sequences has coincided with no-till farming. No-till farming improves infiltration and reduces runoff (Freebairn *et al.* 1996), and has the potential to significantly increase drainage. The greater sowing opportunities associated with no-till have influenced crop selection and increased cropping frequency, significantly reducing the potential for drainage. Water lost below the cropping root zone can have serious environmental impacts, and it is also lost profit. The simulation modelling showed that by focusing on profit and maximising the use of water, farmers in the Moonie Condamine districts can have a positive impact on the environment.

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