High Water-Use Farming Systems that Integrate Crops with Perennial Pastures

Brett Honeysett and Neil **Fettell**
NSW Agriculture, Condobolin

Key Points

- Soil water content is being measured to 3 m depth in the CWFS core site.
- The lucerne plots in the phase farming systems contained 200 mm less soil water than the continuous cropped plots at the end of 2003.
- Lucerne had dried the soil to a similar extent after 3 years of lucerne (conventional tilled system) and 2 years of lucerne (reduced till system).
- Most of the additional moisture in the annual plots was below 1 m depth.
- Including a perennial pasture such as lucerne in a cropping system can reduce the risk of excessive deep drainage.

Background

Including perennial species such as lucerne in the pasture phase has shown considerable promise as a productive way to increase whole-of-rotation water use in grain growing areas, reducing the risk of rising groundwater and salinity. The success of lucerne is dependent upon its ability to create a zone of dry soil below the normal rooting depth of annual crops. This acts as a buffer against water leakage from the soil to groundwater. However, there is considerable uncertainty about the rate at which lucerne can 'dewater' subsoils and how long the 'dewatering benefit' may last after the recommencement of cropping. There are also areas and soil types where lucerne is not successful and alternative herbaceous plants are required. In central NSW, the incidence of summer rainfall means that specific guidelines need to be developed. For example, summer rainfall is likely to contribute heavily to deep drainage in a winter cropping system but it may also allow the use of other species such as native or introduced perennial grasses. Also, long (nine month) fallows are commonly used between pasture and cropping phases and these could contribute to deep drainage.

The Project

A project to develop high water-use farming systems that integrate crops with perennial pastures is underway across southern Australia. The aim is to integrate productive perennial pastures into annual cropping systems so as to improve the profitability and sustainability of dryland farming. The site at Condobolin is jointly funded by the CRC for Plant Based Management of Dryland Salinity, GRDC, NSW Agriculture and CWFS.

The CWFS Condobolin Site

The CWFS Core Trial is particularly suitable for this project for a number of reasons.

1. The four farming systems cover a range in perenniality, from a purely annual cropping system to a perennial-based, continuous pasture system.
2. The two phase farming systems are ideal for measuring the soil water balance in the transition to and from annual crops and lucerne pastures, including the effects of fallow periods
3. The trial is well designed, with each phase of the rotation present

each year and with four replications. 4. The plot size is large enough (2 ha) to avoid edge effects and to allow realistic management and the inclusion of grazing animals.

Since the project began in April 2003 approximately 150 neutron access tubes have been installed to a depth of 3.2 m across the trial. This is well below the rooting depth of annual crops (about 1.4 m maximum) and thought to be beyond the maximum for lucerne and perennial grasses on this soil type. This will allow the soil moisture content of the crop root zone to be monitored as well as any dry "buffer zone" which perennial species may be able to create.

Results to Date

Full scale monitoring began in September 2003, just after completion of the first 5 year rotation of the trial. The measurements therefore reflect the long term effects of each system as well as the short term seasonal effects.

Total soil water content in the top 3 m of soil after two years (Reduced till system) and three years of lucerne (Conventional till system), under annual cropping (Zero till) and perennial grass-based pasture (Perennial pasture) are shown in Figure 1.

Under the very dry spring conditions, soil water content declined from early September to mid November in all treatments. In September, there was 150 mm less water under lucerne than annual cropping. This difference increased to 180 mm in October-November and 210 mm in January 2004. Values for the perennial pasture were intermediate. It should be noted that the values shown are total soil water content, including water that plants cannot remove.

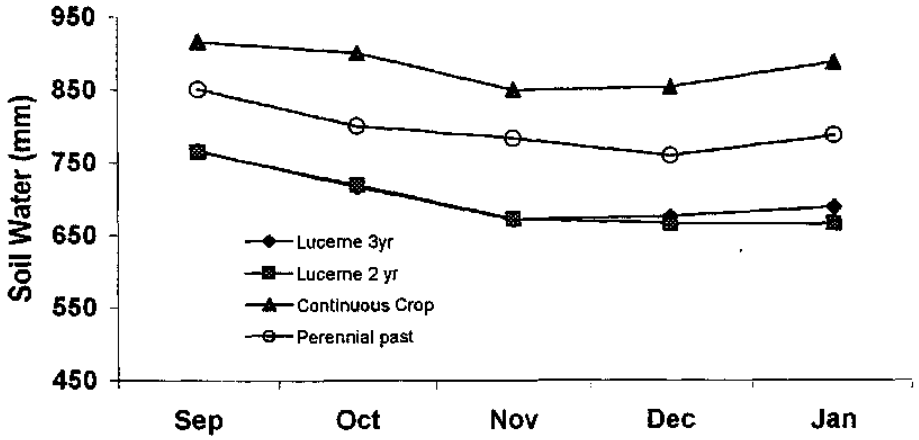

Figure 1. Total soil water content to 3 m depth from September 2003 to January 2004 under two and three year old lucerne stands, continuous annual cropping and continuous perennial grass pasture.

The location of the water in the soil profile can be seen in Figure 2 which shows the volumetric soil water content (% moisture) profiles in early September and mid November 2003. Soil water contents were much higher in the annual plots below 100 cm, showing that the annual crops had used less water at depth.

Available water in the 20-50 cm layer was rapidly removed in all treatments during this period.
Lucerne in some plots has now been removed and wheat will be sown in 2004, allowing the rate of recharge of the soil profile under annual cropping to be measured.

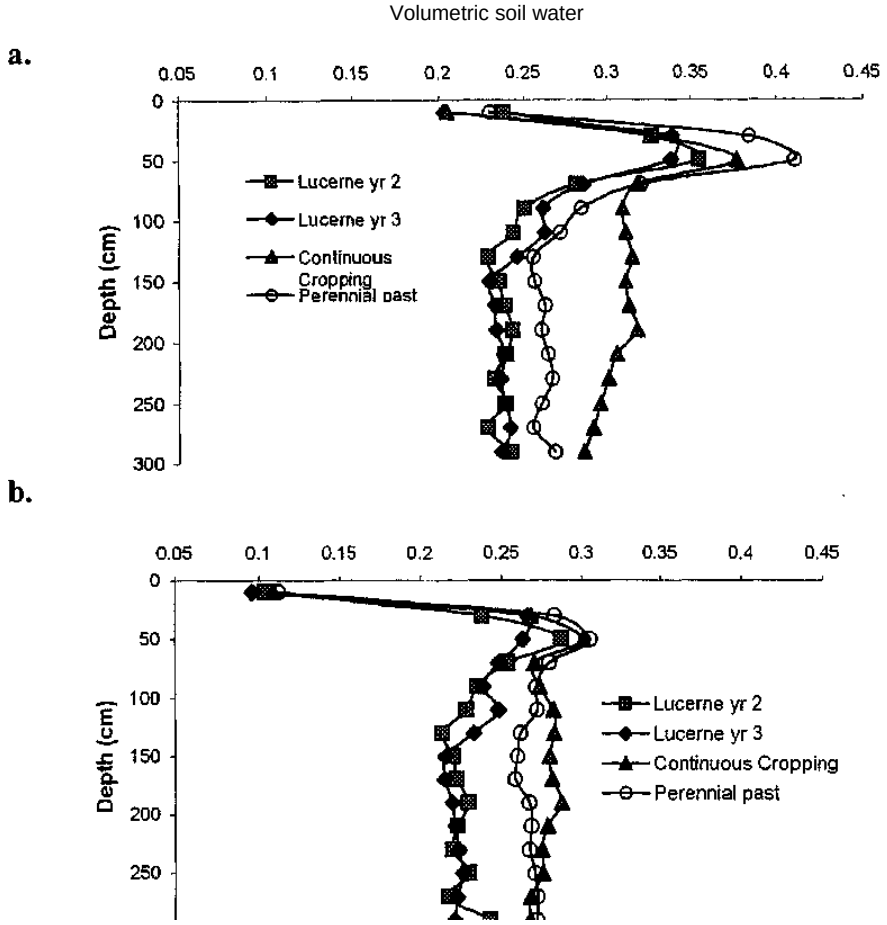

Figure 2. Soil water profiles under the four treatments in a) Sept 2003 and b) Nov 2003.

Experiments in 2004

Soil water monitoring will continue on the CWFS Core Site. In addition, there is a need to measure the rate and depth of water extraction under a wider range of soil moisture conditions than have occurred naturally so far in the years of the project.
In April 2004 we have set up plots in which the soil profile has been filled with water to differing amounts. Two sites are being prepared, one with a history of annual cropping and one a three year old lucerne stand. Annual crops (wheat and peas) and pastures (medic sub clover mix) and lucerne will be established on each site.

A second initiative is to measure soil water content under varying land management at 4 locations in the Condobolin region. This work is in collaboration with several Landcare groups and CSIRO, who will be measuring soil water potential and estimating deep drainage.