Salinity control

Clever crop rotations help mop up salinity

CSIRO Land and Water and CSIRO Plant Industry researchers Warren Bond, Chris Smith, Frank Dunin and Kirsten Verburg explain how farmers can modify their existing farming systems and include lucerne in the crop rotation to help in the continuing battle against salinity.

Adopting cropping methods which reduce deep drainage will help contribute to halting the spread of salinity, according to new CSIRO research.

Studies carried out by CSIRO Land and Water and CSIRO Plant Industry indicate opportunities exist for significantly reducing the potential for ground water recharge if farmers modify their existing cropping systems. One method of doing this is to include a lucerne phase in the crop rotation.

Most farmers are aware of how agricultural practices in Australia have contributed to the spread of dryland salinity. Excess leakage of water through the soil contributes to salinity, resulting in the widespread loss of land, income and biodiversity.

Using lucerne in the cropping rotation has been shown to reduce the risk of water leakage. Under-sowing with lucerne during the final year of the cropping phase and using objective measures to determine when to change from lucerne back to cropping are expected to further reduce this risk.

Research also suggests other farming options such as companion cropping with summer active, winter dormant species should be considered.

Native vegetation

Over the past 100 years, the clearing of native vegetation and the planting of crops and pastures have caused ground water levels to rise.

Native vegetation uses more available water from rainfall than most crops and pastures. When an area has been cropped, the excess water accumulates in the subsoil beneath the root system and leaks through to the ground water. This contributes to rising ground water, which may intersect the land surface, bringing with it reserves of salt which had previously been locked away from vegetation root systems.

This problem could be resolved by re-introducing woody vegetation but the amount of land needed would have a negative impact on cropping income, particularly in areas where rainfall is too low for commercial farm forestry.

Instead, CSIRO researchers are looking for ways to prevent excess water accumulating in the subsoil under crops, while maintaining productivity and profitability.

Paddock trials

Paddock measurements have been carried out at three properties in the Wagga Wagga district of New South Wales since 1997. Measurements of rainfall, evapotranspiration, soil moisture storage, deep drainage and crop yield were made in five paddocks containing rotations of canola, wheat and triticale crops. All paddocks have included a lucerne phase either before or during the monitoring period.

Measurements were also made at two sites in a nearby forest dominated by the native species white cypress pine, Callitris glaucophylla.

These measurements allowed comparisons of patterns of water use by cropping rotations with water use by native forest, and to identify the soil water processes operating. The data was then used to determine ways to modify farming systems to reduce potential groundwater recharge. Computer modelling has allowed the results to be extended over a longer time and climatic sequence.

Increased water use

The research showed that in the forest, water drained into the subsoil each winter but was extracted again during summer.

Summer water use was facilitated by the perennial nature of the trees and under-storey and the deep rooting systems of the trees. Although annual crops allowed less water to drain into the subsoil during winter, the lack of vegetative cover meant it was not extracted in summer (see Figure 1).

inbrief

• Adopting cropping methods which reduce deep drainage will help control the spread of salinity.

• CSIRO research shows using lucerne in the cropping rotation and under-sowing with lucerne during the final year of the cropping phase will reduce ground water recharge.

• Ongoing studies will look at the potential of other farming options such as companion cropping with summer active, winter dormant species and improved crop varieties to reduce subsoil water leakage into paddocks.

*Note: Positive values indicate storage of water; negative values indicate extraction. The cropping season is the period from March to December and the between crops period is December to April.

Source: CSIRO Land and Water and CSIRO Plant Industry.*
Accumulation of water in the subsoil eventually results in the subsoil filling up and water moving deeper to become ground water recharge. This can be likened to a leaking tap (the crop) filling up a bucket (the subsoil). When the bucket is full, it overflows (to the ground water).

To reduce ground water recharge methods must be found to empty the subsoil ‘bucket’ before it overflows, in the way that deep-rooted trees in forests do. Reducing the rate of water leakage by crops so the subsoil ‘bucket’ fills more slowly also is beneficial, because it increases the number of crops which can be grown before the subsoil fills up.

Phase farming with lucerne is currently the most effective option for reducing deep drainage and ground water recharge.

Water accumulates in the subsoil during the cropping phase and is removed from the sub-soil during the lucerne phase. This is because, like the forest, lucerne is perennial and has a deep rooting system — at least three metres in soils studied around Wagga Wagga — and is effective at ‘mining’ subsoil water (see Figure 2).

The results also show that although there is some drainage of water into the subsoil during the first winter of lucerne, more water is extracted from the subsoil within a year (see Figure 3). During its second year lucerne continues to extract large amounts of water from deeper in the subsoil.

**Long term lucerne impact**

Computer modelling was used to test the results and predict what impact lucerne phase farming would have on deep drainage over the past 40 years, using historical weather data from the Bureau of Meteorology.

For a fixed rotation length of three years of lucerne and three years of cropping (which has been suggested as best practice) deep drainage would be reduced by 60–80 per cent compared with continuous cropping.

The size of the reduction depends on specific model inputs and assumptions used and is likely to vary with climate, soil type, rooting depth of lucerne and a range of other factors.

**Flexible rotation**

The computer modelling shows there are periods when inclusion of a lucerne phase reduces deep drainage to values similar to native vegetation. It is only during years with above average rainfall that there is substantial deep drainage.

During a run of years with above average rainfall the cropping phase may need to be shorter to prevent deep drainage. When the rainfall is below average the cropping phase can be longer.

**Ongoing research**

Further research is expected to produce a range of options to help farmers reduce deep drainage. Developing other economically viable perennial plant systems with deep rooting characteristics which can empty the subsoil water storage in a similar way to lucerne is a priority.

Developing crop varieties which use more water during the growing season and therefore reduce the rate at which water accumulates in the subsoil also will be valuable.

Another option may be to introduce deep-rooted summer active, winter dormant companion crops such as continuous perennial pasture into the farming system. If selected properly, companion crops would not affect overall paddock productivity and may provide a method for emptying the subsoil water storage on an annual basis.

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