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Soil moisture network for better irrigation decisions in the Murray Valley

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Key findings

- Farmers in the Murray Valley show strong interest in an irrigation soil moisture network.
- A cost effective soil moisture network is possible with live soil moisture data easily assessable by growers.

Introduction

Recent results from the Murray and Murrumbidgee Valleys showed that 64% of monitored crops produced lower yields than expected from the volume of irrigation water applied ('Soils under an irrigated environment' project, ICF00008). Yield is lost at a rate of 1 t/ha for every five days of moisture stress and/or waterlogging between late August and mid October.

In most cases moisture stress occurs because the first spring irrigation is too late. It is important to note that the key to identifying these periods of potential stress is to monitor soil moisture and schedule irrigations to prevent moisture stress.

Both Victoria and South Australia monitor soil moisture using soil sensor networks using capacitance sensors with a focus on dryland systems. This project developed and trialled technology that enabled a soil moisture monitoring network in irrigated systems that used soil water potential sensors to be implemented cost effectively.

The project was designed to demonstrate to winter crop irrigators the advantages of irrigation scheduling and its potential to increase yields. It had two main objectives:

1. pilot the concept of a soil moisture network in an irrigated district to gauge acceptance and uptake
2. test the technology and its viability.

Method

Six sites within the Murray Irrigation Ltd area were selected that represented a range of climate, soil, and irrigation systems. Fields growing wheat were given preference when selecting sites to ensure a standard crop was being represented at each site.

Two irrigation systems were selected: border check and overhead sprinkler. These are common systems in the Murray Valley for irrigating wheat. Soil type at the sites, although important, was not prioritised over the geographic location. Crop, soil and irrigation type are listed in Table 1, and the site locations shown in Figure 1.

Figure 1. Map showing site locations. Table 1 provides additional detail.

Table 1. Details of each site monitored. Barley was selected at the Deniliquin site because wheat crops under sprinkler irrigation were not available.

Map reference	Site	Crop	Soil type	Irrigation type
A	Moulamein West	Wheat	Sandy loam	Centre pivot sprinkler
B	Moulamein East	Wheat	Self-mulching clay	Border check
C	Deniliquin	Barley	Billabong clay	Linear move sprinkler
D	Blighty	Wheat	Red–brown earth	Border check
E	Finley	Wheat	Red–brown earth	Linear move sprinkler
F	Berrigan	Wheat	Red–brown earth	Border check

Soil water (matric) potential sensors (Irrometer Watermark™ 200SS) were installed as they measure the suction (in kPa) required by plants to extract water from the soil. They have an advantage over other soil moisture sensors as they do not need to be calibrated for different soil types, ensuring that readings from all sites are comparable. All sites were installed by 6 August 2018. Crop growth stage and tiller count were recorded at this time, and a photo of the crop was taken to help other irrigators assess how the monitored site compared with their own.

Two depths (three replicates of each) were measured at each site: 15 cm and 30 cm at the overhead sprinkler sites and 30 cm and 45 cm at the border check sites. Because plants experience drought stress when the matric potential at the bottom of the active root zone exceeds –60 kPa, the shallower depths – readings from the 15 cm at overhead sprinkler sites, and 30 cm readings at border check sites – were used for the suggested irrigation triggers.

Telemetry, developed within the project, allowed the soil sensor network and live access to the data to be cost effectively implemented.

WiFi-enabled microcontrollers (Electric imp001) were used to pull data from Irrometer 900M loggers and post the data to Google sheets.

A public website (http://murrayvalleysoilmoisture.site/) was built to host the graphs and data from Google sheets and to make this data available to growers. Figure 2 shows an example of how the data was presented on the website. The predicted time for the next irrigation was displayed in both a table and also as a line drawn in the graph. This was calculated by finding the slope (rate of decline) between the most recent reading and the 24-hour reading before this (two readings 24 hours apart). The slope was then extrapolated to the trigger point of –60 kPa; the point of interception was used as the forecast irrigation date. All the calculations were done in a linked Google sheet allowing an automatically recalculated forecast every time a new soil moisture reading was uploaded.

The website also included basic paddock information such as the previous crop, soil type and sowing/top dress time and rate to enable other growers to compare the monitored crops with their own.

Google analytics was used to gauge the acceptance and uptake of the soil sensor network. This allowed important usage metrics to be gathered such as users to the site, number of times they revisited the site and total page views.

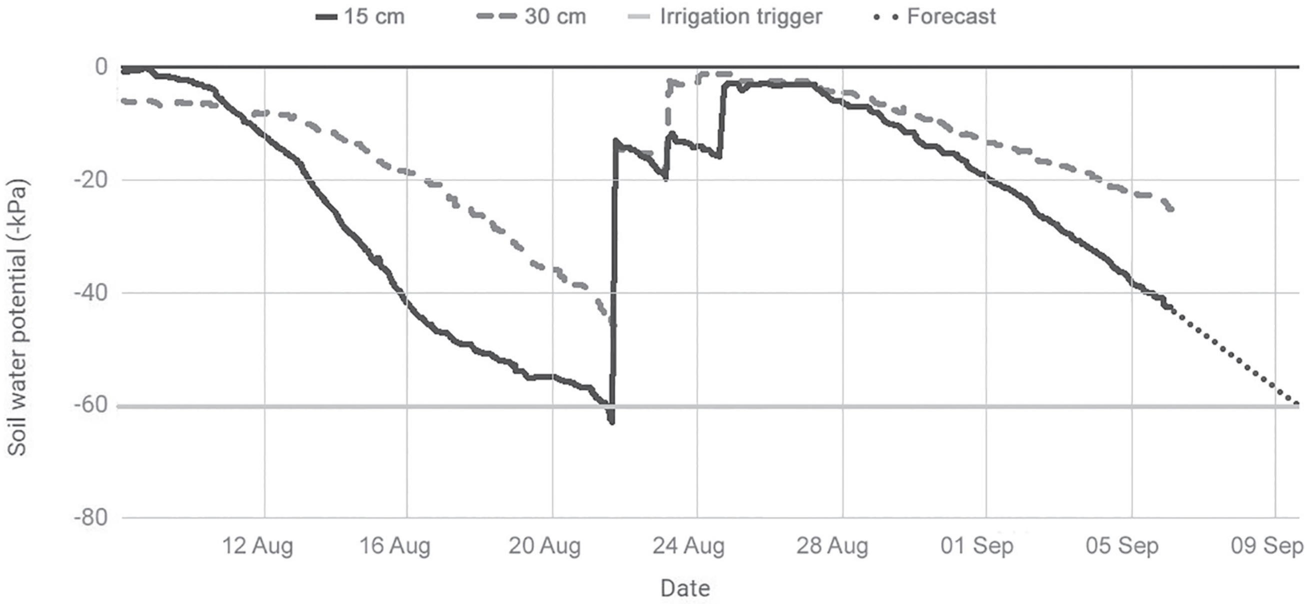

Figure 2. An example of a soil water potential chart from an overhead irrigation site displayed on the website.

Results

The website that hosted the data from the soil monitoring sites had 1,619 page views by 112 users from when the website went online (8 August 2018) through to the end of October. The average session lasted just over five minutes, in which time the user looked at five pages/sections.

The cost-effective telemetry meant that there were no subscription fees, which can be as high as $30/month/site through commercial providers. The only ongoing cost was for a data plan, which was $70 per six months for each site.

Discussion

This pilot was run in 2018, a year that received below average rainfall (Finley NSW received 125 mm, considerably less than the long-term average of 390 mm). Due to the dry season, soil moisture monitoring was not required to schedule the first irrigation – crops were irrigated as soon as water was available through the supply channel.

It was anticipated that the website would be publicised by the Murray Local Land Services extension network amongst irrigators. However, this was not done as irrigators did not need it to trigger the first irrigation, as well as small issues with the technology early after implementation. Despite not being actively publicised, the website still reached 112 users who, on average, visited the site three times, showing that there is interest in this type of information. This indicates that growers possibly see value in the soil network to schedule subsequent irrigation, and the experiment would have benefited from the network website being publicised.

The soil moisture network and associated technology developed for this project was effective. However, there were some issues early after deployment due to the telemetry in low reception locations increasing the power consumption. Larger solar panels and external antennas resolved the issue, ensuring reliable data transmission, increasing the confidence in the technology.

If a soil moisture network similar to the one used in this project was made available permanently, and it was adopted by growers, there is the potential to lift irrigated wheat yield by 1 t/ha through reduced waterlogging and drought stress. The network also creates the opportunity to add live agronomic messages about each crop to remind growers of key actions related to growth stages, making it a valuable resource for irrigators.

Acknowledgements

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