Utilising Soil Water Sensing and Modelling to Guide Grower Decision Making in Dryland Cropping Systems – A Case Study

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Abstract
A focus paddock established in 2011 as part of a GRDC funded extension project near Salter Springs in the Lower North of South Australia provides a valuable case study on integrating soil water sensing and crop modelling to guide grower decision making. In the focus paddock, a sub surface capacitance probe together with *Yield Prophet*^{TM} (Hochman *et al*. 2009) and the CSIRO Your Soils Potential Yield and Nitrogen Calculator (Baldock *et al.* 2005) were utilised to help guide post emergent nitrogen fertiliser applications on a durum wheat crop.

Both sensing and modelling approaches proved extremely useful in providing the grower with confidence to apply post emergent nitrogen fertiliser in a challenging season based on indicated yield potential, with the focus crop successfully achieving high yields and high quality. In most instances, the approaches were consistent in indicating the trends in plant available soil moisture, although the absolute amount of predicted PAW differed between methodologies.

Key Words
Soil water, monitoring, capacitance probe, sensors

Introduction
There is considerable debate amongst soil water researchers and advisers about the pros and cons of estimating plant available water via sensing (i.e. capacitance probes) or by soil moisture/crop models to aid decision making by growers.

In 2011, a GRDC-funded extension project conducted in the lower North cropping district of South Australia involved grower groups establishing focus paddocks where soil moisture sensing and modelling was employed in tandem to compare and contrast the two approaches. The aim was to improve understanding of grower participants in soil moisture estimation, to evaluate the appropriateness of sensing and modelling approaches in guiding decision making during the growing season, and to assess the merit in integrating the two approaches.

One focus paddock near Salter Springs provided a valuable case study where integrating the two approaches guided grower decision making on nitrogen fertiliser management with successful outcomes in a challenging season.

Methods
The Salter Springs focus paddock was situated on a clay loam soil type with a sub surface capacitance probe including an automatic rain gauge and telemetry unit installed at the site in 2009

In April 2011 core samples were taken to a depth of 1m in the vicinity of the soil moisture probe with subsamples taken down the profile at 15 to 30 cm intervals. The samples were analysed by CSBP Laboratories for the standard *Yield Prophet*^{TM} suite of tests; nitrate and ammonium nitrogen, electrical conductivity, chloride, pH, moisture content and organic carbon (0-10cm).

The paddock was subsequently sown with WI803 durum wheat on the 15th of May. During the growing season APSIM modelling was undertaken using the *Yield Prophet*^{TM} program, using reference soil characterisations sourced from CSIRO's APSoil database(Dalgliesh *et al*. 2012). The grower also monitored potential yield outcomes and associated nitrogen requirements using the CSIRO Your Soils Potential Yield and Nitrogen Calculator (Baldock *et al.* 2005)

Soil characterisation was undertaken in 2011 by CSIRO Ecosystem Sciences to provide more specific assessment of Drained Upper Limit (DUL) and Crop Lower Limit (CLL) (Dalgliesh and Foale 1998) with the aim of retrospectively evaluating the accuracy of APSIM simulations.

During the subsequent growing season the grower, together with members of his crop production group, monitored the *Yield Prophet*™ simulations and the soil moisture probe outputs to track plant available water, crop yield potential and nitrogen requirements as a basis for nitrogen decision making and group discussion.

At the end of the season, the crop was harvested with a commercial harvester fitted with yield monitoring equipment to assess grain yield in the vicinity of the moisture probe, and grain protein was analysed at the San Remo durum receival point at Balaklava using a standard NIR analyser.

Results

Critical events and decisions made in the Salter Springs focus paddock are detailed below:-

- February commenced with a full soil moisture profile (120mm PAW as indicated by the soil moisture probe), following high rainfall over the December-January period.

- February – March: Continued rainfall events during February and March maintained high soil moisture levels into April.

- 19th April: Soil water and nitrogen tests indicated 129 kg/ha of soil nitrogen in the top 1m of soil and a near-full profile of plant available water (140 mm as indicated by *Yield Prophet*™ - Figure 1; 120mm as indicated by the soil moisture probe – Figure 3).

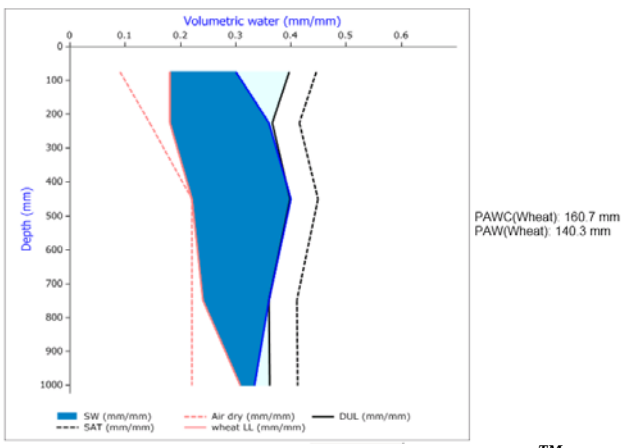

Figure 1: Soil moisture as indicated by Yield Prophet™ at the Salter Springs focus paddock on the 19th of April 2011.

- May 15th: The crop was direct drilled with a disc seeding unit together with 18kg of N. The soil moisture probe indicated 95mm of Plant Available Water (Figure 3).

- June to July: The growing season rainfall tracked at Decile 1 based on Bureau of Meteorology rainfall records (Figure 2).

- On the 4th of August the grower elected to apply an additional 46kg per ha of nitrogen as topdressed urea. Using the CSIRO Your Soils Potential Yield and Nitrogen Calculator, this application together with stored soil nitrogen measured in April and N applied at seeding and allowing for potential mineralisation, would effectively supply the crop with sufficient nitrogen to achieve a grain yield of 4.9 t/ha at 13% protein (DR1 quality)

- September 5th:- Growing season rainfall continued to track at Decile 1 (Figure 2).*Yield Prophet*™ predicted a 50% probability of achieving 5.6t/ha yield, and a 20% probability of achieving 5.8t/ha,

however, additional nitrogen would be required to reach this potential. At the time, soil moisture was reducing rapidly due to the lack of winter rainfall.

- September 26th : Rainfall was forecast for the region. The grower, with the information available, decided that if greater than 5 t/ha of grain yield was still possible, the crop was unlikely to meet the 13% protein requirement for DR1 grade. As a result, the grower made the decision to apply an additional 46 kg/ha of N and received 40 mm of rainfall in the three days following the application.

- Using the CSIRO Your Soils Potential Yield Nitrogen Calculator, the additional nitrogen applied together with soil N measured in April, N already applied as fertiliser, together with potential mineralisation, would have supplied sufficient N to achieve 5.7 t/ha of grain yield at 13% protein (DR1 quality).

- November: *Yield Prophet*™ predicted final yield – 6.1 tonnes per hectare (Figure 4).

- December: The crop was harvested using a commercial harvester. Grain yield in the vicinity of the moisture probe was 6 t/ha, at 13.8 – 14.2% protein. DR1 quality was achieved

- Using the CSIRO Potential Yield and N Calculator retrospectively, if the additional urea was not applied in September, a 6t/ha yield could still have been achieved, however grain protein would have struggled to reach 11%. As a result, the crop would have achieved DR 3 quality with potential price discounts of between $50 and $65 per tonne. Over a 6 t/ha grain yield this represents a potential value of between $300 and $390 per hectare.

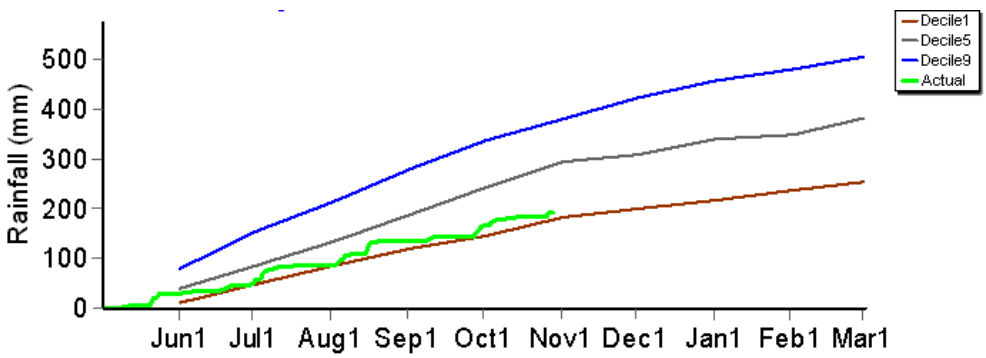

Figure 2: Growing season rainfall deciles versus actual rainfall for the Salter Springs focus paddock in 2011.

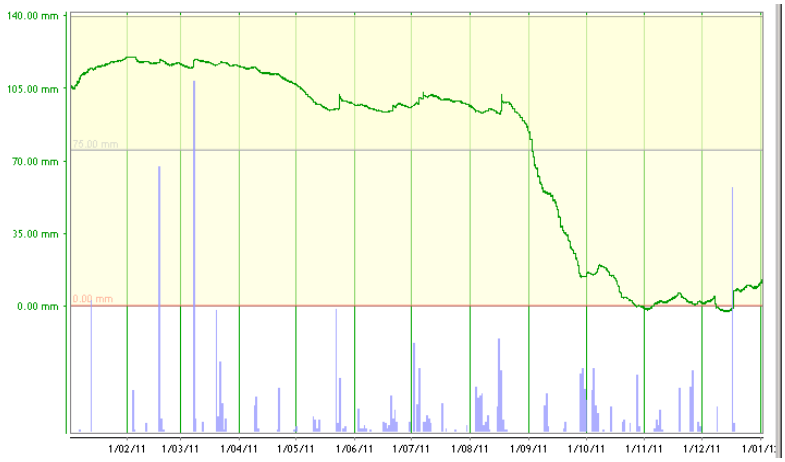

Figure 3: Plant available water estimated by a sub surface capacitance probe at the Salter Springs focus paddock in 2011.

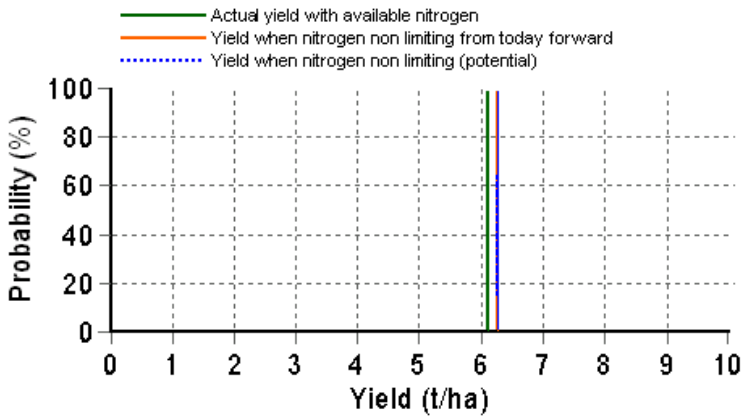

Figure 4: Yield Prophet™ predicted yield outcomes, November 2011 for the Salter Springs focus paddock

Conclusions

Both sensing and modelling approaches proved extremely useful in guiding grower decisions on post emergent nitrogen applications based on indicated yield potential. In most instances, the approaches were consistent in indicating the trends in plant available soil moisture, even though the absolute amount of PAW differed between methodologies.

The combined outcome was that the information did provide the grower with increased confidence in basing decisions on the sensing and modelling outputs. This outcome is illustrated by the following quotes made by the grower.

"*Without the information behind me I would have not have the confidence to apply the amount of urea in September as I did"*

"Yield Prophet was telling me that I still had available soil moisture for at least two weeks. The soil moisture probe was saying the same thing and the Nitrogen Calculator was telling me I was underdone on N inputs if yield was going to be greater than 5 t/ha".

"With a strong rainfall forecast for late September, I thought I had to go for it, with the end result of 6t/ha of DR1 quality grain and a gross margin of over $1500 per hectare".

For the grower groups involved, a high level of learning and understanding of sensing and modelling approaches was achieved by participating growers, and insights into how the information could be used to assist risk managed input decision making.

Acknowledgement

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