Sensing for precision irrigation

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Irrigators and regulators in New Zealand are looking at irrigator efficiency and soil water holding capacities at irrigation to try and optimise the freshwater available to the crop.

Spatially identification of soil zones that dry out faster and trigger the need for irrigation could improve irrigation efficiency.

Collaborative research between the Centre for Precision Agriculture at Massey University, New Zealand, and Landcare Research, a New Zealand crown research institute for environmental research, is developing new proximal sensing methods for mapping soil water status. This information could be uploaded to the software operating system of a variable rate irrigator for better use of irrigation water.

World consumption of water is doubling every 20 years – at twice the rate of global population increase. This is largely because worldwide intensification of land use, which has successfully fed the world's population over the last few decades, has increasingly relied on irrigation. Today 70% of global freshwater extractions are for irrigation, with significant dependency on irrigation for food production in some parts of the world, eg. 70% of China's grain crops are irrigated, compared with approximately 25% in New Zealand and 15% in USA. The challenge for the coming decades will be to increase food production with less water.

Irrigation accounts for about 80% of allocated freshwater in New Zealand, and while grazing land is by far the biggest user (78%), arable and horticultural users are more reliant on irrigation.

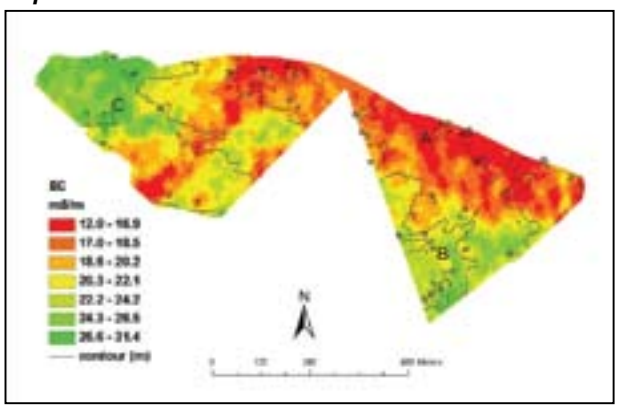
Increased dependency on irrigation, due to agricultural intensification, coupled with significant regional droughts in recent years has resulted in water restrictions being placed on water consent holders during periods of peak demand.

Strategic water use involves withholding irrigation water from parts of the agricultural system at certain times and at certain places. Withholding irrigation water from certain places within a field requires a suitable irrigation system that can deliver different amounts of water to different parts of the field.

Irrigation systems vary significantly – both in design and efficiency. Flood irrigation systems may be only 50% efficient, or worse. That is if 30mm of water is the target delivery, anywhere between 15mm and 45mm is actually applied. Centre pivot irrigation systems are the most accurate and can be expected to be at least 80% efficient.

Our present research uses an electromagnetic induction (EMI) sensor to map soil variability and from this information management zones are identified. The plant available water-holding capacity of each management zone is measured by taking soil samples between very wet and very dry. We also use three metre soil moisture sensors to monitor soil moisture to 60cm soil depth, on an hourly basis in each management zone, as well as taking other soil moisture measurements. This enables us to calibrate the EM map for plant available water-holding characteristics, so that a soil moisture map can be produced (Figure 1).

Figure 1. An EMI (electromagnetic induction) map of 33ha maize field identifies contrasting soil management zones, which can then be characterised for differences in their ability to supply water to the crop. Matching irrigation to soil/crop requirement could lead to yield improvements of 3 to 4t of maize.



A daily time step is then added to this soil moisture map so that as soils dry out, the zones which dry out fastest, and therefore reach the trigger point for irrigation are identified spatially. Our research is currently developing these daily updated soil moisture maps. The next stage of our research will be to upload this information to a variable rate irrigator for precision control of irrigation waters to the crop.

For more information
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