Precision Irrigation Scheduling

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Manaaki Whenua

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What is Precision Irrigation Scheduling?

- Precision irrigation scheduling varies irrigation at any one time under one irrigation system according to soil and crop differences.

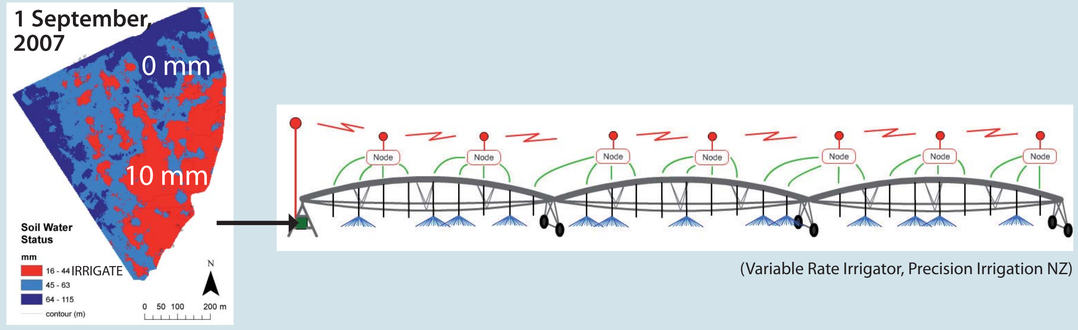
Why is Precision Irrigation Scheduling Important?

- Where variable soils exist under one system, then irrigation should ideally be varied according to these soil differences.
- Sprinkler irrigation systems in New Zealand typically cover 50 to 200 hectares and often traverse highly variable soils.
- It is estimated that the majority of the approximate 750,000 hectares of irrigated land in New Zealand would benefit from precision irrigation because the ability of the soils to supply water to crops is variable - highly variable (e.g. the silty, sandy and stony soils of the Canterbury Plains).

How Does Precision Irrigation Scheduling Work?

- A method has been developed, using on-the-go electromagnetic (EM) soil survey to map the available water-holding capacity (AWC) of soil under one irrigator.
- Daily soil moisture is then monitored to determine when irrigation is required in each AWC zone (Red = Irrigate).
- The derived daily soil water status maps can be uploaded to Precision Irrigation software to drive a fully modified variable rate irrigation system, (Fig. 1).

Figure 1

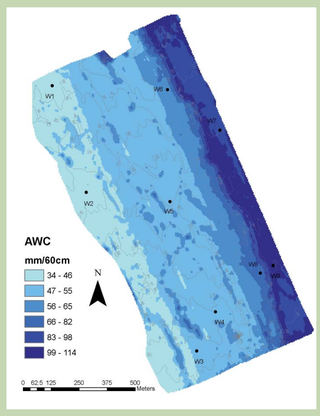


(Variable Rate Irrigator, Precision Irrigation NZ)

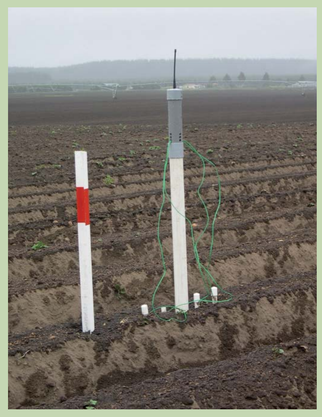
Precision Irrigation Scheduling in Action

- EM mapping is used to define and quantify soil variability.

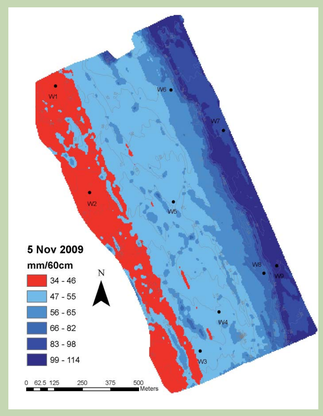
- EM zones are ground-truthed and soil sampled to assess the soil AWC.



- The AWC map is produced.



- Soil moisture is monitored in each zone on the AWC map.



- Irrigation scheduling is varied according to different soil AWCs (Red = Irrigate).

What are the Economic and Environmental Benefits of Precision Irrigation Scheduling?

- Desktop studies (2004–2008) at six research sites suggest that in any one year variable-rate irrigation saves between 9 and 26% of irrigation water, with accompanying energy savings (27 – 77 $kgCO_2$-eq/ha/yr) (Table 1).
- This water can be redirected elsewhere increasing irrigation water use efficiency (dry matter production per millimetre of water applied).
- Irrigation is used more efficiently because soil moisture in the root zone is maintained in the optimum range – not too wet and not too dry, aiming for no plant stress.
- Variable rate scheduling delays irrigation to soil zones with larger AWC, utilising the ability of these soils to hold and supply more water to plants.
- Studies show that runoff and drainage are reduced by up to 55%, which reduces risk of nitrate leaching (Table 1).
- Variable rate irrigation is particularly useful where soils are variable and crop planting date is staggered. For example, potato crops are often planted in sequential blocks over a period of several weeks; and timing and amount of irrigation is critically important for potatoes. Potatoes are drought sensitive and require adequate moisture three weeks after tuber initiation to avoid common scab. However, over-watering also causes disease. Precision irrigation scheduling will potentially increase potato yields by 20–30 T/ha (Wilcox Growers, pers. comm.).

Table 1: Summary of the potential benefits of precision irrigation at six case study sites

Site	Land use	AWC range* mm	Irrigation water saved %	Drainage/Runoff saved during period of irrigation %	Energy saved $kgCO_2$-eq ha^{-1} y^{-1}	Reduced N leaching kg ha^{-1}
1	Maize grain	160–164	26	0	77	-
2	Pasture	77–132	10	19	27	-
3	Maize grain	105–190	12	22	38	-
4	Pasture	44–101	9	55	40	3
5	Maize grain	85–329	21	40	67	0
6	potatoes	81–186	15	29	30	2.5

*AWC = AWC + Capillary rise at Site 5; AWC range calculated for the root zone depth, which is 60 cm (pasture, potatoes) and 100 cm (maize grain).

How to Decide Whether to Invest in Variable Rate Irrigation?

- A cost saving of between about $61 and $150/ha/yr is expected if precision irrigation is employed on variable soils.
- Rule of thumb:
  - 10% water saving where soil AWC varies by 50 mm
  - 15% water saving where soil AWC varies by 100 mm
  - More than 15% water saving where soil AWC varies by > 100 mm
- Additional benefits include the ability for mixed cropping, better control of applied water at either end of the pivot, site specific chemigation and fertigation, and the ability to shut off water onto exclusion zones, such as raceways.

Plans for Commercialisation and Uptake

- The EM mapping gear is subcontracted to Precision Irrigation and Spatial Solutions by Massey University and Landcare Research, for commercial jobs, enabling an affordable service as required.
- AWC maps are produced commercially by Landcare Research in collaboration with Precision Irrigation.
- Landcare Research is developing affordable wireless soil moisture sensors networks for possible integration into the Precision Irrigation commercial package.
- Landcare Research and Precision Irrigation are working with farmers to facilitate uptake of this new technology.

ACKNOWLEDGEMENTS: Precision Irrigation NZ; NZCPA, Massey University; Hew & Cecilia Dalrymple, Eric & Maxine Watson, Monty Spencer, and all the other land managers who have participated in this research. Funding assistance: AGMARDT and William Georgetti. Graphics assistance: Nic Faville.