Smarter irrigation using variable-rate centre pivots

By Dr Alison McCarthy[1] and Dr Joseph Foley[2]

THERE can be over 200 per cent variation in crop water requirements within a single field. But irrigation is typically applied uniformly over the field, leading to overwatering in some areas and underwatering in other areas of the field. Variable-rate irrigation technology allows growers to apply a spatially variable pattern of irrigation to the field under centre pivot and lateral move irrigation machines equipped with solenoid valves on every dropper. These systems provide the potential of precisely applying the irrigation depth that will meet the specific requirements of the soil and crop at all locations across the field. The challenge is determining this spatially variable requirement for each irrigation.

Research on automated variable-rate irrigation prescription map development is being conducted at the National Centre for Engineering in Agriculture (NCEA), a research centre within the University of Southern Queensland (USQ) in a project funded by the Australian Government Department of Agriculture & Water Resources, as part of the Rural Research and Development for Profit program, led by the Cotton Research and Development Corporation 'Smarter Irrigation for Profit'. This project is also partnering with Dairy Australia, Sugar Research Australia, CSIRO and Tasmanian Institute of Agriculture.

Dr Alison McCarthy, Simon Kelderman and Annabel Twine flying drone for cotton imagery collection. (PHOTO: Warwick Waters

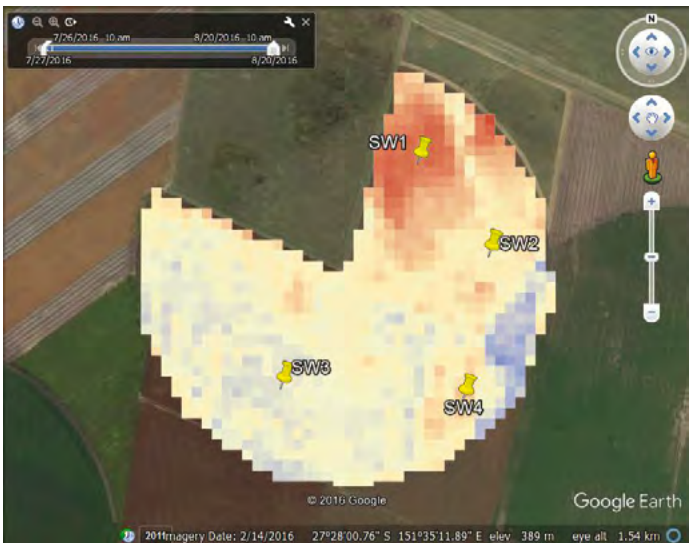
Individual sprinkler variable-rate hardware on centre pivot irrigation machine.

Machine mounted crop camera collecting imagery of cotton cover and fruiting as machine passes over field

The Smarter Irrigation project is evaluating irrigation decision-making systems that combine field sensors, crop and hydraulic models with irrigation control strategies to allow the system to automatically determine the optimal way to irrigate the crop. These layers of information are analysed in the 'VARIwise' software developed by Alison McCarthy at NCEA. VARIwise incorporates weather forecasts, soil moisture monitoring and crop growth monitoring and prediction to determine irrigation requirements over the forecast period.

Variable-rate irrigation prescription maps are currently typically generated using historical electrical conductivity maps, or networks of infield soil moisture or infrared crop temperature sensors. VARIwise incorporates this information with additional data on the crop growth stage and weather forecast to enable irrigation optimisation. Field trials have demonstrated a five to 12 per cent yield improvement, and a 10 to 11 per cent water saving using this adaptive irrigation control.

Trials are being conducted by NCEA in the 2016–17 season to evaluate the software and hardware components of the variable-rate centre pivot irrigation using VARIwise on a seven span centre pivot site growing cotton near Yargullen in Queensland. This has involved installing remotely accessible variable-rate hardware on the centre pivot. The variation in soil properties was measured across the field using an electrical conductivity sensor and soil coring. Soil moisture sensors were installed to measure at three depths in four locations over the field.



Electrical conductivity map and location of soil moisture sensors on irrigated cotton crop.

Low cost cameras on the irrigation machine track the development of the crop by detecting leaf cover and fruit numbers. Cameras installed on the irrigation machine enable unassisted data collection as the machine passes over the field. These cameras are smartphones operating with an App that collects and uploads an image and GPS location when the irrigation machine moves around the field. Image analysis algorithms automatically extract growth, square, flower and fruit counts to populate the crop model in VARIwise.

VARIwise is capable of generating a prescription map that is approved and/or modified by the farmer before being transferred to the centre pivot panel. An interface is being developed to automatically transfer irrigation prescription maps to Valley and Lindsay Zimmatic variable-rate irrigation hardware. This has the potential to create a fully automated irrigation system that can be started when irrigation is required, and will apply water as determined by the infield sensors and optimisation algorithms contained in VARIwise.

As a trial in the cotton industry, the cameras and image analysis processes are also being evaluated using Unmanned Aerial Vehicles (UAVs) at sites near Griffith, Boggabri and Talwood in conjunction with CottonInfo Regional Extension Officers. UAVs enable wider data and image collection on cotton fields at a flexible time interval. This will provide industry validation of the capability of UAVs to collect high resolution imagery necessary for the plant growth and fruiting detection needed in the VARIwise software.

This project is also evaluating the cameras and automated prescription map development for dairy pasture under two centre pivot irrigation machines in Tasmania, surface irrigated cotton near Wee Waa, and sugarcane near Ayr. These infield smartphone cameras are also being used to automatically estimate dairy pasture height and sugarcane height.

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