Aaron uses his phone to check irrigation automation in his sugarcane paddock. (PHOTO: Steve Attard)

In collaboration with the Society of Precision Agriculture Australia, Australian Sugarcane presents a series of articles on a wide range of precision agriculture technologies helping you put PA to Work on your farm.

Sweet success for automated irrigation

By Emma Leonard for Society of Precision Agriculture Australia (SPAA)

A QUEENSLAND sugar farmer has worked closely with teams of researchers developing a system to automate furrow irrigation in sugarcane. His involvement is now paying dividends.

Living 35 kilometres from his 95-hectare block of sugarcane meant that each year Aaron Linton used to spend about 170 hours driving to, from, and around the farm. Added to this was the 11,000 km he drove for the 220 trips just to set up, or switch off, his irrigation each year.

Aaron, a third-generation canegrower, purchased this farm in 2010. It is set up in 11 unequal blocks, with 42 hectares under drip irrigation and 53 hectares under furrow irrigation. Water is pumped from the Burdekin River, from two pumping points, and drainage water from the furrow irrigation is recycled through the drip system.

Two years after purchasing the farm, Aaron started addressing automation: "I automated the drip irrigation but that did not help overcome the time commitment of running the furrow irrigation, so I wanted to change that."

Saving time was not his only motivation to automate the furrow irrigation. He was very keen to reduce any run-off into the

Top PA tips…

- Investing in irrigation automation hardware based on modifying current infrastructure returned an annual cost benefit of $184 per hectare.
- Automation has allowed new approaches to irrigation to be tested, to better match soil conditions.
- Adding Uplink and Downlink software has transformed the automation from precision agriculture to digital agriculture removing manual scheduling.
- Peace of mind and saving over 300 hours each year are the greatest benefits to Aaron.

Aaron Linton is a third-generation canegrower on the Burdekin.

Farm details…

Location: Leichhardt, Queensland.

Farm size: 95 hectares.

Rainfall: 865mm plus irrigation from the Burdekin River.

Soil: sandy loams overlaying clay loams along the river bank, transitioning to loamy clays. pH typically 7 to 7.5 in the top 200 mm. Sodicity and increased pH occur at depth.

Enterprises: Sugarcane.

Personnel: Aaron Linton.

FIGURE 1: Showing the 11 blocks, six actuator control radios (C), river pumps each fitted with a pressure transducer (P1, P2), end pit monitoring node (M) and the three furrow drain probe sensors (▲) that cover blocks 1 to 4, 5 to 8 and 9 to 11

environment as well as increase water use efficiency and reduce running costs.

In most of Australia, furrow irrigation uses gravity, via unlined earthen channels for distribution and siphons or gates for in-field application.

But the cane industry generally pumps water via low pressure underground pipes that deliver water to each block. From here, a vertical riser delivers water to the surface where it passes into a 250 to 350 mm flexible walled gated pipe, with outlets, often referred to as cups, located at each interrow.

Traditionally, water is released into a block and it is manually estimated when water reaches the end of the furrow and needs to be switched off.

Furrow automation

In late 2015, Aaron's farm became one of three involved in a large-scale trial for automated furrow irrigation, run by the Centre for Agricultural Engineering, University of Southern Queensland and funded by Sugar Research Australia. A scoping study of available technologies for automation and in-field water distribution equipment identified WiSA radio-controlled systems to be the most appropriate. The WiSA base station is the communication point between the AquaLink software running on a computer and the eight radio nodes located at each control or monitoring point.

"For the trial, our current infrastructure and original control valves were adapted to minimise cost. Eleven electric actuators were added to the linear butterfly valves and we constructed the bracket mountings in the workshop."

The layout of the blocks and the equipment is illustrated in Figure 1. This shows the paired location of most of the valves enabling two actuators to be controlled by one radio node. The WiSA nodes used in the trial only allowed complete opening of the valves but partial opening options are available.

Monitoring

There are two key areas that require monitoring – water flow and identifying when water has reached the furrow end. Water pressure in the concrete riser cylinders is measured. If a pump fails, the pressure in the riser is outside a defined range and an alarm set to message (via SMS) Aaron or to automatically switch off the pump. Due to layout of the irrigation supply system a single electronic pressure sensing transducer (control node) was installed which can monitor all valves connected to the common supply.

TABLE 1: An example of the variation of end of row sensors' times in minutes for four blocks recorded between May and November 2016

	Block 1	Block 2	Block 3	Block 4
Max time	1595	1559	1338	1153
Min time	568	1273	840	885
Average	869	1442	1006	999

Block 1 shows a variation from 9.5 to 26.6 hours. (Source M.Gillies, et al.)

To monitor water front advance, three soil moisture sensors (drain probes) were buried in the drain leading to the drainage pit, with data captured by two end-of-field radio nodes. The data, such as time of outflow, again is communicated back via the radio links to AquaLink software. The AquaLink records data, triggers an action to close valves and open others, or to switch off the pump. Table 1 shows the end-row sensor times for four blocks on another of the trial farms. The variation in the maximum and minimum time for the end-row sensors shows that a fixed irrigation time is not appropriate. Instead flexibility by block, field and crop conditions is required.

FIGURE 2: Breakdown of savings per hectare from the automation of furrow irrigation for a 54 hectare sugarcane block

"Having this peace of mind that the system is working without my intervention is a huge benefit; being able to access the computer remotely and see what is actually happening gives me confidence in the system."

Saving opportunities

Labour savings represent a huge benefit to Aaron due to his remote location from the farm. But automation also enables him to irrigate during off-peak electricity tariffs. Using the automation to control start and stop times has allowed him to convert from Tariff 66 to Tariff 62, saving over $6000 a year.

Part of the project was to complete a full cost analysis for the installation and operation. Figure 2 illustrates the breakdown of costs with saving in vehicle repairs and maintenance and fuel and pumping cost savings also significant. It roughly costs $50 a megalitre to pump water, so stopping water appropriately results in substantial savings in these costs.

The annual benefit is $378 per hectare, and the annual cost benefit is $194 per hectare.

"The cost savings and overall cost benefit against the investment of $68,365 dollars is great. Plus, we have minimal run-off. But the fact that I have recouped over 250 hours that I use to spend with my family and on managing other aspects of the business is the biggest win for me."

While Aaron's biggest saving related to labour and travel, other farms in the project gained the most from reduced pumping time. All farms saw significant yield improvements from the automation of furrow irrigation due to less plant stress.

More appropriate irrigation

When to stop is only one part of the irrigation equation: knowing when and how much to irrigate are other vital elements. By better matching water applied to crop need, yield can be improved due to less water stress through, under and over watering.

Aaron has been using the irrigation scheduling tool from SQR Software 'IrrigWeb' with the Canegro model. IrrigWeb uses soil water deficient and estimated crop water use to provide the amount of irrigation water required. This information is currently calculated from initial set-up data plus manually uploaded rainfall and actual irrigation data, which needs to account for deep drainage and run- off. With the support of IrrigWeb, Aaron could then calculate the irrigation schedule based on the soil's hydraulic group and off-peak timing for the electricity. For example, some blocks have poor lateral soakage, so water runs through very quickly, even with low flow rates.

With automation Aaron has been experimenting scheduling multiple short one hour irrigation events over different time periods.

"This pulse style of irrigation would have been far too time consuming without automation, despite the fact we were wasting 20 to 30 per cent of the water as run-off. The IrrigWeb system helps me calculate the correct amount of water per application for these slow infiltration blocks."

To move his automated irrigation system from a precision to a digital approach, Aaron has been using an Uplink program developed by the National Environmental Science Program's Tropical Water Quality Hub led by researchers at James Cook University and funded by the Australian Government's Department of Environment and Energy. The Uplink program automatically gathers the irrigation and rainfall data from the WiSA system eliminating the need for records to be manually inputted into IrrigWeb.

It has been estimated that using the Uplink program saves Aaron a further 64 hours per year.

To fully automate the system a Downlink program was required to download, calculate and apply irrigation schedules automatically.

The Downlink program continues to be refined but initial trials reported further time savings, the ability to match or improve grower-based scheduling and to prioritise fields according to irrigation availability.

"The capacity for the Downlink program to account for infrastructure limitations, such as pump capacity at peak times, is valuable. Overall the Uplink and Downlink systems are helping improve yield and save water and energy inputs," he says.

But the fact Aaron can trust the systems and has more time to spend with his young family is the greatest payback on his investment in automation.

Further information, including full costings is available on the Sugar Research Australia website: ***www.sugarresearch.com.au/ growers-and-millers/ farming- systems/***

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