Looking beyond the basics to optimise irrigation

By Lou Gall – Project Officer, Gwydir Valley Irrigators Association

As irrigators and cotton growers, we are so often at the centre of discussions about water use in agriculture. For over 10 years the irrigation industry has been actively working in irrigation research to ensure that producers are able to maximise the productivity that they are able to achieve with the limited water that is available.

Any irrigation decision factors in a whole range of issues from water availability, through to the plant growth stage, soil characteristics, weather conditions, and the farm resources or management objectives. No two farms will be the same, but there is most likely something every farm could do to improve their irrigation efficiency. The Smarter Irrigation for Profit Phase 1 project found that improved water productivity hinged on getting the basics right. This may be conducting an audit on your overhead irrigation system, working to place siphons accurately to deliver uniform flow rates or adopting automation or new and innovative technologies.

The majority of irrigated cotton uses manual siphons. Consistent flow rates can be difficult to achieve with manual siphons as outlet placement, furrow entry conditions, and supply head height will all impact flow rate. Flow through siphons increases as head increases and decreases as head decreases. The head is the height difference between the head ditch water level and the water level in the Rotobuck area, or the siphon outlet.

Testing siphon flow rates with a flow meter has shown variations of two to three litres per second depending on how the siphon is placed or the head height. Placement of siphons at different angles to the flow of the head ditch is also important as it can cause preferential flow into some of the siphons resulting in flow variation. Ensuring all siphons are placed perpendicular to the head ditch can help overcome this problem.

USQ researchers Joseph Foley and Malcolm Gillies discussed precise real time irrigation. (PHOTO: Melanie Jenson)

Once growers are confident that they have the basics right many are looking at automation and new and innovative technologies. The Smarter Irrigation for Profit 2 (SIP2) project is continuing to support irrigation research which is optimising irrigation through the use of many of these innovative irrigation technologies and sensors. These technologies all lend themselves to progression of irrigation into automation, and ultimately autonomous irrigation.

Two of the SIP2 projects were discussed at the recent GVIA field day. Malcolm Gillies and Joseph Foley from the University of Southern Qld (USQ) discussed optimisation of irrigation events using SISCOweb, part of the *'Precise real time automated cotton irrigation to improve water productivity'* project. While Hizbullah Jamali and Chris Nunn from CSIRO discussed '*Plant based sensing for cotton irrigation'*.

Precise real time automated cotton irrigation to improve water productivity

This project is an extension of research conducted by the University of Southern Qld (USQ) in the previous Smarter Irrigation for Profit program. It includes the support of the commercial development of irrigation automation technologies at project sites near Jondaryan and Wee Waa, as well as the VARIwise control system and SISCOweb.

The Wee Waa automated irrigation site utilises a small pipe-through bank setup, with 75 mm pipes at two metre centres. Each of the pipes has been installed in the secondary head ditch so the outlets are level, meaning flow rates are uniformly influenced by head height in the secondary head ditch.

This setup has been working at Wee Waa since 2015–16 and is well suited to automation. Irrigation events are initiated by automatically or remotely opening gates to move water from the primary head ditch into the secondary head ditch. Channel level sensors installed in the secondary head ditch are used to accurately estimate flowrates in each irrigation set. Combined with infield sensors it is possible to optimise each and every irrigation event.

The performance of irrigation is highly dependent on conditions in the field at the time. To address this the USQ team, with support from the Cotton Research and Development Corporation (CRDC), earlier developed the IrriMATE suite of measurement and evaluation tools. Since the initial release of IrriMATE to consultants, USQ has been working to streamline and automate this process and has developed SISCOweb which is an online alternative to the manual IrriMATE process for furrow optimisation. There have also been improvements in sensor inputs, and new data transmission equipment has undergone rigorous field testing for sensor to server interactions.

To utilise the system, at the beginning of the season, the field is setup with sets of water advance sensors positioned down furrows in the field. These sensors monitor the deceleration of the waterfront down the field, sending information in real time

Hiz Jamali and Chris Nunn gave presentations on plant-based sensing. (PHOTO: Melanie Jenson)

to the web server. Data utilised by SISCOweb includes siphon flow rates and soil infiltration characteristics, which are assessed during each irrigation across the season.

The information is forwarded to the SISCOweb software which operates on a web server. The grower is sent recommendations for when to cut off the irrigation from SISCOweb as an automated SMS. It is also possible for this information to be sent to an actuation system which can automatically open and close gates and pipes to control water delivery to the field. This system ensures that irrigation is started and importantly stopped at the optimal time, so crops are not under or over watered. The benefits include improved irrigation water use efficiency, productivity, and enhanced farm management. Additionally it provides real-time data on irrigation performance. This technology is currently being commercialised and will be available for growers to utilise in the near future through suppliers.

Plant based sensing for cotton irrigation

Plant-based sensing techniques including canopy temperature sensors (CTS) and UAV thermal imaging can increase cotton yields while reducing labour and water costs. These benefits are realised by matching the irrigations with crop water demand through continuous monitoring of plants.

As canopy temperature is a direct response of the plant's access to (or lack of) soil water, continuous monitoring of canopy temperature provides real time information on a crop's need for water. This can then be used to inform irrigation scheduling. In SIP1 the CSIRO research team monitored the canopy temperature on farms in different valleys where growers used their own experience and/or fixed soil moisture deficits to make irrigation scheduling decisions. This research showed that there were opportunities to optimise the timing of irrigations using the canopy temperature technology.

Cotton plants grow most efficiently at a canopy temperature around 28°C. On hotter days, plants tend to maintain their temperature close to the optimum of 28°C by releasing their heat load through transpiration which basically is releasing water through stomata on the leaf surface. When plants run out of water or cannot access water easily, their first response is to shut down their stomata, causing the plants to get hotter. This signal in the plant or canopy temperature is monitored by the CTS and used to inform the timing of irrigations.

Canopy Temperature Sensors and the thresholds to trigger irrigations are now commercially available to growers through Goanna Ag as part of its GoField Plus irrigation management system incorporating CTS and soil moisture probe. Although the algorithms only use canopy temperature and weather data to trigger an irrigation, it is equally important to monitor soil moisture using capacitance probes.

It means you are measuring what is going on under the ground as well as in the crop itself. Canopy temperature tells us when to apply an irrigation and moisture sensors indicate how much water might be needed to complete an irrigation. Sometimes we also see a stress signal in crop canopy temperature for other reasons, such as disease. In those situations, soil moisture data helps determine that an irrigation will not be beneficial to the crop.

The current SIP2 project is refining these technologies and working closely with Goanna Ag to streamline the process of providing growers the actionable data in real time. Critical to the adoption of the technology is to ensure the technology is both practical and reliable at a commercial scale. Collection of data from commercial cotton farms is ongoing and is being utilised to help better understand how CTS can be most effectively used to improve water use efficiency and productivity for fully irrigated and also for partially irrigated cotton.

There is ongoing testing of CSIRO's canopy temperature predictive algorithms platform for scheduling irrigations in advance, and continuing investigation of spatial variability of canopy temperature on larger commercial farms to determine the minimum number of canopy sensors required for effective and efficient irrigation scheduling.

There is quite significant potential for the CTS in limited water situations because CTS offer a quantifiable means of assessing crop stress. The impact of water stress on yield is affected by crop development. Canopy temperature is a function of day degrees (radiation) and water stress, which together determine crop development stage.

Trials conducted at CSIRO Narrabri using canopy temperature sensors showed peak flowering as the best time to apply an irrigation when water is available for a single irrigation only. The timing of this single irrigation can likely be optimised by considering both the crop development stage and the accumulated stress. This is currently being validated through on-farm trials in different valleys in collaboration with the CottonInfo team.

Canopy temperature sensors can aid in decision making and ultimately assist in optimising both fully irrigated and limited water cropping systems.

For more information, webinars and videos visit:

https://smarterirrigation.com.au/precise-real-time-automated-cotton-and-dairy-irrigation-for-improved-water-productivity/

https://smarterirrigation.com.au/joseph-foley-talks-about-automation-of-large-scale-irrigation/

https://smarterirrigation.com.au/andrew-greste-talks-about-precise-real-time-automated-cotton-and-dairy-irrigation-for-improved-water-productivity/

https://smarterirrigation.com.au/plant-based-sensing-for-cotton-irrigation-2/

https://smarterirrigation.com.au/canopy-temperature-sensors-as-an-irrigation-tool-by-cottoninfo/

https://smarterirrigation.com.au/plant-based-sensing-optimising-irrigation-timing-in-limited-water/

https://smarterirrigation.com.au/responsive-irrigation-management-with-canopy-temperature-stress-technology/

For more information on the Smarter Irrigation for Profit 2 program visit the website: *https://smarterirrigation.com.au/*

Hotter, drier, CRISPR: Editing for climate change

GENE editing technology will play a vital role in climate-proofing future crops to protect global food supplies, according to scientists at The University of Queensland.

Biotechnologist Dr Karen Massel from UQ's Centre for Crop Science has published a review of gene editing technologies such as CRISPR-Cas9 to safeguard food security in farming systems under stress from extreme and variable climate conditions.

"Farmers have been manipulating the DNA of plants using conventional breeding technologies for millennia, and now with new gene-editing technologies, we can do this with unprecedented safety, precision and speed," Karen said.

"This type of gene editing mimics the way cells repair in nature."

Her review recommended integrating CRISPR-Cas9 genome editing into modern breeding programs for crop improvement in cereals.

Energy-rich cereal crops such as wheat, rice, maize and sorghum provide two-thirds of the world's food energy intake.

"Just 15 plant crops provide 90 per cent of the world's food calories," Karen said.

"It's a race between a changing climate and plant breeders' ability to produce crops with genetic resilience that grow well in adverse conditions and have enriched nutritional qualities.

"The problem is that it takes too long for breeders to detect and make that genetic diversity available to farmers, with a breeding cycle averaging about 15 years for cereal crops.

"Plus CRISPR allows us to do things we can't do through

Dr Karen Massel from UQ's Centre for Crop Science.