SMARTER IRRIGATION FOR PROFIT

GVIA

Gwydir Valley Irrigators Association Inc.

2017 Grower-led Irrigation Research Field Day

Australian Government
Cotton Research and Development Corporation

Australian Government
Department of Agriculture and Water Resources

2017 GVIA Grower-led Irrigation Research Field Day

SMARTER IRRIGATION FOR PROFIT

The project aims to improve the profit of 3,000 cotton, dairy, rice and sugar irrigators by $20,000 - $40,000 per annum, with the support of 16 research and Development partners and 19 farmer irrigation technology learning sites.

The project consists of three components;

1. Practical, reliable irrigation scheduling technology.
2. Precise, low cost automated control systems for a range of irrigation systems.
3. A network of farmer managed learning sites located in major regions referred to as ‘optimised irrigation ‘ farms.

The GVIA grower-led irrigation field day today is visiting two of the Gwydir Valley optimised irrigation farms; Auscott Midkin and Red Mill. We also have Keytah in the Gwydir Valley and Waverley in the Lower Namoi.

The project is supported by funding from the Australian Government Department of Agriculture and Water Resources as part of its Rural Research and Development for Profit Programme.

Research in the Gwydir Valley is also supported by the Cotton Research and Development Corporation.

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Agenda

	Auscott Midkin Optimised Row Configuration Site		
8:00	Welcome and Open the Field Day		Zara Lowien (GVIA)
8:10	Introduction to new regional staff		James Quinn (CSD)
8:20	Smarter Irrigation Optimised Row Configuration Trial		Lou Gall (GVIA)
8:30	Key reasons behind the Optimised Row Configuration trial.		Jake Cutcliffe and Rod Gordon (Auscott)
8:50	Benefits of true Control Traffic Farming systems		Michael Braunack (CSIRO)
9:10	Look at site and discuss with Auscott team		
9:30	Buses to Red Mill - Morning tea on arrival at Red Mill		
10:30	Smarter Irrigation Optimised Furrow Irrigation Trial		Lou Gall (GVIA)
10:40	Grower Experience this season, management, installation erosion and automation.		Ray Fox (AFF)
10:50	Remote Control of irrigation	Siphon Automation with the smart siphon	Gavin Kelly (Islex), Michael Shea (4Sync)
11:10		Level sensors, Automation and water management	Dave Robson / Peter Moller (Rubicon)
11:30	Tools to aid in irrigation decision making	Goanna Telemetry Systems for Remote Sensing in Agriculture	Dr Janelle Montgomery (CottonInfo)
		IrriSAT	
11:50	Tools to enable autonomous irrigation	Variwise control system using cotton crop model	Dr Alison McCarthy (USQ NCEA)
12:10		Furrow irrigation automation and performance	Dr Malcom Gilles (USQ NCEA)
12:40	Fully automated irrigation	Towards Autonomous Furrow Irrigation using small PTB's	Dr Joseph Foley (USQ NCEA)
1:00	Grower Experience remote control and automation at Waverley.		Andrew Greste / Steve Carolan (Waverley Ag)
1:15	Lessons learnt from Modernisation of Furrow Irrigation in the Sugar Industry		Steve Attard (AgriTech Solutions)
1:30	Inspection of components – Lunch and Close		

Optimised Row Configuration

The project is an extention of trial conducted in 2014-15 and 2015-16. It has been designed to investigate the relative yield potential and water use efficiency of different row configurations; 30inch, 40inch and 60inch under full irrigation.

It will help growers maintain productivity by providing information to enable them to make informed decisions on planted area and water use during times of limited water. It will also aid in decisions relevant to crop rotations and farm operations.

The research is designed to provide growers more information on the maximum potential yield of each of the row configurations under optimal water. Additionally it provides information on possible water savings which may be achieved from each of the row configurations compared to 40inch.

This information will help growers determine which row spacing is best suited to their operations, especially when faced with seasons where water availability is limited at planting.

The trials in 2014-2015 confirmed that to achieve maximum yield potential, field preparation and bed structure are very important regardless of whether 1m or 1.5m beds are used. Where bed structure is not ideal it can impact on establishment, potentially reducing yield and water use efficiency.

The yield performance of the two narrow row configurations is very similar. Where there is sufficient water to fully irrigate the findings suggest that either a 30inch or a 40inch row configuration would produce higher yields. They both also have better water use efficiency and Gross Production Water Use Index (GPWUI).

In situations where irrigation water is limited and a solid plant may not be appropriate, growers can now make more well informed decisions on what configuration to plant. The 60inch configuration has performed well and is a viable alternative to the solid row configurations.

The final decision as to which row configuration is most appropriate will depend on reliability of irrigation water, crop rotation and the overall farm operations.

In situations where broad acre cropping is carried out in conjunction with cotton production a move to 30 or 60inch may be beneficial as they allow for the three metre wheel spacing commonly found in broad acre cropping.

Key Results from 2014 to 2016.

- Good bed structure is critical. Beds should be developed well in advance of planting.
- Narrow row spacings are best suited to full irrigation.
- Wider row spacings are more suited to limited water.
- Reliability of irrigation water and farm management decisions are key considerations in any decisions on row configuration.

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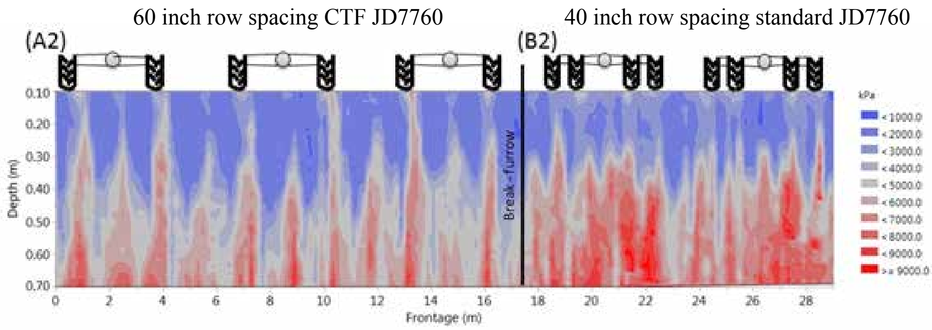
Cotton row spacing and soil compaction: things to think about

With the new round bale pickers there is double the weight in the field as there was with basket pickers. As such, we need to assess to what extent the soil is damaged in terms of compaction, what other aspects of the production system does this impact, and how might we minimise the impact?

In terms of compaction, 100% of the nine sites investigated showed detrimental compaction under the wheel to 80 cm depth. To avoid soil damage that would affect crop production, the soil had to be dried to permanent wilting point to 80 cm depth. Just because we don't see big wheel ruts does not mean compaction is not occurring.

How do we minimise the compaction? True controlled traffic farming (one wheel per side of the axle and all track widths for all operations matched; CTF) is the most effective way to minimise compaction. Figure 1 demonstrates this. The blue regions are acceptable for root growth, with less limitation on water infiltration, while the red and grey regions limit growth and infiltration. Under the standard machine we see greater subsoil impact corresponding to more wheels on the soil. In fact, the outer and inner wheel have the same effect on soil compaction, even though the rear wheel only follows the inner wheel!

Figure 1
Soil strength across 12 plant rows after 2 seasons of JD7760.



In the 40 inch cotton system, CTF can't be easily achieved, as it results in 2m internal wheel track causing the machine to be highly unstable. The 60 and 30 inch systems are better suited to true CTF, as a 3m internal wheel track is possible. Conversion costs around $68K for the JD7760, but could be conservatively cost recovered over 2-3 seasons with ~724 ha of 60 inch cotton.

We need to consider yield in terms of the gross margin, rather than simply bales per hectare. We need to do the economics on the 30 inch system. While its yield was comparable to the 40 inch, the technology cost will increase if using BollgardII®, as there is 133% of the cotton per hectare, relative to 40 inch. For the 60 inch there is 66% less cotton in the same area (less tech cost). In water limited climates/seasons, 60 inch cotton can result in better cotton growth than the 40 inch, while we would presume that the 30 inch might be comparative to the 40 inch. However, having 30 inch rows might provide some flexibility in being able to pick and choose when to grow 60 or 30 inch cotton. It is noted that the 60 inch cotton produced less bales per hectare than 40 inch cotton in Moree, but was within half a bale at Warren and had better gross margin. The 30 inch could initially have less gross margin, but the same bales/ha as the 40 inch, but we would expect the gross margin to recover with time as the compaction effect is limited. It seems to me that we now have options to grow flexibly given climate and water availability, and still achieve comparable gross margins that are suited to CTF: So, will you go 60 or 30 inch?

Contact: Dr John McLean Bennett (NCEA); John.Bennett@USQ.edu.au

Key Points:

- Soil compaction occurs at 100% of sites under the JD7760
- Easiest way to minimise compaction is true controlled traffic farming (CTF)
- CTF suits 60 and 30 inch cotton
- 60 inch cotton provided comparative gross margins to 40 inch
- We believe 30 inch will have comparative gross margins to 40 inch once soil has recovered
- Conversion costs associated with CTF could be recovered in 2-3 seasons.

Acknowledgements: Auscott Warren and Moree, and Keytah for data and information, CRDC for funding.

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Optimised Furrow Irrigation
Investigation of Siphon Automation Options

The Keytah Irrigation System Comparison trial has demonstrated that alternative systems to siphons may not be suitable in many situations. As such growers are interested in investigating ways in which siphon irrigation can be transitioned into the future.

Grower-led trials have shown that there are high labour resourcing requirements with siphon irrigation. The availability of labour is becoming more difficult, and it is possible that the labour resource needed to start siphons may not be available in five to ten years. This has the potential be become a significant problem for the industry as the majority of the industry currently utilises a standard siphon system

This then raises a number of questions;

1. What options are available to reduce the reliance on labour?
2. What are the practical constraints of these options; installation, channel maintenance, erosion, blockages, repairs and maintenance, reliability, suitability and capability of componentry?

The Red Mill trial is the first step to investigating possible labour saving alternatives. It includes traditional siphons, smart siphons and small pipe through bank siphons. The trial will investigate the practical constraints associated with instalation, set up costs, use as well as the impact on the resources of water and labour.

In addition the GVIA are working with the team from USQ and NCEA to collect information on WUE, irrigation schedulling and crop development using a number of tools including; flow meters, thermal cameras, VariWise cameras and soil sensors.

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Key Parameters being assessed:

- Optimise water and labour → ensure satisfactory yield is attained
- Maintain or improve WUE → distribution uniformity and application efficiency
- Capital setup costs → cost effectiveness and return on investment
- Retro fitting a siphon automation system into an existing systems is relatively easy / practical to achieve.
- Repairs and maintenance costs are kept to a realistic level.

AFF

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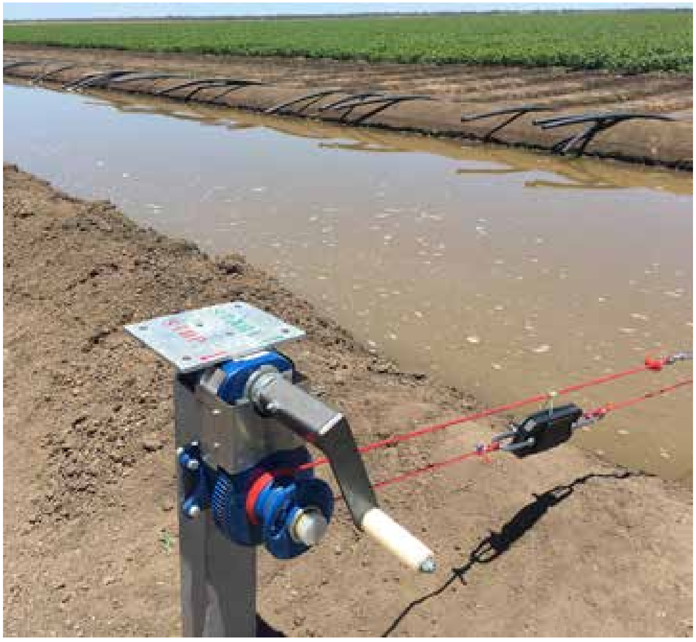
Remote Control of Irrigation
Siphon Automation with the Smart Siphon

Smart Syphon is a ground breaking simple solution that unlocks the door to flood furrow irrigation automation.

All that Smart Syphon does is rotate an open pipe to raise and lower the end of a pipe through the bank and in doing so start and stop the flow of water. No valves or complicated mechanical controls - just a rotating pipe. Simplicity is the reason it works.

Its simplicity is the method of automation, rotating the pipe requires it to move in line with the head ditch making it possible to control multiple units with a single controller, distributing the cost of control and automation across 100-150 units.



Water application rate is no longer constrained by the pipe sizes and people's capability to manually start a hand syphon.

We have established that by increasing the pipe diameter and restricting the entrance, flow volumes are significantly increased and pipe exit velocity reduced and can be individually calibrated to the water application requirements of the field, plant and individual irrigation event. You can control of your most significant commodity, water.

The future of Smart Syphon will be the application of water to maximise plant performance and the elimination of tail water.

Five trial sites this season of our proto-type 75mm smart syphon have provided us with the blueprint of the commercial smart syphon, operating and grower requirements and constraints.

It is now possible to take advantage of the years of research by USQ and Grower groups to revolutionise and your water management.

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smart syphon

Remote Control of Irrigation
Level sensors, Automation and Water Management

Rubicon FarmConnect Water Level Sensors

The Rubicon FarmConnect MicronLevel Air water level sensor lets you continuously monitor farm channels, storages and recycle locations without having to travel to site.

When used with FarmConnect Software, the MicronLevel Air will send you an SMS alert when a preset water level is reached. Alternatively, you can program it to automatically start or stop a pump or open or close a bay or channel gate when your desired water level is achieved.

The software is cloud-based which allows you to manage your irrigation from any device that has an internet connection - anywhere in the world. The software is flexible and expandable, so you can add more devices and more functionality as your needs change over time.

An app is available for you to quickly view multiple water levels around the farm. A glance at the trend indicator (below) will show the trend in water level over the past 30 minutes. You can easily set alarms which are received as an SMS or email alerting of unanticipated level changes. Farm workers can also manage the devices and be notified of alarm alerts.

The device can be purchased to communicate over a cellular network or can communicate via radio to an on-farm base station called a FarmConnect Gateway. This is a more economical option for farms deploying more than six devices around the farm.

An optional rain gauge can be integrated into the device which is very useful during heavy rain events, particularly when positioned at recycle locations on the farm.

The device is easy to set up in the field. Just join the connector, turn the device on and the self-calibrating level sensor will capture a level.

The device can be purchased with a frame and screw-in foundation for ease of installation on a channel bank or the device can be supplied with an arm which allows you to attach it to an existing structure.

For further information: please phone

David Robson 0418 740306 or

Peter Moller 0418 953999 or

visit www.rubiconwater.com

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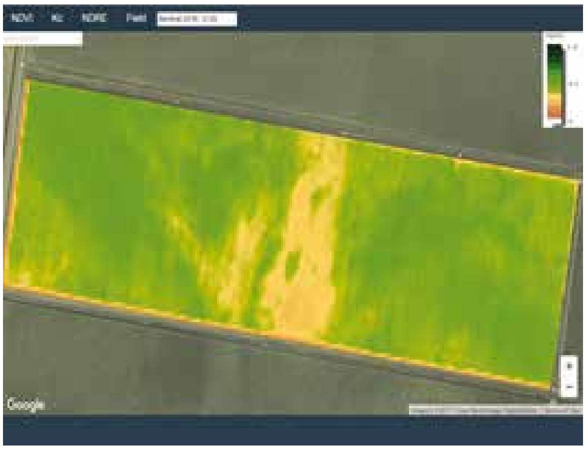
Tools to aid in Irrigation Decision Making
Telemetry Systems for Remote Sensing in Agriculture

Goanna Telemetry provide a combination of tools and technology to help clients in their water scheduling and crop monitoring. Goanna utilises the IrriSAT technology, Goanna weather stations and their soil moisture probes to aid in the irrigation decision making.

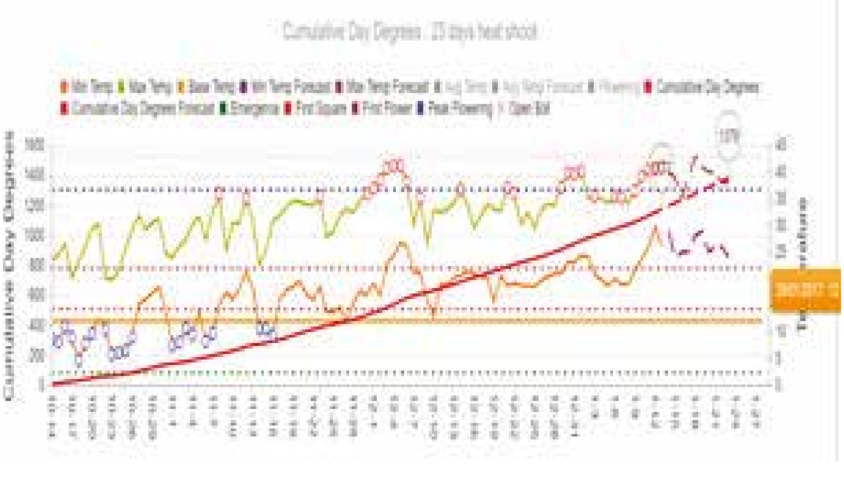
One of the features of the goanna platform for reporting on soilmoisture is the ability to use the IrriSAT technology on the Goanna Soil Total Graph. This enables you to more accurately predict the irrigation data with the crop ETc forcasted daily water use. As well as probe daily water use from Goanna soil moisture calibrations.



Goanna provides imagery from three satellites at present. The two Landsat satellites and the Sentinel2a. NDVI and NDRE imagery are provided regularly on your Go Probe report and your GoSat report.

Goanna calculate and provide total ETc crop water use. Total ETc crop water use is used at the end of the season for calculating water use efficiency in bales/ML, mmm/Kg and $/mm. Using the IrriSAT technology and a Bureau of Meteorology licence for forecasted weather data. Goanna provides a 10 day daily crop water use in mm for your field.

Part of the GoSat reporting provides forecasted 10 day rainfall and maximum and minimum air temperatures.



The report provides seasonal historical temperatures, heat and cold shock days, crop growth stage markets and cumulative day degrees. All accessible on the soil moisture probe report specific to that field.

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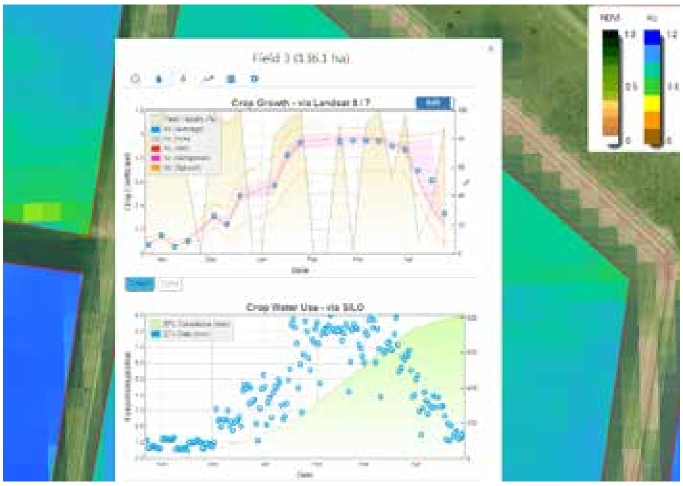
GOANNA TELEMETRY SYSTEMS
REMOTE SENSING FOR AGRICULTURE
www.goannatelemetry.com.au

IrriSAT: Weather based irrigation scheduling and benchmarking technology

IrriSAT is a weather based irrigation management and benchmarking technology that uses remote sensing to provide site specific crop water management information across large spatial scales.

IrriSAT calculates crop coefficients (Kc) from relationships with satellite (Landsat and Sentinel) derived Normalised Difference Vegetation Index (NDVI) data. Daily crop water use (ETc) is determined by multiplying Kc and daily reference evapotranspiration (ETo) observations from a nearby weather station.

IrriSAT is moving weather-based scheduling into the future. The free IrriSAT app (**https://irrisat-cloud.appspot.com**) automates satellite processing and information delivery of satellite data and provides water management information to assist in irrigation scheduling and crop productivity benchmarking.



IrriSAT provides daily crop water use and a seven day crop water use forecast at low cost and across a large spatial area.

When seasonal crop water use is combined with yield data it provides a measure of crop productivity. Variation in crop productivity can be examined within and between fields, farms and regions.

Crop water use index = total production (bales)/Crop Evapotranspiration (ML)

Irrigators aim to maximise returns per ML. IrriSAT will help irrigators apply the right amount of water at the right time, provide benchmarks and examine performance drivers to enable continuous improvement in crop productivity.

The current project is working with consultants and irrigators to further develop app functionality. Without any data input, you can click on a field and see your crops daily crop water use and track crop water use across the growing season.

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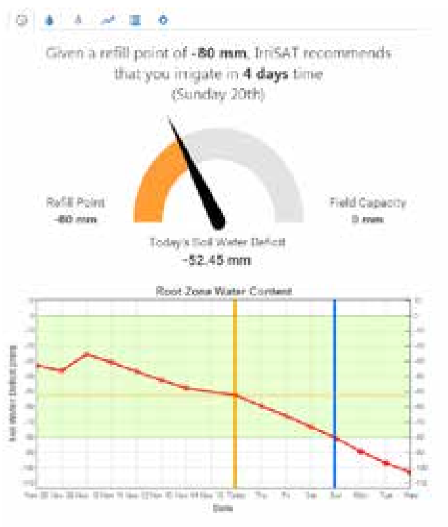

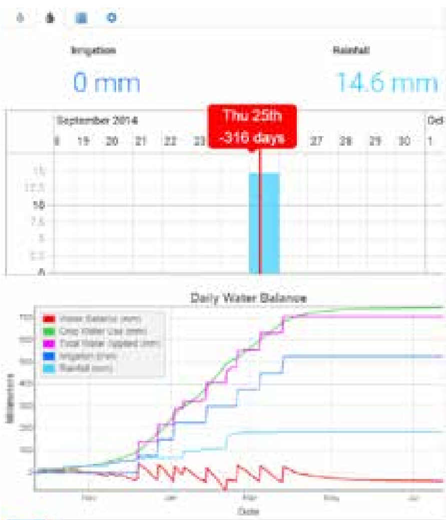

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Tools to Enable Autonomous Irrigation
VARIwise control system using cotton crop modelling

Software 'VARIwise' has been developed that combines field sensors, models and control strategies to automatically determine the optimal way to irrigate the crop. VARIwise incorporates weather forecasts, soil moisture monitoring and crop growth monitoring and prediction to determine irrigation requirements over the forecast period. Low cost cameras in the field and on the irrigation machine track the crop's development by detecting cover and fruiting numbers.

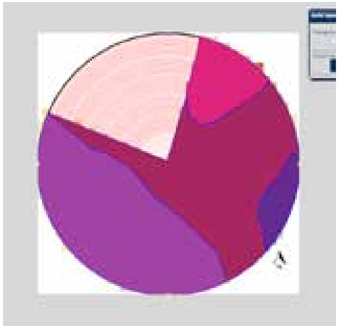
Trials are being conducted in cotton and dairy pasture to evaluate the software and hardware components of variable-rate centre pivot irrigation using VARIwise. The software can be used for determining irrigation timing and application volumes for surface and centre pivot and lateral move irrigation machines.

Recently developed variable rate technology (VRI) now allows farmers to apply a spatially variable pattern of irrigation to the field under these machines. These systems provide the potential of precisely applying the irrigation that will meet the specific requirements of the soil and crop at all locations in the field. The challenge is determining this spatially variable requirement for each irrigation.

There is a range of data collected and analiysed to contribute to the recommendations. The data collected includes an electrical conductivity assessment of the field, weather data, soil moisture and soil type. In addition, cameras are installed on ground vehicles to collect information on plant density, height and fruit load. Where pivots or laterals are used cameras can be installed on the machine.

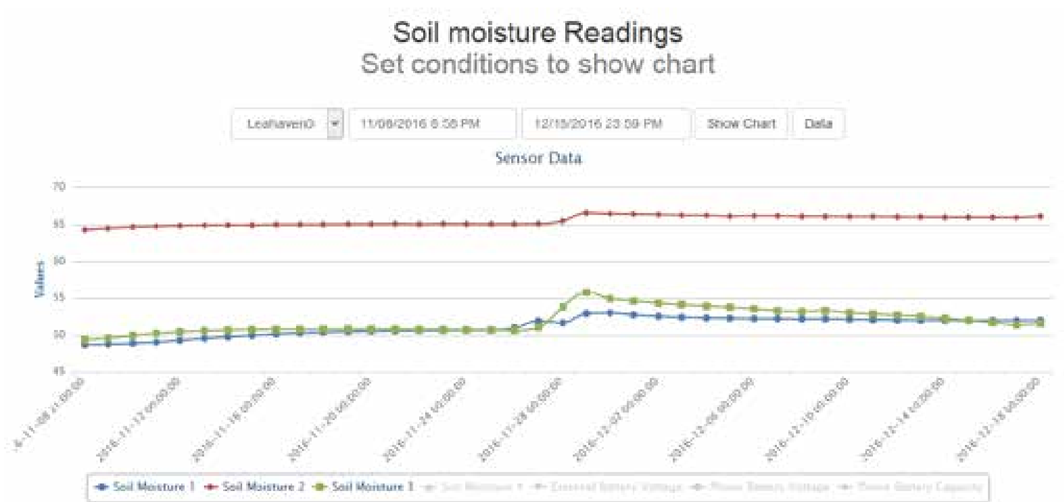
Electrical Conductivity

VARIwise can then be used to generate a prescription map (seen below)that is approved and/or modified by the farmer before being transferred to the irrigation system.



This has potential to reduce labour, risk and human error in irrigation management decisions. Field trials have demonstrated 5-12% yield improvements and 10-11% water savings using adaptive irrigation control.

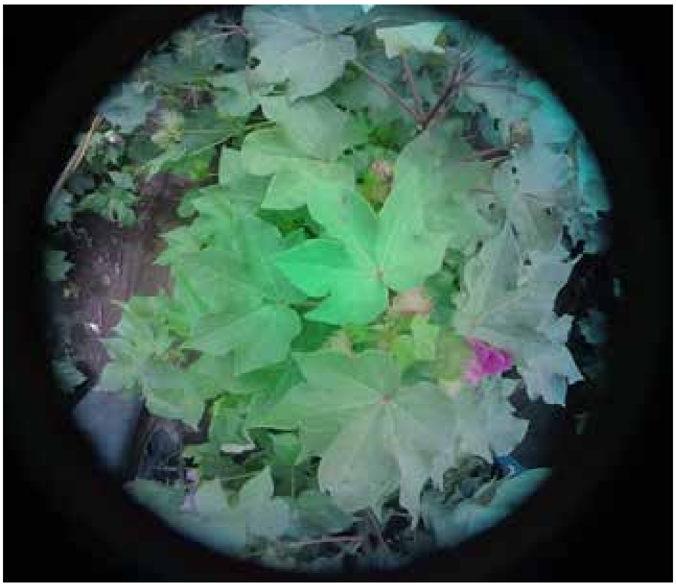
Automated irrigation application systems can increase water use efficiency and crop productivity by automatically analysing historical, current and predicted weather, soil and plant measurements to identify spatial water requirements. *(continued over page)*



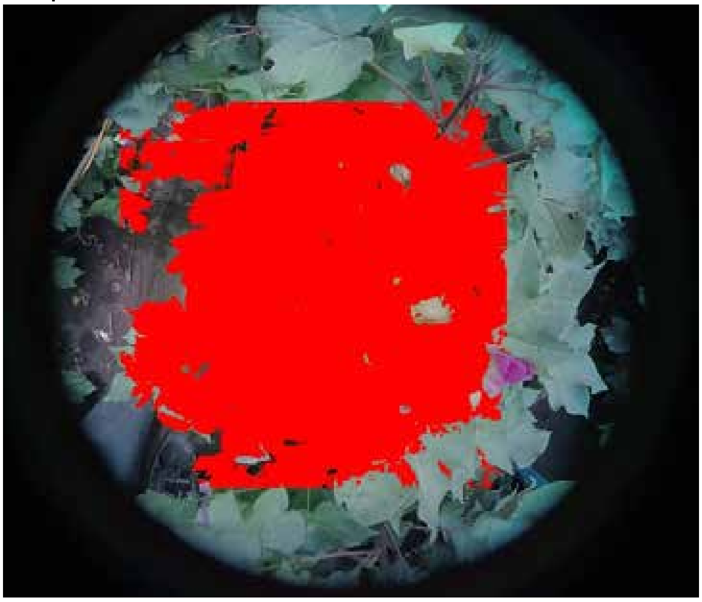
Tools to Enable Autonomous Irrigation
VARIwise control system using cotton crop modelling

The cameras collect images of growth and fruit development as shown below. These areas are then analysed to identify squares, flowers and bolls.

Original image showing square development

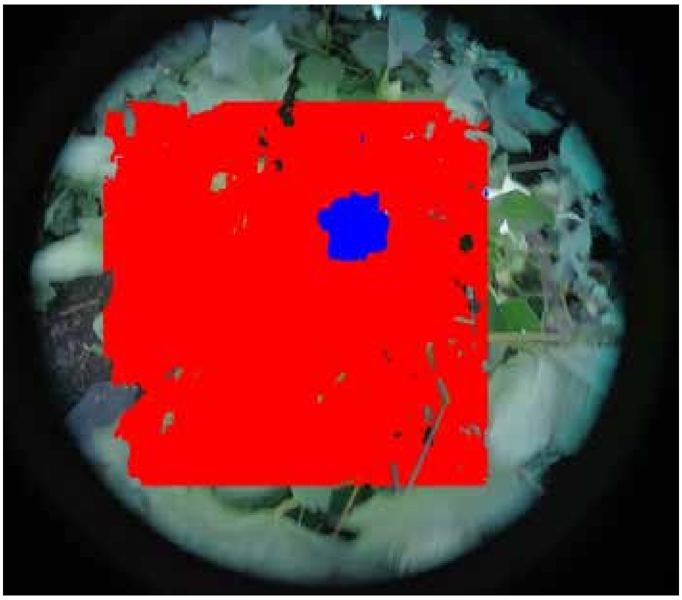


Analysed image, non red areas indicate squares



Original image showing flower development

Analysed image where blue areas indicate flowers



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Research

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Towards Autonomous Furrow Irrigation using Small Pipe Through Bank

NCEA at USQ completed successful remote control furrow irrigation trials with Rubicon FarmConnect systems and structures from 2013 to 2015. This included testing a prototype blind head ditch and small Pipe Through Bank (sPTB) layout at "Red Mill", Moree in 2014/15. In September 2015, Waverley Ag at Wee Waa installed a 108 ha field of automated furrow irrigation. The currently available commercial system installed at Waverley is comprised of :

- A secondary head-ditch supplied through a Rubicon BayDrive dropgate for each irrigation set;
- Small pipes through the bank (sPTB) for each rotobuck (2 m spacing)
- Water level sensors in the main supply channel to provide alarms
- Water level sensors in the secondary head-ditch to estimate flows through the sPTB's

Elements of the Autonomous Furrow Irrigation system to be implemented in the near future include:

- Farm level channel control, from the water storage dam to the field.
- Integration of field sensors and software models to control the irrigation with the optimum shut-off time.

The current research focus at this site aims to improve the existing commercially available system by using plant, soil, weather and hydraulic measurements in combination to autonomously control furrow irrigation from water source to field.

Automation of furrow irrigation using current commercial systems allows the grower to:

- Reduce labour requirements in starting siphons and monitoring water levels,
- Control furrow irrigations remotely from an office computer, smartphone or tablet,
- Remotely monitor water levels in channels and ditches and receive alerts based on level

Future integration of the elements of Smarter Irrigation will enable the system to:

- Control all water flow from the water storage dam through to the irrigation furrows,
- Adapt irrigations to current plant water requirements in real time,
- Ensure irrigation management decisions are correctly made on-time, and are put into action.

Rising labour costs, and a real difficulty in sourcing irrigation labour means that it is increasingly difficult for growers to make the right decisions, and to be able to put them into action on-time. This two staged approach of

1. implementing automation to reduce labour, and
2. implementation of smarter irrigation using novel sensing and modelling technologies,

will ensure that furrow irrigated cotton remains profitable and sustainable into the future.

The automated sPTB system has functioned well in the 2015/16 cotton crop delivering uniform flowrates across each 310m wide irrigation set. The channel level sensors have proven to be very useful for the farm manager, saving many trips to the storage and supply channels to check and adjust water levels. These have given the confidence to know that the gates are opening and closing as scheduled, and irrigations have been completed remotely at the farm house. At this site it is estimated that the cost of implementing the automated layout will be recovered in three to four seasons.

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Grower Experience
Furrow Irrigation with Automated permanent siphons

Waverley Ag:	Owner: Steve Carolan Manager: Andrew Greste
Irrigation Area:	2,478 Ha
Water Source:	Surface water Pian Creek & Lower Namoi & groundwater.
Soil type:	Self mulching grey clay

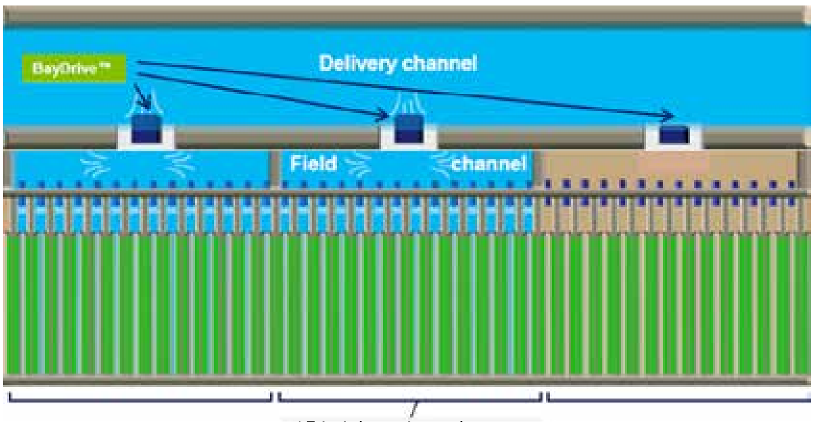
In 2015 108 Ha of traditional siphon country was converted to automated permanent siphons.

It is a twin headditch design incorporating permanent siphons through the bank. Water is delivered from the delivery channel into the headditch via a Padman Stops box culvert fitted with a water tight rubber door (PBC1000 with anti-erosion wings). This fills the headditch where 75mm HDPE pipe (67.7 mm ID pipes) has been buried into the wall of the headditch. Once the headditch fills, the siphons begin to run, watering every 2nd furrow. Rotobucks are still required at the top of the field to direct water into the furrows.

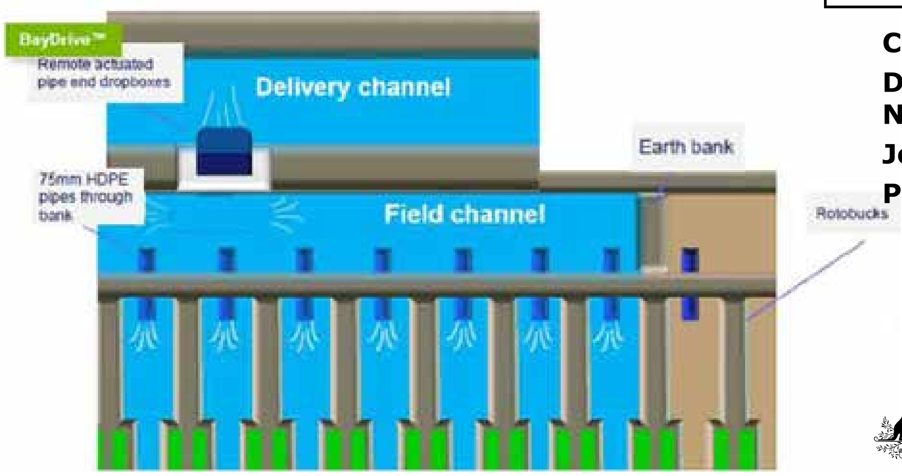
There are 6 outlets (Padman Stops Box Culverts PBC100) which are fully automated using Rubicon BayDrive and Rubicon FarmConnect. Each set consists of 154 siphons, watering 18 Ha. The outlets have been fitted with a Rubicon BayDrive ™. A BayDrive is a remotely operated farm channel gate actuator designed to automatically open and close the outlet gates.

Rubicon water level sensors have also been installed to monitor the water level in the delivery channel and headditch, rather than a trigger to open/close the outlets.

Following successful irrigations of cotton and faba bean crops, another 200+ hectares were installed in October 2016, and plans for further expansion of this automated system have been completed.



Plan view of automated permanent siphons (graphic from Rubicon)



System at a glance:

Crops	Cotton
Area (ha)	108 ha field
Row length (m)	582 m
Bay Width (m)	308m (154 siphons)
Cost ($/ha)	Approx $1000/ha
Siphon Flow rate (L/sec)	3.0 to 4.5 L/sec
Time to irrigate bay(Hrs)	6 to 8 hrs
Bay Slope	1:2000
Automation	Rubicon BayDriveTM, water level sensors and FarmConnect.

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National Centre for Engineering in Agriculture

Lessons Learnt from Modernisation of Furrow Irrigation in the Sugar Industry

Furrow irrigation is the dominant form of irrigation in the Burdekin, Australia's largest sugar growing region. Farmers in the region are under increasing pressures to reduce environmental impacts while facing high pumping energy costs. The water and energy efficiency of furrow irrigation can be improved with careful management by the grower but this means higher labour requirements. Automation of the irrigation systems offers the opportunity to reduce labour costs and ensure that management decisions are made in a timely manner.

A system has been designed that is low cost and best suited to the existing infrastructure. The system is comprised of:

- WiSA radio communication system and Aqualink Software
- Pump control
- Linear actuators on butterfly valves for fluming (layflat gated pipe)
- Pressure/level sensors and flowmeters in supply lines
- Buried soil moisture sensors and/or drain probes to sense irrigation completion

Automated systems were installed at three typical sugar farms in the Burdekin region:

- Jordan Site - 5 irrigation sets (82 ha)
- Linton Site - 11 irrigation sets (51 ha) in addition to an existing 43 ha of drip
- Pozzebon Site - 6 irrigation sets (17 ha)

The automation systems in the current trial allow the irrigator to:

- Control and schedule irrigations remotely from home office, tablet or smartphone
- Use end of row sensors to trigger switching irrigation sets
- Set up text message alarms or system shutdowns based on flow or pressure/level triggers
- Keep records of runtime or water use for each block

Most importantly this system is now commercially available

The most important benefit to farmers is reduction of labour. This does not necessarily mean a direct dollar saving for the family farm but the ability to focus on other activities or catch a good night's sleep.

The ability to irrigate during off peak times is a definite advantage for many growers aiming to reduce pumping costs.

The control systems have been functioning well at all sites since the beginning of 2015 when they were installed. The farmers are already comfortable with scheduling and monitoring the irrigations without needing to visit the field. Work is now focusing on determining the economic costs and benefits of the system.

The Smart Irrigation Project is focussing on incorporating crop and soil sensing, weather measurement and modelling to transform this automated irrigation into a smart system which can help determine the best time to irrigate and how much to apply.

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making every drop count

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Please give us your feed back on the Field Day and on the Irrigation Research at https: //www.surveymonkey.com/r/GVIAFD

Your feed back is essential to ensure future support and direction of Grower-led research and extension.

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