Smarter Irrigation for Profit 2

RRDP 2004 Automated cotton irrigation - key learning sites
Final Report

Australian Government
Department of Agriculture, Fisheries and Forestry

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CRDC

GVIA
making every drop count

Contents

Plain English summary

Automation and optimisation of irrigation in the Australian cotton industry has the potential to improve water productivity, whilst addressing challenges of energy and labour resourcing.

Method

This project was driven by growers and took place on commercial farms with support from farm management and irrigation teams. The aim was to collect commercially relevant comparative data on different irrigation systems, designs and technologies. Project activities were conducted at the Keytah system comparison key learning site, on AFF Limited properties in the Gwydir Valley and on Thuraggi Overflow in St George.

The Keytah System Comparison site is recognised as one of the industry's premier grower-led research locations, with six years of comparative data on four different irrigation systems. The focus is primarily on surface irrigation systems, siphon and bankless channel, but leverages existing data from the Keytah system comparison site to provide information on pressurised systems such as overhead lateral move systems and subsurface drip systems where appropriate. The intent is to provide growers with an improved understanding of the use of decision support systems, the application of different surface irrigation systems and the latest digital technologies for scheduling or precise automated irrigation. The research from Keytah is all commercially viable and available for adoption by producers.

The work at the AFF property Newport was a demonstration to test the fit of the SISCO model with a new commercial provider. It was found that the data collection using the EnviroNode equipment was appropriate and that it could be linked to the SISCOweb system. In addition, it was a demonstration of the information that could be collated by the SISCO model in a manual siphon field. It provided the irrigator with information on how their irrigations had performed and what differences had been observed between different irrigations.

The work at Thuraggi Overflow investigated the potential to apply the SISCO model to a tailwater backup design. It found that for the first half of the field useful actionable information could be determined. There were however challenges associated with performance assessments in the tailwater backup area of the field. Further work is needed for commercial application of the technology into this irrigation design.

Outcome

A key outcome from the project was increased grower and service provider understanding of design specifications and engineering considerations in the adoption of automated irrigation for siphon, bankless channel, drip and lateral systems. Evaluation feedback from project extension participants indicate that many are intending to make investments and transition to more precise automation of irrigation.

The project successfully reviewed measurement tools and decision support systems designed to enhance the efficiency of water use in irrigation, improve productivity and support more precise utilisation of limited resources.

It demonstrated the potential for automation of a large bankless channel field, testing scheduling options and the application of IRRISENS to control irrigation events. The project also assessed the potential for a temporary surface drip system. This assessment included further exploration of the infrastructure necessary to take a typical siphon system forward to an automated system.

The inclusion of productivity metrics in the assessment has enabled comparisons between systems, and the assessment of possible measurement tools provided greater insight into the efficiencies of different irrigation systems and the different management approaches best suited to each system.

The SIP2 economic analysis report found the average productivity gains in cotton to be 11% for water and 5% for multi factor. There was however significant variability in results. Labour productivity gains were found to be larger than water productivity gains. Transitioning from siphon to bankless channel was found to have a 7% water productivity gain (GPWUI) and a 687% labour productivity gain. This transition was found to have a -40% capital productivity. Applying automation to bankless found a 7% gain in GPWUI and a 567% labour productivity gain. This was found to have a -3% capital productivity.

As a result of the project activities cotton producers will have an increased appreciation of system design and automated irrigation at a commercial level, they will better understand the limitations and benefits of technology and be able to adopt the right technology more confidently for their individual needs. The adoption of appropriate decision support systems, scheduling systems and automation systems will be critical in taking the irrigation industry forward in improved efficiency of resource utilisation.

Collaboration

The project built on collaborations and networks, involving partnerships between growers, researchers, technology providers and suppliers who are actively working in the design and implementation of irrigation infrastructure and support tools. These partnerships ensured technologies are explored but that the tools and methods are fit-for-purpose, commercially relevant to growers and flexible to fit into the range of irrigation setups across industry and able to be moved between locations. The assessment of the potential integration of the various tools and technologies into a single functional irrigation system has provided growers greater flexibility to adopt tools and technologies to automate irrigation.

Extension

The project was promoted as commercial industry demonstration and extension. The information collected has been communicated in field activities, at industry conferences and through electronic and print media.

Information is included on the GVIA digital marketing platform which includes a webpage, regular on-line posts, member newsletters, facebook updates and twitter feeds. The GVIA also co-ordinated site visits for irrigators interested in looking at the sites included in the project.

This project was supported by funding from the Australian Government Department of Agriculture, Fisheries and Forestry as part of its Rural R&D for Profit program with in-kind support from Gwydir Valley Irrigators Association.

Abbreviations and glossary

GVIA Gwydir Valley Irrigator Association Inc

USQ University of Southern Queensland

SISCO Surface Irrigation Simulation Calibration and Optimisation

IRRISENS

EFAC EnviroNode Farm Automation Controller

1 Project rationale and objectives

The availability of technology, choices and prices are all changing, and growers are increasingly interested in adopting remote, automated or autonomous irrigation systems. There is particular interest in the fit of such technology into surface irrigation systems, both siphon and bankless. These systems remain the most relevant for Australian irrigated cotton producers.

Growers are seeking objective commercially relevant information regarding the options available, and the approaches needed to successfully install and manage optimised and automated systems.

The research questions developed were;

1. Does irrigation automation optimise the inputs of labour and water for improved productivity?
2. Is automated irrigation with smart siphons a reliable and effective system for the Australian Cotton industry?
3. What decision support tools are useful to progress toward optimised irrigation?

To address these questions project activities included:

1. A sixth season of irrigation system comparison at Keytah. Included was automated smart-siphons in K28, the lateral L1, bankless K29 and an adjusted drip setup in K30. The drip system was replaced with a temporary surface drip tape which utilised the existing pumping and filtering infrastructure. The trial was expanded in 2020-2021 to include the larger 500ha bankless channel design W567, completed at Keytah in 2017. All systems could be remotely managed.
2. An assessment of the various irrigation scheduling tools, resource requirements and management considerations, with specific focus on decision support tools and automation of the different irrigation systems.
   The Keytah fields were fitted with numerous sensors in 2020-2021.
   a. Smart siphon Control/Automation in K28 using EFAC and the EnviroNode hub.
   b. Irrigation management in the siphon field K28 with water level sensors, remote control weir and water advance sensors.
   c. Drip scheduling using soil moisture sensors and remote control.
   d. GoField Plus installed in lateral to collect data to inform plant stress algorithm for overhead irrigation.
   e. GoField Plus installed in W567 to monitor soil moisture and plant stress to aid irrigation scheduling.
   f. Soil tensiometers installed to 20cm with C-probes in W567 to collect comparative data for irrigation scheduling. Data integrated with IRRISENS to inform irrigation decisions.
   g. Pressure transducer and ultrasonic water height sensors on gates between bays in W567 to enable management of irrigation events via IRRISENS.
   h. Weather station in W567

   During 2021-2022 additional tools were assessed at both Newport and Thuraggi Overflow

   a. EnviroNode hub and water level sensor on field 32 Newport
   b. Water advance sensors redeployed from K28 Keytah to field 32 Newport

c. Water level sensors and Padman automation controller for field 5 Thuraggi Overflow.
d. Water advance and soil moisture sensors in bays 7, 8 and 9 in field 5 at Thuraggi Overflow
e. Water monitoring meters at inlet and outlets for bays 7, 8 and 9 on field 5

3. Supported the demonstration of the application of SISCO in a manual siphon field. This took place in field 32 Newport where channel water levels, flow rates, and water advance information was collected. Data was made available from the EnviroNode hub to the SISCO model and reports developed detailing infiltration characteristic, and distribution uniformity. As this was a demonstration using a new commercial provider data was not made available real time to aid irrigation management.

4. Supported an assessment of irrigation performance in a tailwater backup system. This took place at Thuraggi Overflow following an approach from growers in St George. It was done in partnership with CRDC2201. The objective was to collect detailed information on irrigation performance in the siphon-less tailwater backup design. The intention was to investigate the potential to apply surface irrigation optimisation technologies such as SISCO to the tailwater backup siphon-less design. The trial assessed water advance, depth and infiltration characteristics in different rows over three bays of field 5. This was only possible in the top half of the bays, as it was not possible to assess flow rates or opportunity time in the lower half of the bays were tailwater is backing up into the field.

2 Method and project locations

Method – calendar of project activities

2019-2020

- No trials could be planted as there was no irrigation water.

2020-2021

1. Continue the Irrigation System Comparison

- Further testing of reliability and robustness of Islex Smart Siphons and EnviroNode IoT and EnviroNode Farm Automation Controller (EFAC).
- Investigate the temporary surface drip system supported with scheduling advice from Netafim.

2. Expand activities to include automation and scheduling tools in the new Bankless Channel setup W567 supporting Deakin University

- Continue testing and development of Goanna Ag LoraWan Go Field package incorporating soil moisture and Canopy Temperature Sensors.
- Investigate the use of water advance sensors to aid in irrigation management in the smart-siphon field.

2021-2022

5. Investigate application of SISCO model to a manual siphon field with a possible commercial provider in partnership with USQ.

6. Assessment of irrigation performance of a Tailwater Backup design using SISCOweb. The trial measured and monitored water use and movement in three bays of a tailwater backup siphon-less design. CRDC2201 in partnership with CottonInfo.

Over Three Years

7. Extend information collected to industry including:

- irrigation system comparisons since 2009,
- IRRISENS automation of bankless channel,
- SISCO demonstration in manual siphons,
- SISCOweb application to monitor irrigation performance in a tailwater backup system, and
- presentations at key industry events.

The system comparison site continued to assess the performance of each of the systems over the duration of the project and all irrigation water and rainfall applied was recorded. Used soil

moisture was assessed and yield was recorded. The Gross Production Water Use Index (GPWUI) was calculated for each of the systems.

Additional weir control devices were installed, and water meters were serviced and installed to monitor water onto and off all fields. Automation equipment in the siphon field was updated and serviced (EnviroNode IoT). A series of water advance meters were positioned in the siphon field to aid in irrigation optimisation. New automation devices were installed in the new bankless system (Padman Stops). This field was fitted with several GoField plus (GoannaAG) sensors fitted with C-probes and Canopy Temperature Sensors designed to aid in irrigation scheduling. In addition, Deakin University installed soil moisture sensors in W567 to inform scheduling via the IRRISENS cloud based app.

A new EnviroNode hub and water level sensor at Newport was installed. The hub collected information from the water advance sensors (initially used at Keytah). This data was made available to the USQ NCEA team who loaded it into the SISCO model where it was analysed to provide information on irrigation performance.

A new tailwater backup field at St George on Thuraggi Overflow (CRDC2201) was fitted with additional monitoring equipment including, channel level sensors, water flow meters and water advance sensors. The aim was to investigate the irrigation performance using SISCOweb. Importantly the system design with tail water backing up the field means it is not possible to determine opportunity time or uniformity for this part of the field. Some useful assessments of the top half of the field have been made. Include a list of team members and partners involved in your sub-project (including commercial partners and cooperating producers).

Name	Organisation/Business	Role
Nick Gillingham	Sundown Pastoral Company	General Manager Keytah
Nathanial Phillis	Sundown Pastoral Company	Irrigation Manager
Rob Carter	AFF limited	Manager
Earl Carter	AFF limited	Newport farm manager
Craig Saunders	Saunders Farming	Owner
Lucus Wuersching	Saunders Farming	Irrigation and Management
Glenn Lyons	GL irrigation Pty Ltd	Irrigation designer
Dr Janelle Montgomery and Andrew McKay	CottonInfo	REO's

Dr Malcolm Gillies, Assoc. Professor Joseph Foley and Dr Simon Kelderman	University of Southern Qld	Support for SISCO demonstrations at Newport and Thuraggi Overflow
Assoc. Prof John Hornbuckle, Dr Rodrigo File Maia and Dr Carlos Ballester	Deakin University	Support for Keytah bankless automation W567
Grant Oswald	Padman Stops	Support at Keytah and Thuraggi Overflow
Ric Otton	EnviroNode IoT	Support at Keytah and Newport

Name & type of site (field site, laboratory, project partner sites, RDC headquarters)	**Street Address**	**State**	**Postcode**
(Insert rows as required)			
Keytah	Goonal Rd, Moree	NSW	2400
Newport	Newell Highway, Moree	NSW	2400
Thuraggi Overflow	St George	Qld	4487

All the research has taken place on commercial farms with support from farm management and irrigation teams. The research from Keytah is all commercially viable and available for adoption by producers. Data collected over the six years has been forwarded to AgEcon to enable a more detailed economic case study to be completed.

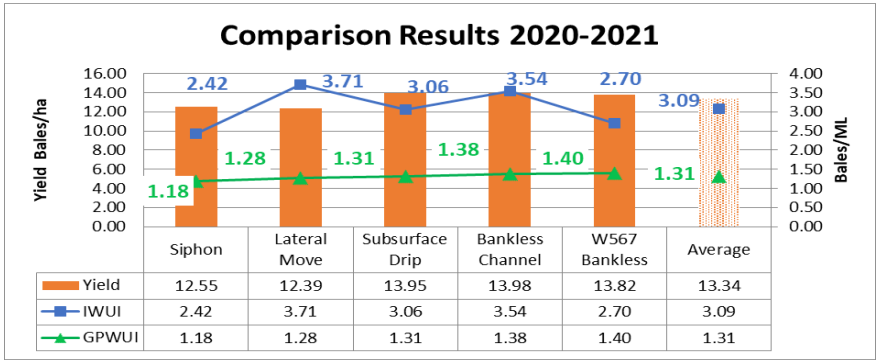
The work at Newport was a demonstration to test the fit of the SISCO model with a new commercial provider. It was found that the data collection using the EnviroNode equipment was appropriate and that it could be linked to the SISCOweb system. In addition, it was a demonstration of the information that could be collated by the SISCO model in a manual siphon field. It provided the irrigator information on how their irrigations had performed and what differences had been observed between different irrigations. The analysis was provided retrospectively to the irrigators so was not actionable during the season.

The work at Thuraggi Overflow investigated the potential to apply the SISCO model to a tailwater backup design. It found that for the first half of the field useful actionable information could be determined. There are however challenges associated with performance assessments in the tailwater backup area of the field. Further work is needed for commercial application of the technology into this irrigation design.

3 Project Outcomes

3.1 Project level achievements

Output and KPI numbers and description	Summary of achievements
Output 5.2 Perform comparative analysis of the use of irrigation and crop sensing technology in automated siphon, lateral move, subsurface drip and bankless channel irrigation systems to determine the water use efficiency as measured by Gross Production Water Use Index (GPWUI) for cotton.	Completed comparative assessment of the use of irrigation and crop sensing technology in automated siphons, lateral move, surface drip, and two different bankless channel designs at Keytah. Complemented this with an assessment of irrigation technology in a manual siphon field and a siphon-less tailwater backup system. GPWUI has not been calculated for the manual siphon as it has not been picked.
KPI 4.23 Provide a brief and final account of the benefits of automated versus manual siphons and bankless with respect to GPWUI. Include findings on the value and reliability of information provided by irrigation and crop monitoring sensors in optimising irrigation	The 2021-2022 irrigation season was a cool and wet season with picking in May and ginning in September. The Keytah comparison technical report was completed in October 2021 and uploaded to the GVIA site and the SIP2 database. The report incorporated details on water use efficiency, climate, yield, and system performance. It included observations and experiences from the perspectives of the irrigation manager (practical infield benefits) and the farm manager and agronomy team. The report also details experiences with sensors and scheduling tools deployed at Keytah.

efficiency and maximising yield and include comment on potential for commercialisation (Activity output 5.2k).
 	
Include any economic data generated to support the analysis.
	The technical report has since been updated to reflect the two additional research sites added to the project in 2021-2022. These projects stemmed from interest in irrigation optimisation using the SISCO model in a manual siphon field and in a tailwater backup field following the GVIA Keytah Field day in February 2021.
	
	To ensure that the greatest value is delivered from investments, the water advance sensors used in K28 at Keytah were redeployed in 2021-2022 to Newport (one of the new sites). The Newport site was completed with support from EnviroNode IoT and the USQ SISCO team. The second new site is a joint project CRDC2201 with CottonInfo. It is investigated irrigation performance in a siphon-less tail water backup field in the St George region. This work was supported by USQ and Padman Automation. The GVIA also supported the continued assessment of the Deakin Smart Sensing IRRISENS project on additional fields at Keytah.
	
	The results are detailed in the RRDP2004 technical report. Summary findings are as follows;
	
	• Irrigation system performance is influenced more by seasonal conditions than by system selection.
	• Establishment and disease pressure can have significant impact on field performance as measured by GPWUI as seen with the lateral and smart siphon fields at Keytah in 2020-2021.
	  ○ Crop establishment in the smart siphon field was impacted by issues associated with watering up the field. Extremely dry conditions preceding planting in 2020 resulted in leaks where pipes had been installed through the bank (despite allowing considerable time for the head ditch to wet up.) Watering up took approx. 10 days and severely impacted establishment.
	  ○ The lateral field had significant areas where disease influenced performance.
	• The two best performing fields in 2020-2021 were the two bankless field, the drip also performed well.
	
	 
	
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		Siphon	Lateral Move	Subsurface Drip	Bankless Channel	W567 Bankless	Average

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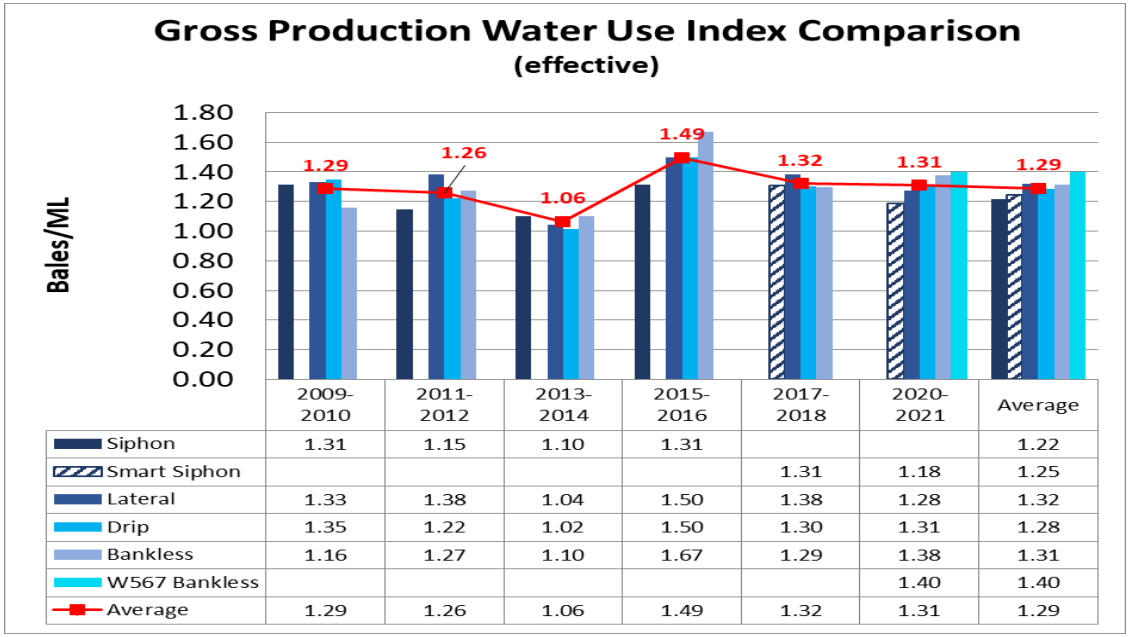
Yield	12.55	12.39	13.95	13.98	13.82	13.34
IWUI	2.42	3.71	3.06	3.54	2.70	3.09
GPWUI	1.18	1.28	1.31	1.38	1.40	1.31

- The GPWUI results over six seasons are as follows.



	2009-2010	2011-2012	2013-2014	2015-2016	2017-2018	2020-2021	Average
Siphon	1.31	1.15	1.10	1.31			1.22
Smart Siphon					1.31	1.18	1.25
Lateral	1.33	1.38	1.04	1.50	1.38	1.28	1.32
Drip	1.35	1.22	1.02	1.50	1.30	1.31	1.28
Bankless	1.16	1.27	1.10	1.67	1.29	1.38	1.31
W567 Bankless						1.40	1.40
Average	1.29	1.26	1.06	1.49	1.32	1.31	1.29

- The smart-siphons could be reliably automated or remotely controlled using the EnviroNode hub and EFACs. The inclusion of a channel level sensor and the installation of a remote weir controller enabled the field to be remotely managed at Keytah. The field was fitted with a series of water advance sensors these were placed to identify how the water was advancing down the field. Delays in acquiring the advance sensors meant that they were not fully utilised in 2020-2021. The water advance sensors are suitable to use to inform the SISCO model as well.
- The surface drip was satisfactorily installed and could be remotely scheduled using soil moisture information. Remote management by Netafim resulted in some areas of the field getting very wet. Scheduling whole fields using a single soil sensor can lead to potential problems, visual assessments of the field would avoid such problems. This is especially important where fields are not very uniform.
- The automated gates in the bankless system were fitted with pressure transducers and ultrasonic water height sensors, they were found to be reliable and easy to use. The management of water during irrigations could have been done remotely, but as it was the first use of the field and assessment of the technology it was not fully automated. A challenge with a large scale development such as this is ensuring that each bay is adequately

	irrigated, correct sensor placement and understanding of heights required to trigger gate opening will be important. • The soil water potential sensor installed to a depth of 20cm was compared to a soil water content sensor to 60cm. Additional information was requested by the agronomic team for 2021-2022 to compare soil water potential at 40cm for irrigation scheduling. This was primarily as scheduling in vertisol soils in the Gwydir is typically done using C-probes at depths below 20cm. • GoField Plus sensors were installed in 9 of the 15 bays in W567. These provided data on soil moisture and accumulated crop stress but were not used for scheduling. There may be a need to more clearly position these to aid in scheduling decisions. • GoField Plus sensors were installed in the lateral to collect data to inform the algorithm for plant stress in overhead irrigation. The sensors provided data but were not used for scheduling. The demonstration of SISCO at Newport in 2021-2022 successfully exposed the model to irrigators, the report provided information of irrigation performance including differences in performance between the measured rows, and between irrigation events. It also enabled the USQ SISCO team to successfully trial the EnviroNode IoT hub and water advance sensors. The two organisations shared data to inform the SISCO model for the field. As the reports were not provided in real time the irrigators were not able to adjust individual events. The assessment of the irrigation performance of the tailwater backup field at Thuraggi Overflow was able to collect useful information on the top half of the field, where flow rates and volumes were assessed. The model could not be used to assess performance in the tail water backup sections of the field as it was not possible to assess opportunity time or flow rates entering from this end of the field. More work is needed in this space. The use of water advance sensors in field provides necessary data to inform the aspects of the SISCO model. The installation and removal of a minimum of three advance sensors in a row is however an intensive activity and is a barrier to the adoption of this useful model.

Please include information from any project specific evaluations you may have conducted.

3.2 Contribution to the SIP2 program objective

a) generating knowledge, technologies, products or processes that benefit primary producers

The results from Keytah show that system performance is influenced more by season than system. As such, irrigators who are looking to improve irrigation efficiencies by changing irrigation systems should firstly optimise the system that they have.

Optimisation of manual siphons is possible by more well timed irrigation scheduling and by stopping irrigation events correctly. The use of GoField Plus with soil probes and Canopy Temperature Sensors can be applied to aid scheduling. SISCO with the use of water advance sensors can also be applied to optimise manual siphons.

Siphon irrigation can be readily automated with the Smart-siphon. This does however require installation of pipes and actuators. The system can be remotely controlled or automated, to achieve this it will be necessary to have channel level sensors and a hub to manage the system.

The cotton industry is transitioning to bankless channel designs, this transition is driven primary by a desire to enhance labour efficiency. Bankless channel designs can be easily automated and managed by a single person. Another driver is energy efficiency, most designs can be gravity fed, requiring none or very little on farm pumping. They can also save time and energy with more efficient machinery use. The Keytah comparison shows that these systems can also improve Water Use Efficiency. It demonstrates that a well-managed bankless channel system can produce comparable or better GPWUI to other systems.

The surface drip system was found to perform well and was able to be remotely managed being scheduled using soil moisture information. The surface tape is designed to be replace annually and can utilise an existing pumping and filtering system or can be installed with a temporary one. Producers who have smaller areas, or areas that have an isolated water source may find drip to be a suitable option. Scheduling irrigation in a drip situation is different to surface irrigation, Netafim work to maintain soil moisture between 60-80% of soil capacity during the growing season.

b) strengthening pathways to extend the results of rural R&D, including understanding the barriers to adoption

Field days and site visits are the primary means to extend results from trials. Despite not being able to plant a crop in 2019-2020 and Covid restrictions from March 2020 the GVIA was able to host a field day at Keytah and support industry and educational visits to the site. It was also possible to work with CottonInfo to support the St George field day in 2022.

The MDBA listening tour enabled discussion on the value of grower-led research and the importance of continued support on commercial research to improve efficiencies of water, labour and energy in the basin.

The feedback from the GVIA field day provided the following insights.

- Thinking about the Keytah Irrigation Efficiency research. How would you rate the value of Grower led commercial scale research? 53% found it extremely useful and a further 43% found it very useful.
- As a grower how useful was the Keytah presentation on their field experience with automated bankless channel? 36% found it extremely useful and 53% found it very useful.

- Thinking about the automated/remote control irrigation information presented: Please rate the likelihood of you adopting the following technology into your operations.

	EXTREMELY LIKELY	VERY LIKELY	NOT SURE	SOMEWHAT UNLIKELY	UNLIKELY	TOTAL
Padman Stops Automated gates	35.00% 14	42.50% 17	20.00% 8	0.00% 0	2.50% 1	40
EnviroNode Farm Automation Control	5.13% 2	23.08% 9	51.28% 20	7.69% 3	12.82% 5	39
SISCOweb irrigation optimisation	5.13% 2	30.77% 12	53.85% 21	5.13% 2	5.13% 2	39
Plant based sensing for cotton irrigation in limited water	10.00% 4	40.00% 16	42.50% 17	2.50% 1	5.00% 2	40
GoannaAg GoField Plus	7.69% 3	48.72% 19	41.03% 16	0.00% 0	2.56% 1	39
Integrated Smart Sensing, automation with Padman gates	22.50% 9	52.50% 21	22.50% 9	0.00% 0	2.50% 1	40
Netafim Modnet modular drip irrigation system	2.50% 1	5.00% 2	25.00% 10	15.00% 6	52.50% 21	40

Feedback from the St George field day provided the following insights.

- Thinking about the information presented: Please rate the likelihood of you making changes or adopting the following technology into your operations.

	EXTREMELY LIKELY	VERY LIKELY	NOT SURE	SOMEWHAT UNLIKELY	UNLIKELY	TOTAL
Automated gates (eg Padman stops)	10.00% 1	30.00% 3	40.00% 4	10.00% 1	10.00% 1	10
Transitioning fields to siphon-less designs	30.00% 3	40.00% 4	20.00% 2	0.00% 0	10.00% 1	10
SISCOweb irrigation optimisation	0.00% 0	20.00% 2	60.00% 6	10.00% 1	10.00% 1	10
Channel level sensors	20.00% 2	50.00% 5	20.00% 2	0.00% 0	10.00% 1	10
Improved monitoring of water in fields	40.00% 4	40.00% 4	10.00% 1	0.00% 0	10.00% 1	10

- With regard technology and automation what do you see as barriers to adoption?

	EXTREME BARRIER	MAJOR BARRIER	SOMEWHAT OF A BARRIER	NOT A BARRIER	TOTAL	WEIGHTED AVERAGE
Reliability of technology	33.33% 3	11.11% 1	44.44% 4	11.11% 1	9	5.44
Cost	37.50% 3	12.50% 1	37.50% 3	12.50% 1	8	5.75
Service provider support	20.00% 2	30.00% 3	40.00% 4	10.00% 1	10	5.30
Understanding the value of the technology	0.00% 0	12.50% 1	75.00% 6	12.50% 1	8	3.13
Understanding what the technology does	0.00% 0	12.50% 1	62.50% 5	25.00% 2	8	2.75

- How would you rate the value of the CottonInfo SIP2 field day; Optimisation and automation of siphon-less irrigation? (zero is no value and 100 is excellent value). The average response was 84.

c) establishing and fostering industry and research collaborations that form the basis for ongoing innovation and growth of Australian agriculture.

The GVIA grower-led automation trial has demonstrated the value of collaboration between producers, researchers and commercial providers. The Keytah site had input from Sundown

Pastoral Company, Padman Stops, GoannaAg, EnviroNode IoT, Deakin University, Islex, CSIRO and the GVIA. In addition, the site has visits from producers, education providers and industry organisations across Australia. In the last three years the site has hosted the

- MDBA listening tour 'Grower led research and development' and site visit in February 2021.
- Visits from UNE GRASS students in January 2020, 2021 and 2022.
- The GVIA field day in February 2021, this included producers, researchers and extension personnel from sugar, rice, horticulture, grains and cotton industries.

The 2021 GVIA SIP2 Field day provided an opportunity to collaborate with NSW DPI and CottonInfo. The field day also provided opportunity for presentations from SIP2 researchers including Deakin University, USQ, CSIRO and commercial partners Padman Stops, GoannaAg, EnviroNode IoT and Netafim. It was attended by the Southern Key learning sites tour (25 people) and the USQ Sugar Extension project (5 people).

Following the field day the GVIA and CottonInfo were approached by an Irrigation designer and producers in St George. This resulted in the development of CRDC2201 which involved collaboration between the GVIA (extension of RRDP2004), CottonInfo, USQ, Padman Stops, GL Irrigation Pty Ltd and Saunders Farming. A field day was hosted in partnership with the St George CGA in February 2022.

3.3 Contribution to SIP2 program outcomes

1. Improved on farm water productivity/water use efficiency through use optimised irrigation practices, precision irrigation technologies and autonomous irrigation systems on participating farms.
The SIP2 Monitoring and Evaluation Economic Report was able to use the GVIA Keytah system comparison as baseline data to inform assessments of productivity outcomes.

The GVIA project has found that system performance is influenced more by seasonal conditions than by system selection. Further to this the economic report notes that "As emphasised by Chancellor et al. (2021), estimates of total factor productivity can be highly sensitive to climate variability and obscure short-term productivity trends."

The economic report found the average productivity gains in cotton to be 11% for water and 5% for multi factor. There was however significant variability in results. Labour productivity gains were found to be larger than water productivity gains. Transitioning from siphon to bankless channel was found to have a 7% water productivity gain (GPWUI) and a 687% labour productivity gain. This transition was found to have a -40% capital productivity. Applying automation to bankless found a 7% gain in GPWUI and a 567% labour productivity gain. This was found to have a -3% capital productivity. Importantly the report found that "For all SIP2 research, the productivity gains from labour, water, and energy outweighed the decreased capital productivity, generating average multi-factor irrigation productivity gains of 5% (median 5%)."

The variable nature of the Australian climate makes it difficult to achieve specific 15% water productivity gains from precision automation in cotton over a short three year time frame. This is especially important when the high cost of automation if factored in. An improvement of 11% in water productivity and a multi factor productivity gain of 5% in cotton should be seen as a good outcome.

Feedback from event participants indicate that many are intending to make investments and transition to more precise automation of irrigation.

- Which irrigation system would you like more commercial data on? 78% indicated automated bankless channel.

Thinking about the automated/remote control irrigation information presented: Please rate the likelihood of you adopting the following technology into your operations.

	EXTREMELY LIKELY	VERY LIKELY	NOT SURE	SOMEWHAT UNLIKELY	UNLIKELY	TOTAL
Padman Stops Automated gates	35.00% 14	42.50% 17	20.00% 8	0.00% 0	2.50% 1	40
EnviroNode Farm Automation Control	5.13% 2	23.08% 9	51.28% 20	7.69% 3	12.82% 5	39
SISCOweb irrigation optimisation	5.13% 2	30.77% 12	53.85% 21	5.13% 2	5.13% 2	39
Plant based sensing for cotton irrigation in limited water	10.00% 4	40.00% 16	42.50% 17	2.50% 1	5.00% 2	40
GoannaAg GoField Plus	7.69% 3	48.72% 19	41.03% 16	0.00% 0	2.56% 1	39
Integrated Smart Sensing, automation with Padman gates	22.50% 9	52.50% 21	22.50% 9	0.00% 0	2.50% 1	40
Netafim Modnet modular drip irrigation system	2.50% 1	5.00% 2	25.00% 10	15.00% 6	52.50% 21	40

Thinking about the information presented: Please rate the likelihood of you making changes or adopting the following technology into your operations.

	EXTREMELY LIKELY	VERY LIKELY	NOT SURE	SOMEWHAT UNLIKELY	UNLIKELY	TOTAL
Automated gates (eg Padman stops)	10.00% 1	30.00% 3	40.00% 4	10.00% 1	10.00% 1	10
Transitioning fields to siphon-less designs	30.00% 3	40.00% 4	20.00% 2	0.00% 0	10.00% 1	10
SISCOweb irrigation optimisation	0.00% 0	20.00% 2	60.00% 6	10.00% 1	10.00% 1	10
Channel level sensors	20.00% 2	50.00% 5	20.00% 2	0.00% 0	10.00% 1	10
Improved monitoring of water in fields	40.00% 4	40.00% 4	10.00% 1	0.00% 0	10.00% 1	10

2. A more knowledgeable and skilled irrigation community with greater confidence in their ability to optimise irrigation performance.

Project field days and publications (GVIA field day booklet and St George Field day booklet) provided producers an opportunity to see commercial research, to hear for commercial suppliers and to get insight into how technology can be applied on farm from growers. This ensures that growers can make informed decisions on how technology can be applied to their operations and what outcomes they can expect. Feedback from both events follows.

- How would you rate the value of the GVIA field day; Application of digital technologies for automated irrigation? 63% found it to be Excellent value, and 35% found it good value.
- Thinking about the Thuraggi Overflow siphon-less trial. How would you rate the value of commercial scale research? (zero is not valuable and 100 is extremely valuable) The average response was 89.

- Following the presentations today, are you likely to work to optimise your irrigation efficiency by

	YES	NO	UNSURE
changing flow rates into fields	44.44% 4	11.11% 1	44.44% 4
adjusting irrigation run times	44.44% 4	33.33% 3	22.22% 2
adjusting field length	33.33% 3	66.67% 6	0.00% 0

3. Improved project RD&E efficiency through knowledge sharing, integration and collaborations between researchers, project participants, and commercial partners.

Knowledge sharing, integration and collaboration between producers, researchers and commercial partners is essential to all aspect of the GVIA project. The Keytah site had input from Sundown Pastoral Company, Padman Stops, GoannaAg, EnviroNode IoT, Deakin University, Islex, CSIRO and the GVIA.

The field day was attended by 150 people from five industries. The geographical footprint extended from the Burdekin in Qld to northern Victoria.

The SISCO demonstration at Newport had collaboration between AFF limited, USQ, EnviroNode IoT and GVIA.

The siphon-less tailwater backup trial at St George had collaboration between Saunders Farming, GL Irrigation Pty Ltd, USQ, Padman Stops, CottonInfo and GVIA.

4 Collaboration

4.1 Project collaborations

The GVIA grower-led automation trial has demonstrated the value of collaboration between producers, researchers and commercial providers. The Keytah site had input from Sundown Pastoral Company, Padman Stops, GoannaAg, EnviroNode IoT, Deakin University, Islex, CSIRO and the GVIA. In addition, the site has visits from producers, education providers and industry organisations across Australia. In the last three years the site has hosted the

- MDBA listening tour 'Grower led research and development' and site visit in February 2021.
- Visits from UNE GRASS students in January 2020, 2021 and 2022.
- The GVIA field day in February 2021, this included producers, researchers and extension personnel from sugar, rice, horticulture, grains and cotton industries.

The 2021 GVIA SIP2 Field day provided an opportunity to collaborate with NSW DPI and CottonInfo. The field day also provided opportunity for presentations from SIP2 researchers including Deakin University, USQ, CSIRO and commercial partners Padman Stops, GoannaAg, EnviroNode IoT and Netafim. It was attended by the Southern Key learning sites tour (25 people) and the USQ Sugar Extension project (5 people).

The SISCO demonstration at Newport had collaboration between AFF limited, USQ, EnviroNode IoT and GVIA. Collaboration is expected to be ongoing between USQ and EnviroNode IoT.

Following the field day the GVIA and CottonInfo were approached by an Irrigation designer and producers in St George. This resulted in the development of CRDC2201 which involved collaboration between the GVIA (extension of RRDP2004), CottonInfo, USQ, Padman Stops, GL Irrigation Pty Ltd and Saunders Farming. A field day was hosted in partnership with the St George CGA in February 2022.

The work initiated in collaboration with CottonInfo, Padman Stops and USQ (CRDC2201) on the Tailwater backup system demonstrated the value of a group working to achieve a desired outcome.

The data associated with the trial is still being finalised, but there have been some encouraging findings. The trial wanted to determine the irrigation performance of this bankless channel design. The results show that the performance in the top of the field can be measured and is quite good. There has also been steps towards determining how to monitor the sections of the field where the tailwater is backing up. Continued investigation in this area would be useful as a large number of siphon fields are being transitioned to this type of design.

The grower partner has found that he could potentially optimise this design by more optimally timing his start times, and by knowing when to shut off the inflow into each bay. Discussions have been held to look at ways this could be achieved using the capital items purchased as part of RRDP2004 and CRDC2201. Given the increasing transition to bankless channel designs continued commercial research to optimise this would be valuable.

5 Extension and adoption activities

5.1 Project extension & adoption activities

- GVIA field day with 150 attendees. Supported by a field day booklet and a series of interviews with the SIP2 researchers and partners presenting at the day. The field day hosted 25 people from the Southern Key Learning tour and five from the USQ sugar extension tour. The booklet and videos were posted on the GVIA and SIP2 websites and social media posts.
- The GVIA hosted the MDBA listening tour with 15 visitors from MDBA, CEWH, NRAR, and local producers.
- The Keytah General Manager Nick Gillingham did an interview with ABC TV
- The St George field day at Thuraggi Overflow in February 2022. 20 attendees. Prepared a booklet (on SIP2 website) to support the panel discussions. Worked with CottonInfo to support the preparation of an article in the Australian Cotton Grower, a podcast on the CottonInfo podcast site and a series of video's talking about the trial.
- Submission to present at St George Food and Fibre conference July 2021 (postponed to Sept 2021 and cancelled)
- Invitation to present at ICC irrigation conference in July 2021 (postponed until 2022)
- Submission accepted to present at IAL postponed to October 2022.
- Application to present at the Australian Cotton Conference postponed to 2022.

5.2 Lessons learnt and recommendations for future extension.

Extension of information is most effectively done on farm where producers can discuss their needs with other producers, researchers and commercial providers. The GVIA was very lucky to be able to host one large and one smaller in field event over the last three years.

One of the more successful approaches was having producers tell their story. At the GVIA and St George events we had panels. The GVIA panel was growers only but resulted in very good interaction from the audience. The St George panel had commercial providers and researchers represented with growers. With the much smaller audience there was less interaction from the audience. One of the commercial presenters at the GVIA field day invited a producer to participate in his presentation, this was very successful giving the audience a much better understanding.

Covid travel restrictions and boarder closures made it difficult to host the smaller one on one site visits normally part of a GVIA project. Nothing can replace this experience.

There have been numerous videos developed as part of the project. Prior to the GVIA field day we investigated doing a virtual field day, live streamed to audiences. Given the poor connectivity and the very high cost this was not practical. We also investigated pre-recording footage and interviews with presenters, given the wide geographical spread of presenters, this was logistically not possible.

As SIP2 has progressed we looked at different ways to capture the information so that it would be of interest and value to producers. Several conversational interviews were recorded towards

the end of the project. These were posted on the SIP2 site as a series of videos and the SISCO Channel Chat was posted as a podcast. The podcast was well received with a continuing number of downloads.

Where possible we have attempted to get producers to participate in videos or podcasts. Generally, they are very reluctant to be involved. This makes field days even more important to get that shared learning.

6 Appendix - additional project information

6.1 Sub-project, media and communications material and intellectual property

6.1.1

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Nature of materials / activities	**Number**	**Details** (Please provide details if appropriate (eg links to publicly available documents)
Press releases		
Media appearances – press and TV		Recorded interview with ABC radio on the Keytah site and Integration 8 Sept 2020 Article in Grain Central: https://yourdata.com.au/smarter-irrigation/#dashboard/records/record-details2/5f4c5c238bc31e0019215744/ ABC TV interview with Nick Gillingham Keytah GM Inland New South Wales rivers may never recover from the last drought, expert warns - ABC News Article on Siphon-less tailwater backup project in Australian Cotton Grower Feb-Mar 2022
Brochures, fact sheets, posters and newsletters		https://smarterirrigation.com.au/gwydir-valley-demonstration-of-the-application-of-the-latest-digital-technologies-for-precise-automated-irrigation/ Project Summary update Project Technical report SIP2 project fact sheet updated GVIA field day booklet (on data base)
Web page		• GVIA Irrigation efficiency page (67 hits as top landing page): https://www.gvia.org.au/community-and-industry-initiatives/irrigation-efficiency/ • GVIA Irrigation System Comparison page: https://www.gvia.org.au/community-and-industry-initiatives/irrigation-efficiency/keytah-system-comparison/ • Smarter Irrigation for Profit 2 video: https://smarterirrigation.com.au/environode-iot-solution-for-smarter-irrigation/ GVIA Irrigation System Comparison

		and SIP2 page updates GVIA Website: https://www.gvia.org.au/community-and-industry-initiatives/irrigation-efficiency/ SIP2 Website https://smarterirrigation.com.au/gvia-sip2-field-day-2021/ CottonInfo Podcast: Craig Saunders talks about Bankless channel with tail water backup CottonInfo YouTube: Bankless Optimisation Trial Bankless optimisation trial sensors and equipment Bankless Optimisation Trial St George Management Field day Bankless Optimisation Trial Summary
Field days, expos, field walks		GVIA field day Gwydir Valley Irrigators Association Inc - Irrigation Efficiency (gvia.org.au) 150 MDBA listening tour -grower led research discussions and site visit 25 St George Field day 20
Stakeholder forums, meetings, presentations, workshops, webinars		Scheduled GVIA field day: https://smarterirrigation.com.au/gvia-smarter-irrigation-field-day/ Irricom held in Moree 11Feb2021 Participated in the GRDC research update irrigation. https://smarterirrigation.com.au/grdc-grains-research-update-online-irrigation-north/
Social media presence		https://twitter.com/Irrigation4P and https://twitter.com/GwydirValley GVIA twitter and facebook @gwydirvalley SIP2 twitter @irrigation4P
Scientific conference presentations		Submission to present at St George Food and Fibre conference July 2021 (postponed to Sept 2021 and cancelled) Submission and paper to present at ICC irrigation conference in July 2021 (Cancelled until 2022) Submissions to present at IAL postponed to October 2022 Presentation at Australian Cotton Conference August 2022

6.2 Monitoring and evaluation

Key messages included earlier in document.

- GVIA Field day feed back
- St George Field day

Full reports included on database.