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Part 1 - Summary Details

Please use your TAB key to complete Parts 1 & 2.

CRDC Project Number: RRD1734

Project Title: Smarter Irrigation: Educating growers in innovative on-farm water management and scheduling practices

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CRDC Research Program: 2 Industry

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Date Submitted: **31 May 2018**

Part 3 – Final Report

Background

The focus of the project was the strengthening of the existing extension efforts on new irrigation scheduling technologies. A combination of tools were used and promoted as aids to improve the accuracy of depth of water required and applied and the timing of applications for optimum agronomic decisions.

At present, in the sugarcane industry extension activities are being advocated by extension deliverers towards the use of available tools for better on-farm water management. The combination of soil moisture monitoring (SMM) tools in combination with a sugarcane specific crop model (IrrigWeb) to assist irrigators gain confidence with using both tools.

IrrigWeb provides irrigators with current and local advice on sugarcane crop water use and development. The tool combines crop water use estimates with user-defined irrigation system constraints and crop cycle inputs to schedule future irrigation events. The selection of the model was based on the review of the tools for irrigation scheduling in the sugarcane industry document which was also co-funded by CRDC (Project RRDP1609) as the most highly rated by practitioners and advisors consulted with.

Objectives

The general objective of the project was to realise significant productivity and profitability improvements for sugarcane growers. The specific objectives were to:

- Engage in coaching and training activities with seven sugarcane growers[1] in the use of innovative irrigation scheduling tools available and supported by the extension community in the Burdekin.
- Deliver a report on the actions and activities taken in the education of sugarcane growers[2] in innovative on-farm water management and irrigation scheduling practices.

Methods

Introduction

The engagement of the seven farmers was carried out through the Burdekin Productivity Services (BPS). BPS has been holding IrrigWeb Workshops since 2016. BPS has received funding and support through DAF, Smartcane BMP and the Rural Water Use Efficiency (RWUE) program to make IrrigWeb available to all members of the BPS free of charge. The support from the CRDC funding strengthened this program and allowed for more time from BPS and AgriTech Solutions to be spent with growers on a one-on-one basis. In addition to this, SRA was able to engage with the sugarcane industry in the Bundaberg area to assist with the set-up and training of irrigation managers on IrrigWeb on three strategic fields.

[1] Additional engagement was had with the one of the millers in the Southern Region who had demonstrated interest in the adoption of irrigation schedulling tools in their operations.

[2] The engagement with Operation Managers at the Mill was considered a positive action considering that decisions to use management tools are made at that level. The Operation Manager engaged has tertiary agricultural qualifications and understands the concepts. They are actively looking for tools to assist them with irrigation control, and management and it's expected that the adoption path will be easier and faster.

Workshops

There were two types of workshops conducted as part of this project:

1. Sessions delivered on the setup and use of IrrigWeb, held at the BPS facilities and
2. Sessions with advisors and managers and non-technical staff in charge of decision-making for irrigation related projects in the industry, at the Ayr Research Facilities (343 Old Clare Road, Ayr QLD 4807)

Three workshops were delivered on Wednesday 28 February and Wednesday February 14 March. During the workshops. The presenters were the three project collaborators:

- Steve Attard (AgriTech Solutions)
- Marian Davis (Burdekin Productivity Services)
- Andres Jaramillo (SRA – Adoption Officer | Irrigation)

The topics discussed were[3]:

- What's a good irrigation?
- How would it be assessed?
- Calculating application volumes
- Common misconceptions about irrigations
- Tools to help monitor Irrigation
- Practical exercises to pull it all together

Photo 1: Workshop with local extension staff

[3] More detailed information about the agenda for the workshop can be found in the appendix.

Photo 2: Workshop on IrrigWeb with growers at the BPS facilities

The target audience for the workshops held, were the sugarcane extension staff working in the Burdekin to stimulate innovation and diffusion within the sugarcane industry. As custodians of the technology transfer process, knowledge management and extension can both take ownership of the promotion of practises and have the ability to influence the behaviour of farmers to adopt them. The interaction with the farmers is considered extremely important to gain insight about the realities of the adoption of irrigation scheduling tools.

Equipment

Considerations at the start of the project were to go for more traditional soil moisture probes and alike. As the project progressed, it was realised that a major missing piece of information was around the volumes applied and the areas irrigated. Some of the funding received was used to purchase tools that were deemed as key for educational purposes, the main purpose of the project. The tools purchased will be more beneficial for demonstrations and accuracy of the data to be used as input in the model. A soil auger and GPSs were purchased to assess irrigated areas and depth of applications. Considerations for the acquisition of portable flow-meters and thickness-gauges was also had as the project developed, but the timing to do so within financial time-frames prevented the purchase from occurring. The purchasing of tools as aids in the process of educating farmers in the irrigation scheduling has been recommended as part of the future work proposed.

Rationale and approaches

- The focus of the project was the strengthening of the existing extension efforts on new irrigation scheduling technologies. The promotion of a sugarcane-designed and calibrated irrigation scheduling model (IrrigWeb) was furthered. IrrigWeb provides irrigators with current and local advice on sugarcane crop water use and development. It combines crop-water use estimates with user-defined irrigation system constraints and crop cycle inputs to schedule future irrigation requirements.

- Over 40 hours of consultations one-on-one between the growers selected and the project collaborators have been had towards the correct setup and familiarisation with the tools as part of the methodology used in this project.

- The workshops emphasised on the skills required to set up the model and therefore understand what it is doing behind the scenes.

- A review of the principles of irrigation and of the practices in the region and particular farms was deemed necessary to be undertaken with the local extension providers' staff. Discussions towards an improved understanding of the available tools, their correct use and interpretation as well as about what extension practices should be enhanced to stimulate adoption of best management irrigation practices were carried out.

- In the sugarcane industry, efforts towards helping growers to improve irrigation efficiencies focus on reducing input costs and increasing returns. The use of G-dots is being promoted as an aid to visually determine the right time for irrigation. Applications are being developed to communicate with these apparatus and other soil moisture sensors to notify irrigators when the water has reached certain location. However, a lack of knowledge about how much water has been applied is oftentimes missing.

- As a consequence of the above, the decision to replace the acquisition of more soil probes as aids to improve the accuracy of depth of water required and instead, acquire portable flowmeters which can be used on several more fields for improvements and adoption of smarter irrigation tools was made.

- The promotion of the combination of at least two tools: flowmeters and irrigation scheduling models was made in order to achieve maximum potential for optimal production.

- One of the growers selected to be taken in this journey was a large canegrower company in the Bundaberg Region who had demonstrated interest in the adoption of smarter irrigation technologies. The company uses a range of irrigation systems and grows sugarcane in over 8000 hectares. The same process of commitment as with the other Burdekin growers has been undertaken with some more one-on-one engagement for assistance with field-measurements and model set-up.

Results

- Confidence in the technology has been gained by the people worked with. Growers and irrigators have worked directly with adoption personnel to develop, implement, and fine-tune the irrigation scheduling tool.

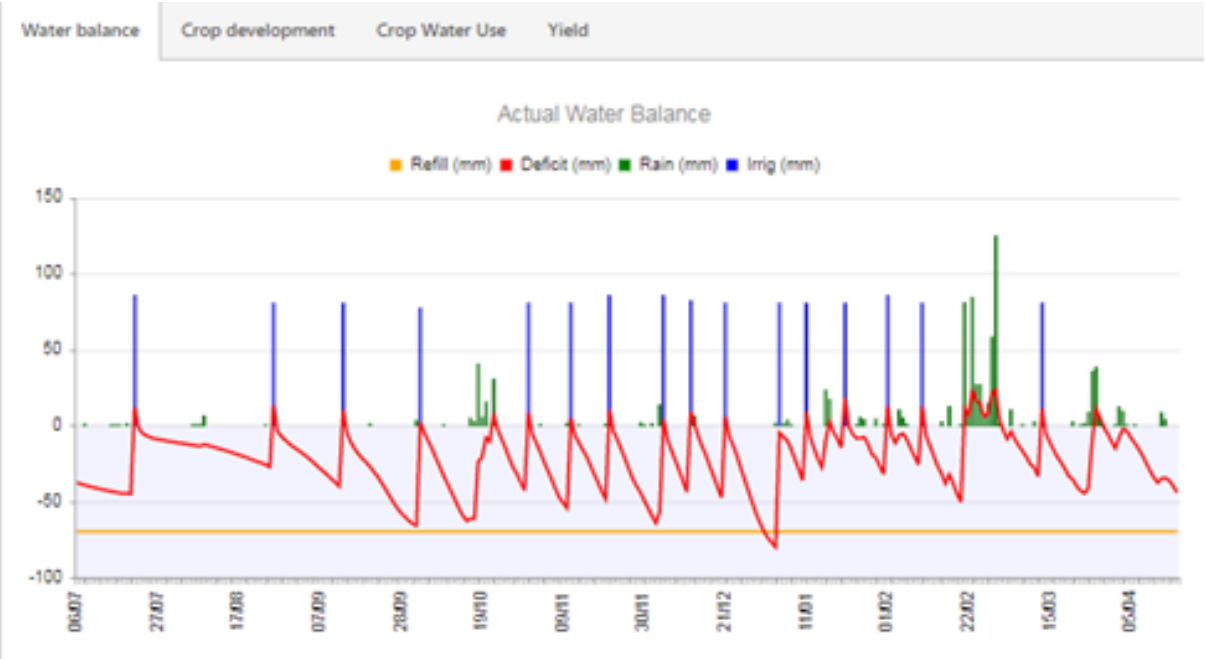
- This is expected to help increase the on-farm water management efficiencies and overall irrigation practices in the years to come.

- These group of people are now part of the over 30 sugarcane produces who are using IrrigWeb as a tool for their irrigation decision making.

- The workshops held, highlighted a need to continue work with the local extension advisors as there are some fundamental concepts and myths that need to be demystified in order for them to embrace smarter technologies and disseminate the message across their stakeholders.

- Selected paddock specific irrigation schedules are being generated by the participants with the assistance of the project collaborators (AgriTech Solutions and Burdekin Productivity Services) on a weekly basis with the crop water use and proposed schedule of each block under trial.

Figure 1. Screen-capture of one of the IrrigWeb's Water Balances for a modelled paddock



Outcomes

Table 1 describes how the project's outputs have matched the planned outcomes identified in the project application.

Planned Outcome	Milestone	Achievement
Engagement of seven farmers	Seven farmers engaged and set up to undertake irrigation scheduling on a number of strategic fields.	Achieved
Linking scheduling tools	Farmers using a combination of soil moisture monitoring, plant growth rates and IrrigWeb to plan irrigation management.	*Partially achieved*
Irrigation scheduling workshop	Hold an irrigation scheduling workshop for local extension provider staff.	Achieved
Building confidence in the technology.	Farmers will work directly with researchers and adoption personnel to develop, implement, and fine-tune technologies to increase on-farm water management efficiencies	Achieved
One-on-one time with project participants	A group of selected farmers will be trained on stalk growing measurements, use of Soil Moisture Probes, irrigation water measurements, set up of Parameters into IrrigWeb and data interpretation.	Achieved
Field walks	Seven field walks will be undertaken showcasing the seven pilot farms using soil moisture sensors, stalk growth and IrrigWeb as tools for irrigation management	*Partially achieved*

Table 1: Project outputs

Advisors Workshop Participants

The workshop, held on (date), was attended by the following people:

- Udi David Stern (N-drip)
- Madeline Molino (BPS)
- David Paine (BPS)
- Ashley Taran (BPS)
- Jasmine Connolly (BPS)
- Dennis Stubbs (BBIFMAC)
- Michael Hewitt (AgriTech Solutions)
- Arwen Rickert (BBIFMAC)
- Gracie White (BBIFMAC)
- Brendan Farr (LBW)
- David Sartori (LBW)
- Paul Godfrey (NQ Dry Tropics)
- Shakira Todd (NQ Dry Tropics)
- Alejandra Santos (AgriTech Solutions)
- Terri Bouno (DAF)
- Brock Dembowski (DAF)
- Marian Davis (BPS)
- Andres Jaramillo (SRA)
- Steve Attard (AgriTech Solutions)

Conclusion

Assessment of the likely impact of the results and conclusions of the research project for the sugarcane industry and take home messages

Impacts

Advisors have a better appreciation of:

a. How to assess/interpret an irrigation performance
b. The simple measurements that can be made
c. The tools that are available

People working in the water/irrigation sector have a significant influence on the way farmers think about and understand irrigation related matters. It is imperative that these people are using a common language to convey a consistent message. When this does not occur, many farmers become confused with the inconsistency.

The starting point must revolve around improving irrigation skills of farmer advisors (extension officers) and other people associated with water management. There are a number of agencies working in the water/irrigation sector, e.g. Lower Burdekin Water, NQ Dry Tropics, BBIFMAC, Department of Agriculture and Fisheries, etc. Many of these people have received little or no training around irrigation management and often lack fundamentals.

While the initial workshops were well received, they need to be ongoing and regular. This would assist consolidating and developing skills, while creating a local mentoring relationship between people working in this sector.

The flow on benefit of this is that, while individuals improve their skill base, they are communicating with the farmers using information and language that is now consistent with their peers.

The industry benefits because farmers gain confidence that extension officers and advisors communicate with a consistent message and advocate the use of the best tools available.

Extension Opportunities

Plan for the activities or other steps that may be taken:

a) To further develop or to exploit the project technology

- There are a wide range of skills within the sugar industry's extension providers, however only a relatively small number have a strong skill set with regard to irrigation management. This project has taken steps towards improving irrigation knowledge within the extension community, however, to be successful, this training needs to be continued. The extension staff who participated in the training funded under this project all indicated that they had found the information valuable and would like to receive further training. How this training would be funded and provided has yet to been determined.

- Ultrasonic flow meters will need to be purchased by the project following from this one. It would be used for on-farm irrigation assessments and allow the calculation of irrigation application volumes. In the Burdekin, where a large number of the groundwater bores are unmetered, many growers are unaware of pump flows and how much water they apply during an irrigation event. To effectively utilise a program like IrrigWeb, volume applied is essential information. With the purchase of the flow meter growers will be able to get their pump flows and then calculate their water use. Two GPS were purchased to aid in the demarcation of the irrigated areas during the phase of setup and implementation of IrrigWeb as a scheduling tool.

- One of the challenges for growers that affects the uptake of IrrigWeb is the requirement to manually enter each irrigation event. The average number of irrigation events in the Burdekin is 20 per block per year. For a grower with many blocks this can soon add up to a large number of events to input. To overcome this barrier to adoption, a NESP (National Environmental Science Program) funded project (Improving water quality for the Great Barrier Reef and wetlands by better managing irrigation in the sugarcane farming system) is investigating the linking of IrrigWeb and irrigation automation software so that data from irrigation events (date, field name, volume applied) are automatically uploaded to IrrigWeb. This first step of the project has been successful, and will help to overcome this major impediment to grower uptake of IrrigWeb.

- Since there have been relatively few adopters[4]of IrrigWeb and therefore not much word of mouth yet, other early adopters rely on testing the innovation for themselves to inform the adoption decision. It is known that a farmer acts when some factor motivates the action. The challenges and adoption strategies for further development of the technology should be focussed on growing the perceptions of relative advantage over the *status quo* to increase the motivation, while simultaneously reducing the perception of risk, complexity and uncertainty which affects enthusiasm over adopting a new farming practise.

b) Future presentation and dissemination of the project outcomes.

- Burdekin Productivity Services (BPS) extension staff are active and strong advocates for the use of irrigation scheduling tools in all their forms – IrrigWeb, soil moisture sensors, crop growth measurements. As a part of general extension activities these tools are discussed with growers and assistance provided with their implementation.

- Growers themselves are also powerful advocates for technology uptake. As more growers use and become comfortable with the IrrigWeb program they will discuss it with their friends and neighbours and this will help with the uptake of the program.

[4] About 30 at present in the Burdekin Region.

c) Future extension work

- It is recommended for the way forward to implement more case-studies and experiments with a suite of extension interventions, informed by the results and the differences obtained in the trials to increase the feedback and world of mouth from actual new users of the technology. Word of mouth will act as a strong influential force. Continuous follow-up with new adopters who have the power to give rise to positive word of mouth and further adoption, requires a strong intervention of extension facilitators to prevent existing adopters from dis-adopting and giving rise to negative word of mouth.

- As part of this continued support for the technology, equipping the extension staff with the tools required to carry out the educations process appears as an imperative action. Initial farm assessments are required in order to learn as much as possible about the paddocks to be modelled. This is a key starting point for the use of smarter technologies such as IrrigWeb and other irrigation scheduling tools.

- Work is needed in developing strategies to narrow the gap between the perspective and goals of researchers, software manufactures and sugarcane growers. Researchers have a slight tendency to concern themselves with accuracy and precision while growers are more interested in aspects such as the ability to improve crop yield, crop quality, and profitability and not necessarily to use water more efficiently. The efficient use of water has historically not been ranked as a high priority in the industry. In many instances growers would only consider adopting innovations only if they helped to reduce the amount of time spent on water management, thereby freeing up time to spend on other activities.

Part 4 – Final Report Executive Summary

This project supported, and added value to the existing irrigation related extension activities across the Burdekin and Bundaberg regions. Within the Burdekin, a sophisticated web-based, sugarcane crop model has been adopted by Burdekin Productivity Services Ltd as their primary tool for irrigation scheduling. Engagement with the milling company in the Southern Region on education towards irrigation scheduling practices is expected to strengthen their capabilities and once the system is implemented, serve as a showcase for farmers in the region for further endorsement and transfer of the technology and eventual adoption. The chosen tool also assists in irrigation record-keeping and benchmarking of on-farm water management, both of which are required to achieve Smartcane BMP accreditation.

Educating sugarcane growers about improved irrigation practices requires a sustained investment in both farmers and extension staff. Typically, Burdekin sugarcane farmers have irrigated on a fixed cycle schedule without any knowledge of how much water they were applying, nor how much water their crop was using. Instilling an appreciation for the importance of this basic information will require a concerted, long-term program. Raising the knowledge base of local extension staff about irrigation fundamentals is also critical to lifting the understanding of the irrigators. While the workshops conducted through this project were well received, participants highlighted that on-going professional development of extension staff should be considered as a priority.

Appendix

Workshop Material

Workshops Agenda

MORNING

Agenda item	Who	Time	Time Allocation
Welcome & introductions	AJ	8:30 – 9:15	30-45 min
What is a good irrigation & how would it be assessed? • Understanding CWU • SWHC • Definition of scheduling - time & volume • Rooting depth • Soil type • Cycle time • Application volumes • Evap, ET0, ETc	MD/SA	9:15 – 10:15	60 min
Exercise – calculating application volumes	MD/SA	10:15 – 10:30	15 min
Break	10.30	10:30 – 10:50	20 min
Common misconceptions • Cup colour = flow • Bigger pipe = higher flow • Time defines irrigation efficiency • Increasing flow = good irrigation /efficiency • 7-day cycle is the best • Schedule is timing only • Minipan = CWU • Capacitance mm = CWU	MD/SA	10:50 – 11:10	20 min
Tools • What is available ▪ Minipan ▪ Gdot ▪ Capacitance ▪ Shovel • Strengths & limitations • What tools actually measure • Calibration vs relative	AJ/MD/SA	11:10 – 11:30	20 min
Wrap up/pulling it all together	MD/SA	11:30 – 12:30	45 – 60 min

AFTERNOON

Agenda item	Who	Time	Time Allocation
Welcome & introductions	AJ	1:30 – 1:50	20-30 min
What is a good irrigation & how would it be assessed? • Understanding CWU • SWHC • Cycle time • Definition of scheduling - time & volume • Application volumes • Evap, ET0, ETc	MD/SA	1:50 – 2:40	50 min
Common misconceptions • Cup colour = flow • Bigger pipe = higher flow • Definition of scheduling - time & volume • Time defines irrigation efficiency • Increasing flow = good irrigation /efficiency	MD/SA	2:40 – 3:00	20 min
Practical example	MD/SA	3:00 – 3:30	30 min

SCENARIOS

APPLICATION VOLUME

1. What is the application volume (ML/ha) for the following scenario?
The cup flow rate is 1 L/s, and there are 50 cups in the set. Each set runs for 6 hours. The row spacing is 1.52 m, and the row length is 300 m.

How many mm does that equate to?

2. What is the application volume (ML/ha) for the following scenario?
A pump flow test has been done and the pump is supplying 104 L/s to 80 cups. The row spacing is 1.65 m and the row length is 800 m. Each set runs for 24 hours.

How many mm does that equate to?

3. What is the application volume (ML/ha) for the following scenario?
A pump flow test has been done and the pump is supplying 120 L/s. The area being irrigated is 10.56 ha. Each set runs for 24 hours.

How many mm does that equate to?

CROP WATER USE

4. How much water has the crop used since the last irrigation, and how does that compare to the volume being applied?
Average daily crop water use is 3 mm/day. The last irrigation was 10 days ago. The average application volume is 47 mm.

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5. How much water has the crop used since the last irrigation, and how does that compare to the volume being applied?
Average daily crop water use is 7 mm/day. The last irrigation was 10 days ago. The average application volume is 59 mm.

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IRRIGATION ASSESSMENT

What is your assessment of this irrigation?
The cup flow rate is 1.3 L/s and there are 75 cups per set. The row spacing is 1.60 m and the rows are 950 m long. The soil is a sodic duplex with a readily available water content of 35 mm/m, rooting depth is 1 m. Each irrigation runs for 24 hours and is on a 7 day cycle. Daily crop water use is 6 mm/day.

What is your assessment of this irrigation?
The pump supplies 80 L/s. The row spacing is 1.80 m and the rows are 875 m long, there are 40 rows per set. The soil is a heavy clay with a readily available water content of 60 mm/m, rooting depth is 1 m. Each irrigation runs for 12 hours and is on a 7 day cycle. Daily crop water use is 7 mm/day.

CALCULATIONS

APPLICATION VOLUME

When you know the flow per cup (L/s)

$$Volume\ (L/ha) = \frac{\#\ cups\ x\ cup\ flow\ rate\ (L/s)\ x\ hours\ to\ irrigate\ x\ 3600}{area\ irrigated\ (ha)}$$

When you know the pump flow (L/s)

$$Volume\ (L/ha) = \frac{pump\ flow\ rate\ \ (L/s) x\ hours\ to\ irrigate\ x\ 3600}{area\ irrigated\ (ha)}$$

Megalitres and millimetres

$$Megalitres\ per\ hectare\ (ML/ha) = \frac{litres\ per\ hectare}{1{,}000{,}000}$$

$$millimetres\ (mm) = ML/ha\ x\ 100$$

CROP WATER USE SINCE IRRIGATION

$$Crop\ water\ use\ since\ irrigation = daily\ crop\ water\ use\ (mm/day)\ x\ days\ since\ irrigation$$

AREA

$$Area\ irrigated\ (ha) = \frac{number\ of\ rows\ x\ row\ spacing\ (m)\ x\ row\ length\ (m)}{10{,}000}$$

$$Area\ (ha) = \frac{area\ (square\ metres)}{10{,}000}$$

DEFINITIONS

Soil Water Holding Capacity – the volume of water that the soil can hold
Plant Available Water Content – the volume of water held in the soil between field capacity and permanent wilting point

Readily Available Water Content – the volume of water that the crop can readily access

Crop Water Use – the amount of water removed from the soil by the crop (transpiration) and lost from the soil surface (evaporation)

Evapotranspiration – the amount of water removed from the soil by the crop (transpiration) and lost from the soil surface (evaporation)

Evaporation – water that is lost from a surface

Irrigation scheduling – refers to the frequency of irrigation and the volume that is applied