Rural R&D for Profit Programme

Smart irrigation: when and how much
Project 1a
Final Report

RRDP

June 2015 – May 2018]

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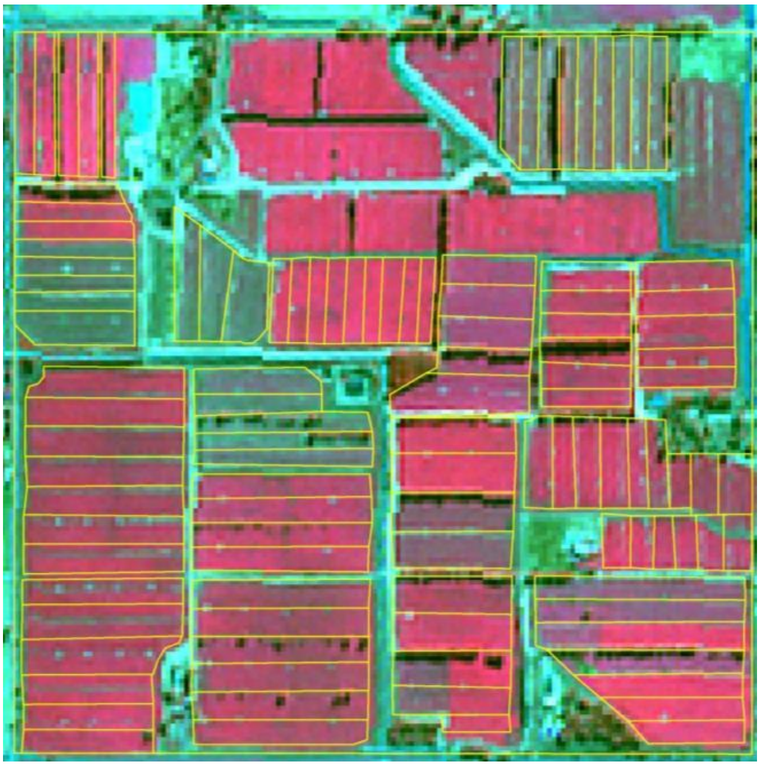

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[If applicable].

Contents

Plain English summary

Introduction

Economic and social concerns are driving an increased focus on water use in irrigated dairying in SE Australia. Engineering improvements in irrigation supply infrastructure have substantially increased the ability of irrigators to control both the timing and amount of water delivered to crops, and industry water saving options are focused on improving the ability of farmers to match irrigation water use to plant water requirements.

This project combines recent and forecast weather data with satellite imagery to provide local, web based crop and location specific measures of reference evapotranspiration (ETref) and crop coefficient (Kc) for use in irrigation scheduling. The project uses the recently developed satellite/weather based irrigation information system (SBIIS) which can determine crop water requirement at paddock scale over large areas and successfully demonstrates its ability to provide reliable and affordable automated irrigation scheduling on dairy farms in Victoria.

Irrigators require simple and affective scheduling tools that allow them to capitalise on the farm and regional irrigation infrastructure investments enabling the minimisation of water use and attendant labour and energy costs. The project was designed to provide irrigation information that affordably matches on-farm irrigation supply with crop water demand over large production areas and negates the need for irrigators to independently acquire the technical skills needed for precision irrigation practices.

The objectives of this project have been:

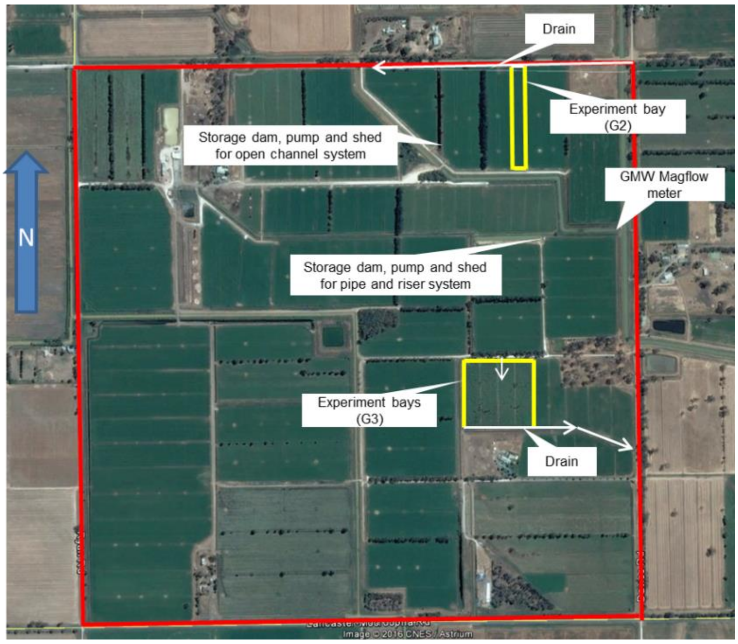
1. To develop SBIIS irrigation performance pilots to be implemented on commercial dairy farms.
2. To implement and demonstrate to irrigators and irrigation service providers automation of irrigation events triggered by SBIIS.
3. To deliver SBIIS based web service that is available to irrigation industries

Methods

The project selected a dairy farm in Northern Victoria to undertake SBIIS irrigation performance pilots in partnership with irrigation automation service providers Rubicon. Rubicon have established irrigation automation incorporating a basic scheduling service on the property as depicted in the figure below.

This project specifically researched the performance of a satellite based approach to irrigation scheduling in surface irrigation of perennial pastures making the results applicable to the grazing based industries, particularly dairy in south eastern Australia.

The project aimed to develop and test a simple and robust irrigation scheduling system based on satellite and weather information which can be repeatable and scalable to manage large number of bays.



Results

The project successfully achieved high application efficiencies and significantly reduced irrigation duration and volume over the period of the trial (2016/17-2017/18).

A scheduling system has been developed based on satellite imagery and weather data to estimate pasture water use, bay scale soil water deficit and the timing and duration of irrigation events.

Despite the uncertainty inherent in the estimates of crop water requirement and in the measurement of inflow and runoff, results suggest that the system has the potential to manage irrigation automation for relatively low permeable dairy soils.

Conclusions

The outcomes of this project highlighted the need to simplify the on-farm and decision-making components that an irrigator requires to develop a robust irrigation schedule. The current complexity in irrigation scheduling equipment (i.e. soil moisture monitoring) means that irrigators need to spend time interpreting and analysing data to arrive at irrigation decisions. This is challenging when dealing with a few irrigation bays but many dairy farms may have 100 plus bays.

This presents a big challenge for irrigators when they want to scale up the water management decision making and align with farm operations such as grazing. Irrigators therefore typically will drop back to experience and how they have always operated as a default.

Satellite-based irrigation scheduling methods avoid this problem by having minimal reliance on in-field hardware, and the maintenance of costly on-farm instrumentation of the large numbers of bays that are needed on large modern dairy farms.

Abbreviations and glossary

Provide a list of abbreviations and description of key words if used frequently throughout the report.

SBIIS.	Satellite/weather based irrigation information system
ETref	Reference evapotranspiration
Kc	Crop co-efficient.

1 Project rationale and objectives

In plain English, explain why the project was undertaken and how the project addresses an industry need.

Describe the project objectives including any changes to the project objectives that may have occurred over the life of the project.

Economic and social concerns are driving an increased focus on water use in irrigated dairying in SE Australia. Engineering improvements in irrigation supply infrastructure have substantially increased the ability of irrigators to control both the timing and amount of water delivered to crops, and industry water saving options are focused on improving the ability of farmers to match irrigation water use to plant water requirements.

This project combines recent and forecast weather data with satellite imagery to provide local, web based crop and location specific measures of reference evapotranspiration (ETref) and crop coefficient (Kc) for use in irrigation scheduling. The project uses the recently developed satellite/weather based irrigation information system (SBIIS) which can determine crop water requirement at paddock scale over large areas and demonstrates its ability to provide reliable and affordable automated irrigation scheduling on dairy farms in Victoria.

The project will allow producers to capitalise on the farm and regional irrigation infrastructure investments enabling irrigators to minimise water use and attendant labour and energy costs. The project will be designed to provide irrigation information that affordably matches on-farm irrigation supply with crop water demand over large production areas and negates the need for irrigators to independently acquire the technical skills needed for precision irrigation practices.

The objectives of this project have been:

1. To develop SBIIS irrigation performance pilots to be implemented on commercial dairy farms.
2. To implement and demonstrate to irrigators and irrigation service providers automation of irrigation events triggered by SBIIS.
3. To deliver SBIIS based web service that is available to irrigation industries

2 Method and project locations

Provide a brief description of how the project was carried out and if there was any change in methods over the life of the project.

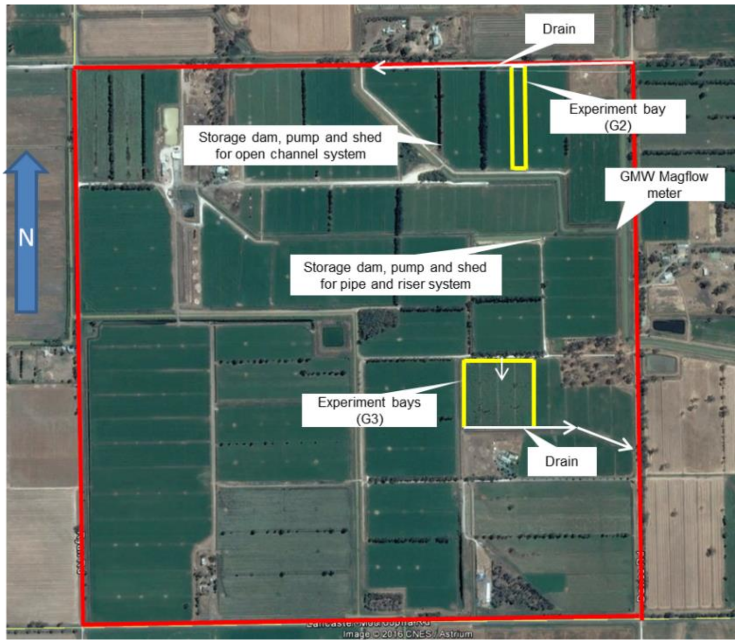
Provide a list of the locations of all project activities.

Describe the locations and/or regions where the research findings are applicable. This may be represented using a map.

For example, the research activities may include a specific university and a number of demonstration farms, yet the research findings may be applicable to dairy farms across south eastern Australia.

In delivering Activity 1a the project combined current, recent and forecast weather data (BoM) with satellite imagery to provide local, multi-crop web-based crop- and location-specific measures of ETref and Kc for use in irrigation scheduling, and will test the immediate ability of the approach to support high quality practical affordable automated irrigation water management on farms in Victoria.

As part of objective 1 the project selected a dairy farm in Northern Victoria to undertake SBIIS irrigation performance pilots in partnership with irrigation automation service providers Rubicon. Rubicon have established irrigation automation incorporating a basic scheduling service on the property as depicted in the figure below.



In year 1 the project worked with the providers and dairy farmer to:

- develop an SBIIS based irrigation module that will provide scheduling information for the irrigator and the automated system.

- establish an evaluation program (field trial) of the effectiveness of the triggers in improving scheduling and production outcomes for selected bays/fields within the pilot farms.

In year 2 (2016/17) the project implemented SBIIS for an irrigation bay growing perennial pasture on the trial farm. The irrigator ran his automated irrigation system according to the scheduling recommendations of the SBIIS for the 2016/17 irrigation season. Performance measurements of the irrigation events was captured in terms of irrigation timing, duration and runoff generated. Informal feedback was sought from the irrigator as to the practicality of the scheduling recommendations in the context of farm operations.

In Year 3 (2017/18) the project modified and extended the trials to cover 2 field sites and multiple perennial pasture bays across both medium and light soil types. The undertook the same performance measurements conducted the previous year. The software components of the service were modified to incorporate the generation of scheduling recommendation for multiple bays.

This project specifically researched the performance of a satellite based approach to irrigation scheduling in surface irrigation of perennial pastures making the results applicable primarily to the grazing based dairy industries in south eastern Australia.

3 Project achievements

Describe key results for each component of the project. Include graphs, tables and/or images where applicable.

3.1 Project level achievements

The projects objectives were

1 To develop two SBIIS irrigation performance pilots to be implemented on commercial dairy farms

2 To implement and demonstrate to irrigators and irrigation service providers automation of irrigation events triggered by SBIIS

3 To deliver an SBIIS based web service that is available to irrigation industries by June 2018

To deliver these the project has successfully:

- developed and tested for 2 irrigation pilots a simple and robust irrigation scheduling system which can be repeatable and scalable to manage large number of bays.
- developed an irrigation automation system based on satellite imagery (NDVI) and weather data (SILO/BOM) to estimate pasture water use, bay scale soil water deficit and the timing and duration of irrigation events.
- achieved high irrigation application efficiencies on the irrigation pilots by supporting irrigation events that are geared to a consistent soil water deficit and water application.

Documentation of the outcomes of these pilots are attached in the form of technical reports in the appendix.

The developed software system is currently hosted on the FarmBuild platform at http://52.63.122.142/farmbuild/index.html.

The activities undertaken successfully achieved objectives 1 & 2 and demonstrated that irrigation scheduling supported by the SBIIS approach can achieve high irrigation application efficiencies and can support scaling to a larger number of bays.

While we developed a web service that is available for irrigation service providers to test (objective 3) it is not in a form that can be fully integrated into an automated irrigation system. Consequently, the next challenge for this approach to be adopted as a fully automated approach to irrigation requires the further building of confidence by both irrigators and irrigation system providers that these approaches can be managed within the context of the whole farm operations.

3.2 Contribution to programme objectives

Generating knowledge, technologies, products or processes that benefit primary producers

The project has both demonstrated an approach and delivered tools that can support significant improvements in irrigation efficiencies by irrigated dairy farmers in an environment of increasing costs and lower availability of water. The pilot showed that irrigators can take advantage of the recent satellite technology to more precisely schedule their irrigations (timing and amount) based on plant water requirements without the need to install, operate and maintain significant in-field sensors. This is an important step in developing an automated irrigation scheduling system based on satellite information. In the pilot results are indicative of a 20% improvement in irrigation efficiencies increasing the irrigators ability to make profits through saving on water, power and labour. Components of the SBIIS developed in this sub-project are available as through an open source platform (http://52.63.122.142/farmbuild/index.html.) to all irrigation system providers. Through working with extension staff, the dairy farmers (e.g. Dairy Australia) and the irrigation systems industry (e.g. Rubicon) the findings and benefits of this software will become more widely known and built upon.

Strengthening pathways to extend the results of rural R&D, including understanding the barriers to adoption

The project has developed an improved understanding of the application of satellite/weather base scheduling and its role in farm water management through the undertaking of the pilot with a respected irrigator and his service provider Rubicon. The project has also interacted and supported irrigation extension staff in the region in delivering information on scheduling approaches. Through discussions with irrigators and extension staff the project team were able to confirm that the need to install, maintain and operate in-field sensors in order to schedule (i.e. timing and duration) and potentially automate an irrigation system can be a significant barrier to many dairy farmers. Overcoming this barrier through using a simple to use satellite based system may then allow more dairy irrigators to take advantage of water efficiencies than would occur otherwise. The project also established that an irrigation scheduling system needs to scale its application to the whole farm (e.g. 100 plus irrigation bays) and integrate with the farm operations such as grazing rotations (see Lesson's Learnt Section).

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

Through participating in the broader Smarter Irrigation project, the researchers in this sub-project have been able to have extensive participation in workshop, conferences and events to promote and enhance research collaborations. This has included discussions on issues and findings with the researchers and collaborators in the other Smarter Irrigation sub-projects. Similarly, the team has strengthened its collaboration with the water industry through its work with Rubicon (see Collaboration Section).

Improve the productivity and/or profitability of businesses and/or primary industries.

The project was able to demonstrate that the pilot participant achieved at least a 20% improvement in application efficiencies (90%) and irrigation durations. The current estimate of

dairy water use on perennial pastures is 109 GL in the summer period so a 20% saving represents 38 GL of irrigation water in Northern Victoria. This can represent up to a $7.6m annual saving to the dairy industry through not having to access the temporary water market.

The key to achieving these savings is to design irrigation scheduling systems that are simple to implement and can be scaled to the farm and integrated with farm operations. The system developed and trialled in this project represents an approach that can be implemented without excessive amounts of on-farm monitoring technology and can be scaled down or up to the farm scale.

4 Collaboration

The project has established several key collaborations over the life of the project, these include:

- Rubicon Water – Rubicon provide channel supply and on farm irrigation system services to the Goulburn Murray Irrigation District (GMID). Rubicon provided access to their FarmConnect software as well as provision, installation and support of monitoring equipment in the trial bays on the farm. In addition several workshops were held with Rubicon business managers and software developers to share the learnings of the research undertaken and the future directions of Rubicons on-farm and system software development. This collaboration will continue with further activities being planned with Rubicon on the pilot farm.
- Dairy irrigator Nick Ryan – Nick Ryans dairy farm represents a highly automated irrigation system to support dairy grazing. The collaboration with the irrigator has been highly productive for the researchers and has seen Nick begin to adopt the scheduling approaches tested in this project to other parts of his farm. There is a high likelihood that this farm will start to form the basis for further research into extending the scheduling approaches to support whole farm water management.
- Agriculture Victoria irrigation extension officers – The project has developed collaborations with key irrigation officers in Victoria who currently work with farmers on adopting weather and soil moisture based approaches to irrigation scheduling. This collaboration will continue with the further development of the SBIIS and its integration into improved scheduling.

5 Extension and adoption activities

The following extension activities have been undertaken through the life of the project. The extension activities have exposed a range of irrigators and service providers to the benefits of climate based approaches to irrigation scheduling which will ultimately translate into further adoption of these approaches which this project has been developing.

Presentations for these forums are attached in the appendix.

- Murray Dairy Business Forum held at Nick Ryan's farm for 15 irrigators (25 May 2017)
- Agriculture Victoria dairy and irrigation extension staff – 5 attendees (31 May 2017)
- Rubicon irrigation engineers, business managers and software developers – 8 attendees (25 May 2017)
- Smarter Irrigation webinar with the Smarter irrigation dairy team. – 12 attendees - (6 September 2017)
- Farm Irrigation in a modernised system workshop - 25 attendees (29th November 2017)
- Soils Discussion Group: Irrigation Scheduling Tools - Advances and practical application - 30 attendees (8 February 18)
- Workshop with irrigator and Rubicon to discuss 17/18 results and future directions – 7 attendees (14th May 2018)
- Paper "On-farm Evaluation of Satellite Based Irrigation Automation System for Border-check Irrigation in Northern Victoria' accepted at upcoming IAL Conference Sydney (14-17th June 2018)

6 Lessons learnt

The key lessons learnt as part of this project is the need to simplify the on-farm and decision-making components that an irrigator requires to develop a robust irrigation schedule. The current complexity in irrigation scheduling equipment (i.e. soil moisture monitoring) means that irrigators need to spend time interpreting and analysing data to arrive at irrigation decisions.

This presents a big challenge for irrigators when they want to scale up the water management decision making and align with farm operations such as grazing. Irrigators therefore typically will drop back to experience and how they have always operated as a default.

Satellite-based irrigation scheduling methods place minimal reliance on in-field hardware, and the maintenance of costly on-farm instrumentation of the large numbers of bays that are needed on large modern dairy farms.

Methods described in this project are therefore readily scalable to deal with whole-farm automation systems which need to be addressed before large scale adoption is achievable

The programme would benefit from less emphasis on technology and more emphasis on the farming systems, irrigator behaviour and how we move to improvements in irrigation scheduling and then what role technology will play in this.

7 Appendix - additional project information

7.1 Project material and intellectual property

This project has produced the following technical reports:

Tech report 1: Irrigation scheduling system and proposed monitoring program.

CRDC RRDP 1A technical report 1.pdf

Tech report 2: 2016/17 Field evaluation of satellite based irrigation automation system

CRDC RRDP 1A technical report 2.doc

Tech report 3: 2017/18 Field evaluation of satellite based irrigation automation system.

CRDC RRDP 1A technical report 3.pdf

7.2 Equipment and assets

List of all equipment or assets created or acquired during the period covered by the project.

7.3 Media and communications material

Irrigation workshop_29.11.17.

smarter irrigation workshop_05.03.18.

SBIIS Presentation1_14.5.

7.4 Evaluation report

Attach the final project evaluation report.

7.5 Budget

A statement of funds and contributions received and spent over the life of the project.

If practical, this section may be the final financial report (section E.4 of the grant agreement), containing:

- financial statements for the receipt, holding, expenditure and commitment of the grant, including a full reconciliation against the budget in the grant agreement and statements clearly showing expenditure against the grant
- a report of the receipt of other contributions (including the grantee’s contributions), or if other contributions were not received as projected, an explanation of action taken in response to this shortfall
- the interest that the grantee has earned on the grant.

If not practical to satisfy requirements for the final financial report at the time of submitting the final report, please use this section to give a statement of the budget for the life of the project and submit the final financial report within 60 days of submitting the final milestone report.