

Rural R&D for Profit Programme

Smart irrigation: when and how much, Activity 2c Final Report

July 2015 to June 2018

Mike Morris



Ownership of intellectual property rights

Unless otherwise noted, copyright (and any other intellectual property rights, if any) in this publication is owned by the [name of grantee].

Creative Commons licence

All material in this publication is licensed under a Creative Commons Attribution 3.0 Australia Licence, save for content supplied by third parties, logos and the Commonwealth Coat of Arms.



Creative Commons Attribution 3.0 Australia Licence is a standard form licence agreement that allows you to copy, distribute, transmit and adapt this publication provided you attribute the work. A summary of the licence terms is available from creativecommons.org/licenses/by/3.0/au/deed.en. The full licence terms are available from creativecommons.org/licenses/by/3.0/au/legalcode.

This publication (and any material sourced from it) should be attributed as: [Author(s) of the report, 20XX, C & Guo, F 2016, *[Title of the report]*, [Name of grantee (eg. Meat and Livestock Australia), [Publication location (eg. Sydney)]], [Date of publication (eg. March)].

This publication is available at agriculture.gov.au/publications.

Department of Agriculture and Water Resources
Postal address GPO Box 858 Canberra ACT 2601
Telephone 1800 900 090
Web agriculture.gov.au

Disclaimer

The Australian Government acting through the Department of Agriculture and Water Resources has exercised due care and skill in publishing the information and data in this publication. Notwithstanding, the Department of Agriculture and Water Resources, its employees and advisers disclaim all liability, including liability for negligence and for any loss, damage, injury, expense or cost incurred by any person as a result of accessing, using or relying upon any of the information or data in this publication to the maximum extent permitted by law.

Acknowledgements

[If applicable].

Contents

Plain English summary	iv
Abbreviations and glossary.....	Error! Bookmark not defined.
1 Project rationale and objectives	1
2 Method and project locations	2
3 Project achievements.....	3
3.1 Project level achievements	3
3.2 Contribution to programme objectives	3
4 Collaboration	5
5 Extension and adoption activities	6
6 Lessons learnt.....	7
7 Appendix - additional project information	8
7.1 Project material and intellectual property	8
7.2 Equipment and assets	8
7.3 Media and communications material	8
7.4 Evaluation report.....	9
7.5 Budget.....	9

Plain English summary

Border-check is a surface irrigation practice used by over 90% of irrigated dairy farms in the southern Murray Darling Basin. Laser guided landforming machinery is used to grade land to a smooth slope generally from 200 to 1000 m long with an elevation gradient of between 1 in 200 and 1 in 1000. Low check banks are then formed down the slope to create bays that are usually between 40 and 80 m wide. Irrigation water is released at the top of each bay from a supply channel, with a drain at the foot of the bays directing excess surface water to a re-use dam.

Conventional border-check irrigations on sites with low permeability soil profiles are inherently non-uniform because drainage of excess surface water from bays is very much slower than the process of applying the water. Water can be applied relatively quickly with modern irrigation supply systems, but once the supply is cut off energy rapidly dissipates, leaving excess surface water to slowly find its way down the length of irrigation bays in a process that can take days to complete.

This project established a field experiment and demonstration site in the Macalister Irrigation District (MID) of Victoria that aimed to show higher irrigation performance through modification of irrigation bay surfaces to improve surface water drainage. The field experiment and demonstration site consisted of four adjacent border-check irrigation bays producing perennial ryegrass pasture grazed by dairy cows. The surfaces of two randomly selected irrigation bays were modified to reduce the duration of surface water ponding after irrigations and reduce variation of ponding duration within each bay.

Six irrigations on the four bays were measured during the 2016/17 and 2017/18 irrigation seasons, however accurate scheduling of irrigations proved to be infeasible using the non-modernised and manually operated farm irrigation system. The resulting variability in irrigation applications reduced the value of direct comparisons between the conventional and modernised irrigation bays.

The experiment was able to demonstrate the effectiveness of the modified bay surface in draining excess surface water rapidly after irrigations. Pasture consumption varied between irrigation bays and between seasons, but exhibited no consistent difference between the conventional and modified bay surface treatments. Similarly, there was no difference in the observed pugging damage by cows between the bay surface treatments.

The work at this site has highlighted that realising the full potential of the modified bay surface requires an irrigation supply system with the capability to deliver consistent, precise irrigations to each bay. While the modified bay surface can improve the performance of any bay that ponds excess surface water, it should be implemented as one component of an efficient, modernised and automated surface irrigation system.

1 Project rationale and objectives

The large investment made by Governments and irrigators in the past decade to improve district and farm irrigation delivery systems provides the opportunity for more precise irrigations that meet plant water requirements. However conventional irrigation bays commonly limit this opportunity because they inherently deliver non-uniform irrigations.

The objective of this project activity was to demonstrate to border-check irrigators and irrigation service providers in the Macalister Irrigation District of Victoria the benefits of an improved irrigation bay surface that reduces the duration and variation of surface water ponding within border-check bays after irrigations.

Reducing the duration and the variability of duration of water ponding after border-check irrigations will deliver greater uniformity of surface irrigations and thereby enable precision scheduling of border-check irrigations.

2 Method and project locations

The project used a modified 2D ANUGA surface water flow model to identify a bay surface modification that substantially reduced surface water ponding duration and reduced the variation in ponding duration within irrigation bays after irrigations. A wide range of prospective bay surface designs was evaluated. The stand-out performer with respect to simulated hydraulic performance and robustness under a wide range of conditions was also straightforward to implement.

Field demonstration of the modified bay surface involved four adjacent perennial ryegrass pasture bays located on a commercial dairy farm in the Macalister Irrigation District of Victoria. Two randomly selected bays had the modified surface installed, while the other two bays retained a conventional bay surface. The simplicity of the bay modification allowed us to have the demonstration site established in October 2016. All irrigation bays were managed by the farmer.

Assessment of the irrigation performance and productivity of each of the four bays has been undertaken since October 2016. During this period the modified bays have been hydraulically assessed in the field against the conventional bays and against model predictions by capturing inflow hydrograph, runoff hydrograph and surface ponding duration on each bay. Pasture production has also been monitored on all bays.

This project focused on improved border check bay (i.e. flood irrigation) design. The results are applicable to industries that use this method of irrigation with shallow rooted crops on soil profiles that have a slow final infiltration rate. The use of the modified 2D ANUGA model to simulate potentially more efficient irrigation designs would be applicable to other surface irrigation systems.

3 Project achievements

3.1 Project level achievements

The project has established a field experiment and demonstration site in the Macalister Irrigation District (MID) of Victoria that has attempted to show higher irrigation performance through modification of irrigation bay surfaces to improve surface drainage. The field experiment and demonstration site consisted of four border-check irrigation bays producing perennial ryegrass pasture grazed by dairy cows. The surfaces of two randomly selected irrigation bays were modified to reduce the duration of surface water ponding after irrigations and reduce variation of ponding duration within each bay.

Six irrigations on the four bays were measured during the 2016/17 and 2017/18 irrigation seasons. Accurate scheduling of irrigations proved to be infeasible using the non-modernised and manually operated farm irrigation system. The high variability in irrigation applications reduced the value of direct comparisons between the conventional and modernised irrigation bays.

The experiment was able to demonstrate the effectiveness of the modified bay surface in draining excess surface water rapidly after irrigations. Pasture consumption varied between irrigation bays and between seasons, but exhibited no consistent difference between the conventional and modified bay surface treatments. Similarly, there was no difference in the observed pugging damage between the bay surface treatments.

While the experiment was able to demonstrate greater irrigation uniformity and reduced durations surface water ponding on the modified bays, the work at this site has highlighted that realising the full potential of the modified bay surface requires an irrigation supply system with the capability to deliver consistent, precise irrigations to each bay. While the modified bay surface can improve the performance of any bay that ponds excess surface water, it must be implemented as part of a well managed, modernised and automated surface irrigation system to achieve its potential.

3.2 Contribution to programme objectives

Over 90% of irrigated dairy farms in the southern Murray-Darling Basin use border-check systems. Similarly, it is the most common irrigation system in the Macalister Irrigation District in southern Victoria. It is very commonly used on sites that have elevation gradients of less than 1 in 250 and soils that have relatively low permeability. Border-check systems do have a shortcoming, though, particularly on these relatively flat sites with low permeability soil profiles.

The problem arises because drainage of excess surface water from bays is very much slower than the process of applying the water. Excess surface water at the top of bays must find its way

to a drain by flowing across the entire downslope surface of the bay in a process that can take days to complete.

Modernised irrigation supply systems provide substantially higher, more uniform and more accurately measured irrigation flow rates that can be ordered and delivered at much shorter notice. For the first time in regulated irrigation areas, irrigators have the opportunity to more precisely schedule irrigations to better meet plant water need. At the same time, new and improved systems for irrigation scheduling continue to appear and are the focus of active ongoing research, development and extension.

A limiting factor for precision scheduling of border-check systems is the non-uniformity of the conventional irrigation bay itself. An optimal schedule for the top of a conventional bay will favour unproductive swamp plants at the bottom of the bay, while optimising for the bottom will cause regular periods of water stress at the top.

By modifying bay surfaces with very shallow surface drains, all areas of the bay receive a similar irrigation and experience shorter durations of surface water ponding. An irrigation schedule for a modified bay can be optimized and will be optimal for the whole bay.

Irrigators using modified bays believe they have consistently high pasture production across the whole irrigated area. Because ponding duration is reduced there is also less deep drainage below the rootzone which saves water and reduces the environmental footprint of irrigation.

4 Collaboration

The project has facilitated improved links within Agriculture Victoria between surface irrigation research centred in northern Victoria and irrigation extension services located in Gippsland. Collaboration has been established with irrigation extension staff based in the Maffra office who have provided local monitoring data acquisition and oversight of the project demonstration site.

Prior to conclusion of the project, the demonstration site established under this project will be relocated to the Macalister Demonstration Farm. This will support integration of this project with the activities of the Rural Research and Development for Profit Programme (RRDPP) Smart Irrigation “Optimised Dairy Irrigation Farms” project and will facilitate ongoing collaboration across Agriculture Victoria and the dairy industry in the Macalister Irrigation District.

Increased discussion and engagement with fellow researchers in other states and other agricultural industries has improved the exchange of water use efficiency ideas and issues. This is likely to develop further in any further national irrigation projects

5 Extension and adoption activities

As described under Section 4, the demonstration site established under this project will be relocated to the Macalister Demonstration Farm (MDF), integrating it with the complementary activities there. A factsheet, technical note and video have been prepared to support ongoing extension of the project findings at the MDF. This will ensure the continued exposure of the project findings to irrigators, particularly in the Gippsland region. This ongoing demonstration, combined with the ability to present the empirical evidence from this project on the improved drainage efficiency of modified bays, will provide irrigators and irrigation service providers with the confidence to adopt these modifications appropriately.

A presentation at the Irrigation Australia Conference and Exhibition in Sydney in June 2018 will promote the project findings nationally.

The following lists the project extension activities:

Presentations:

Two presentations on the project background and aims have been made to farmers and service providers at Maffra. Attendance at each was approximately 12.

Fact sheet:

How to improve every irrigation bay - an effective system for faster and more uniform irrigations

Technical note:

How to improve every irrigation bay - an effective system for faster and more uniform irrigations

Online video:

An improved border-check irrigation bay

Conference presentations:

“Alternative designs for border-check irrigation bays” at the Irrigation Australia Conference and Exhibition in Melbourne in May 2016

“Improving border check irrigation precision by modifying the bay surface”, 2018 Irrigation Australia Conference and Exhibition, Sydney, 13-15 June 2018 (in prep)

6 Lessons learnt

Field experiments run on commercial farms are attractive because the experimental treatments can be cost-effectively evaluated at scale and under commercial conditions. The experiment site can also be used to demonstrate the new technology or innovation applied on a real farm, so results can be more directly relevant to farmers. However, experiments run on commercial farms that impinge on existing farm management practices are unlikely to succeed. With the best will, the objectives and priorities of the farmer for the experiment paddock and those of the researcher will not be the same. Non-treatment effects and confounded results will ensue.

We under estimated the difficulty of managing a project site that is five hours away by car. Fieldwork and extension/adoption activities had to be performed as a series of discrete three day expeditions with substantial travel overhead each time and limited contact between visits.

The project demonstration site has also highlighted that realising the full potential of the modified bay surface requires an irrigation supply system with the capability to deliver consistent, precise irrigations to each bay. While the modified bay surface can improve the performance of any bay that ponds excess surface water, for the modified bay to reach its potential it must be implemented as part of a well managed, efficient, modernised and automated surface irrigation system.

7 Appendix - additional project information

7.1 Project material and intellectual property

Include a summary of all material and all intellectual property created or arising during the period covered by the project.

Technical Report 1: Improved bay designs for the Macalister Irrigation District



M2-MID
BayDesignTechRepo

Technical Report 2: A report on establishment of a demonstration of improved irrigation bays in the Macalister Irrigation District



M4_MIDSiteEstabTe
chnicalReport.pdf

Technical Report 3: A report on the results from the modified irrigation bay experimental site in the Macalister Irrigation District



MIDSiteResults technicalReport.pdf

7.2 Equipment and assets

7.3 Media and communications material

“Alternative designs for border-check irrigation bays” at the Irrigation Australia Conference and Exhibition in Melbourne in May 2016



IAConf2016.pdf

Presentation at Griffith workshop, March 2017



20170321-Morris-Sm
arterIrrigGriffithPrese

Fact sheet:

How to improve every irrigation bay - an effective system for faster and more uniform irrigations



FactSheet_2c.pdf

Technical note:

How to improve every irrigation bay - an effective system for faster and more uniform



TechNote_2c.pdf

Video:

An improved border-check irrigation bay (in prep)

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.