Hort Innovation

Final Report

Almond irrigation best practice management

Project leader:

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Delivery partner:

Minister for Primary Industries and Regional Development (acting through the South Australian Research and Development Institute)

Project code:

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Project:

Almond irrigation best practice management AL17004

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Content

Summary

The project conducted an audit of drip irrigation systems in almond orchards across the Northern Adelaide Plains (NAP), Riverland, Sunraysia and Riverina districts, which between them encompass the vast majority of the Australian almond industry.

Irrigation evaluations were carried out on 50 irrigation valve units across these regions. A valve unit consists of all pipework and emitters downstream of a single control valve, and which therefore run as a unit when that valve is opened. Valve units are the smallest unit of control within an irrigated property, and for this reason the uniformity of application within a valve unit is critical to applying water evenly across plantings of a horticultural crop.

Dripper pressure and flow rate were measured at multiple locations across each valve unit. The variation in pressure and flow rate across the valve unit, and coefficient of uniformity of flow rate were calculated, as was the variation from the design flow rate of the drippers.

Pressure variation was large on some properties (up to ±75%), but in pressure compensated drip systems, the majority of those represented in the data, this is not a problem as long as the pressures are within the operating range of the drippers.

Flow variation is a much more critical measure of system performance, and showed a range up to ±36%, compared to the recognised industry standard of <±5%. Furthermore, around 80% of sites showed flow variation greater than the standard, indicating less than ideal performance in the majority of sites tested.

Coefficient of uniformity (CU) was also calculated as an indicator of performance, with the industry standard being >90%. In contrast to the situation for pressure variation, over three quarters of the sites showed CU greater than the standard, indicating good performance.

These apparently contradictory results suggest that, while most dripper flow rates were similar (high CU), there were individual drippers with very high or low flow rates (high variation), indicating that some individual trees across the site receive very variable amounts of irrigation.

Variation from the design dripper flow rate gave figures ranging from -17% to +47%, indicating some sites with reduced flow rates (8 sites), but more sites where flow rate was greater than the design value (22 sites).

Reasons for this may include wear in the dripper labyrinth, or clay and silt build-up in the drippers affecting the operation of the pressure compensating diaphragm.

The manager of each site was interviewed in order to collect information to assist in interpreting the results of the field assessments. For example, the information collected assisted in identifying whether poor performance was due to system age, poor system design and installation, problems with maintenance programs, or poor quality of water being applied.

Comparison against these critical factors revealed that variation in flow rate showed a positive correlation with age of dripline (higher age = higher variability), and a negative correlation with flushing frequency (higher frequency of flushing = lower variability). No other factors showed consistent trends.

A summary of the project, including graphs of the results and evaluation of best practice management principles arising from the analysis, is available for public access through the Almond Board of Australia website (irrigation.australianalmonds.com.au). This site also hosts a Drip Irrigation Evaluation Tool, which guides growers through the process of collecting data from their own irrigation systems for entry into the tool, and then displays performance data for the grower's site alongside the data collected during this project.

The website also contains links to information sources to assist growers to improve their irrigation performance.

Keywords

Almond; *Prunus dulcis*; drip irrigation; irrigation performance; pressure variation; flow variation; coefficient of uniformity; website.

Introduction

In recent decades the Australian almond industry has moved to predominantly drip irrigation systems. This has been associated with the common harvesting practice of shaking nuts onto the ground, and the subsequent sweeping and pickup of nuts using specialized machinery. The ideal orchard floor associated with these harvest activities is bare soil, which is easily achieved and maintained under drip irrigation. Drip irrigation is also believed to be more efficient than sprinkler irrigation, although management of the irrigation applications is a stronger influence on efficiency than system type per se (Skewes and Meissner, 1997a, b).

Due to the harsh climate in most Australian almond growing regions, and the high level of canopy cover in most orchards, Australian almonds require a large amount of water per hectare, and the industry is predicted to reach a total water usage of 600 GL per annum by 2021 (ABA SIP, Horticulture Innovation Australia Limited, 2017). As a result the industry needs to demonstrate that it uses efficient irrigation practices in order to justify its continued access to this precious resource.

In addition, this high water requirement can become a significant operating cost to orchards that lease the majority of their water, particularly in years of water scarcity when prices increase. Efficient water use guards against periods of water scarcity, assists growers to minimise production costs, and maximises the conversion of water into saleable yields.

General information about recommended irrigation management and maintenance procedures is well established and readily available in Australia. However, many almond irrigation systems do not perform to the expected standards, with a key problem being the wide variability in flow rate from individual drippers within an irrigation valve unit. In turn this reduces the efficiency of irrigation systems, and results in more water being required to maintain productivity than would be the case if the irrigation system performance were in line with accepted standards.

This project was designed to:

- scope the extent of the problem and provide general feedback to the industry as a whole;
- provide tools to assist individual almond growers to audit the performance of their own irrigation systems;
- direct almond growers to relevant information sources to assist in improving on-farm irrigation efficiency.

Methodology

An irrigation performance audit of the Australian almond industry was carried out to assess the efficiency of irrigation systems across 4 of the 5 major Australian almond production regions (Northern Adelaide Plains, Riverland, Sunraysia and Riverina). The Western Australian almond growing region was not included in the project due to its distance from the other regions, and the cost associated with travelling to that region for field work.

The Almond Board of Australia's (ABA) Almond Production Committee acted as the Project Reference Group. This group made recommendations about the proposed methodology, and conducted a mid-project review of the methodology and progress of the project, making recommendations on the ongoing direction of the project.

Initially a target number of 30 sites across these regions were approached with a request to evaluate a valve unit for application rate and flow variability, for comparison against design specifications and accepted standards (<±5% variation in flow rate).

Each evaluation required the collection of flow rate (L/h) and pressure (kPa) from at least nine emitters across the valve unit. These figures were used to calculate variation in pressure and flow (±% of the highest and lowest readings from the midpoint), and coefficient of uniformity of flow rate (%), as well as the variation of the average figure from design/nominal figures where these were available. In addition, the flow rate (L/h) of a complete lateral was measured and compared with the theoretical flow rate of the lateral based on length, dripper spacing and nominal dripper flow rate.

All of these calculated indicators have specific standards which are accepted across the irrigation industry, and so each valve unit was compared to the standards in order to rate its performance.

For each valve unit on which an irrigation assessment was conducted, additional information was collected about the irrigation system specifications, including age, dripper model and flow rate, dripper spacing between and along rows, and design application rate. Information was also collected about the water source (groundwater, river, dam), and the filtration systems on the property, including any check filters at the valve unit tested.

In addition, the property manager was asked to provide information about the maintenance schedule in place on the property, including filter, submain and lateral flushing programs, fertigation practices and chemical (acid, chlorine) dosing programs. The irrigation manager was questioned about the application of the maintenance schedule, that is whether the schedule is rigorously applied or not, and if not, what actually happens. In addition, information about any historical or ongoing issues in the valve unit tested was collected, as well as information about the fate of filter flush water.

Following this initial data collection round, the Project Reference Group reviewed the methodology used and the data collected. The Project Reference Group recommended that lateral flow rate should be measured at as many of the test valve units as possible, as to that point only a few sites had this data collected, due to the difficulty posed in taking this measurement, and questions as to the value of this measurement.

Following this project review a further 20 irrigation valve units were assessed, to bring the total number of audits to 50. In addition, most of the sites previously tested were revisited to collect lateral flow rate measurements, with the result that there was no difference in data collected from sites tested prior to and after the review.

Table 1 shows the number of sites assessed in each of the regions. The original intention was to spread the sites across all regions, with fewer in the NAP due to its relatively small size. As it happened, only two orchards with drip irrigation could be located in the NAP region. Both of these orchards were assessed. With respect to the Riverina region, five sites were assessed early in the project, but it proved impossible to return to evaluate any more sites due to the distance of travel from Sunraysia and Riverland, and the workload of the project officers.

Table 1 Number of valve units assessed in each growing region

Region	Number of Valve Units Evaluated
Northern Adelaide Pains	2
Riverland	21
Sunraysia	22
Riverina	5

Results of the performance audit were collated anonymously, and a benchmarking comparison conducted to rank the sites according to performance against the various indicators. The results were graphed to display the range of performance across the almond industry. These graphs were provided to the property owners, with their own sites highlighted, allowing them see how their systems performed relative to the rest of the sites assessed.

Further analysis of sites according to the additional information collected above was used to assess the impact of a range of factors on irrigation performance, including the impact of age of the dripline, frequency of flushing and chemical dosing, use of pressure compensating vs non-pressure compensating drippers, and flushing submains vs flushing individual laterals.

Information about the project was presented at a number of almond industry forums, as outlined in Table 2. These presentations summarised the project and presented the results of the industry audit of irrigation efficiency, and the Best Practice Management outcomes from the industry audit.

A Benchmarking Tool was developed which allows growers not directly involved in this project to test their own irrigation valve units, enter the data they collect, and compare their performance against the industry audit data collected above. All data entered is stored in an online database, and a summary report of the valve unit's performance relative to the 50 site industry audit is provided to the grower. The report is only accessible through a specific access code, or by creating a username and password. An example of the report is attached as an Appendix (Example Grower Report.pdf).

The tool is similar to the Irrigation Performance Audit and Reporting Tool (IPART), part of the Knowledge Management System for Irrigation (KMSI) (https://kmsi.usq.edu.au/) developed and hosted by the National Centre for Engineering in Agriculture (NCEA) at University of Southern Queensland (USQ), but is the first such tool that we are aware of for drip irrigation systems.

Outputs from the project were collated and posted on an Almond Irrigation Efficiency website (irrigation.australianalmonds.com.au). The website is designed to allow growers to access the Drip Irrigation Evaluation Tool to assess the performance of their own drip systems, and to link to information resources which will assist them in improving their irrigation efficiency.

Outputs

Data collected during the project was analysed to calculate a range of indicators of irrigation performance, as described above (Methodology). Results were displayed in two primary forms.

Results for each performance indicator were ranked and graphed in order to display the range of performance across the industry against each indicator. Figure 1 is an example graph, and shows the performance of the 50 valve units against variation in flow rate. Blue bars are pressure compensating drippers, yellow are non-pressure compensating drippers, and the orange line at 5% indicates the standard below which all sites should be.

Industry performance graphs for the full range of indicators are feature at the Almond Irrigation Efficiency website (irrigation.australianalmonds.com.au).

The full list of indicators evaluated is:

- Variation in pressure;
- Variation in flow;
- Coefficient of uniformity for flow;
- Variation of average flow from nominal/design flow;
- Variation of flow rate for a complete lateral from nominal/design flow.

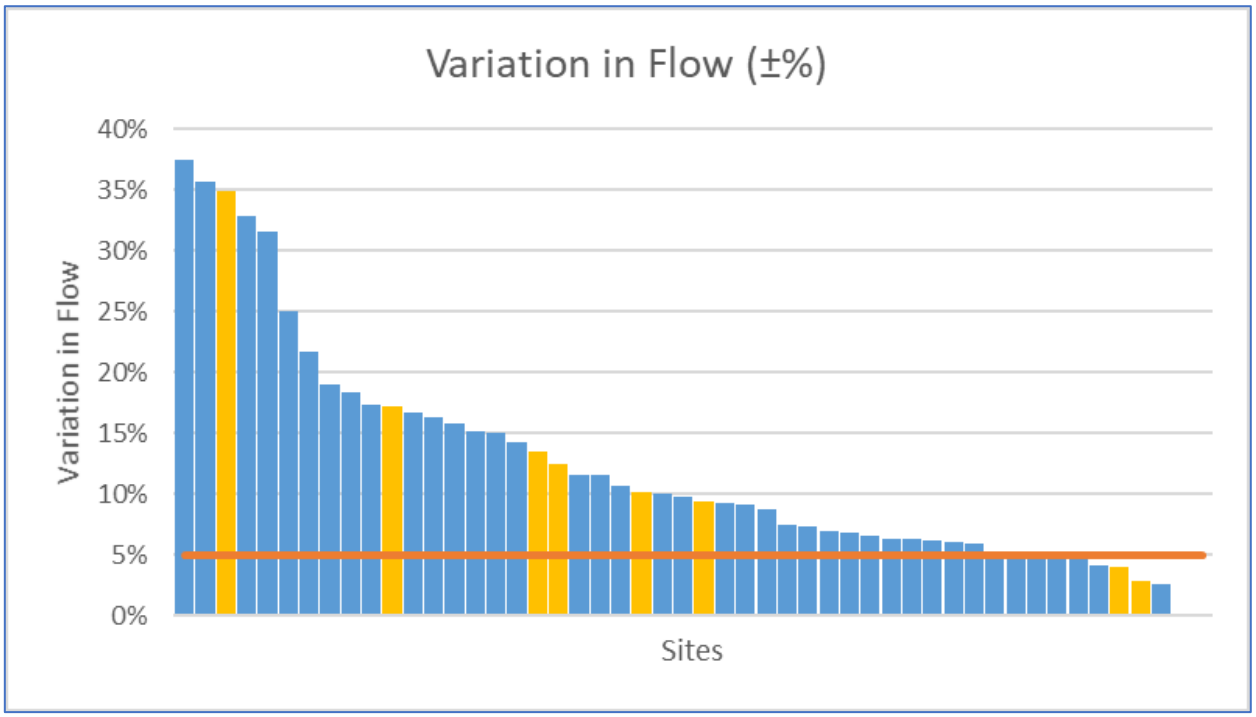


Figure 1 Sites ranked by variation in flow rate, standard = <5% (blue bars are sites with pressure compensating emitters, yellow bars have non-pressure compensating emitters)

In addition to the assessments exampled in Figure 1, a second set of analyses was carried out to identify practices which influenced irrigation system performance. Variation in flow was plotted against information collected from the growers by interview, and assessed to determine the impact of the factor on performance.

The full set of comparison graphs is featured at irrigation.australianalmonds.com.au.

Figure 2 displays an example of this comparison, and shows the relationship between the year of installation of the dripline at each valve unit and the variation in flow rate measured during the evaluation. The trend line suggests that age of dripline may explain some of the variation in a proportion of the sites, as might be expected, but it is also clear that some older sites performed very well.

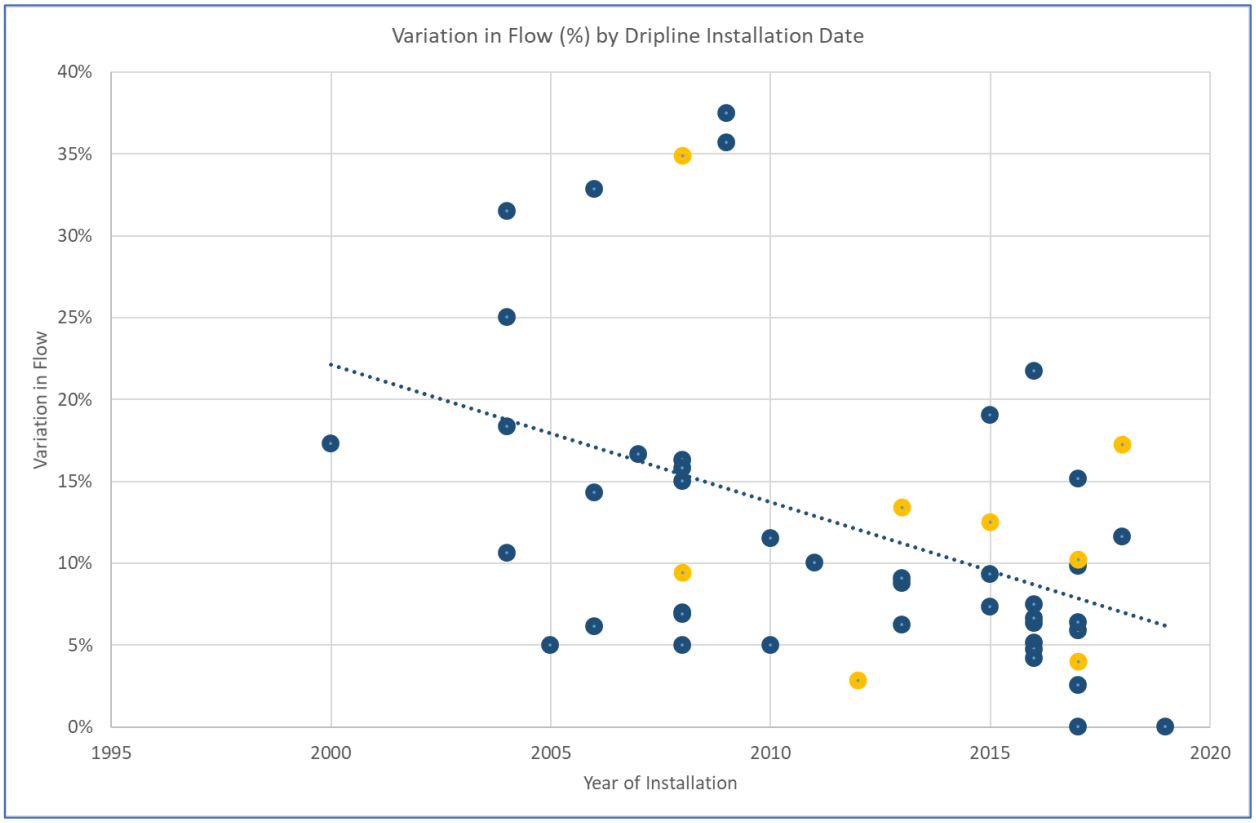


Figure 2 Relationship between dripline age and variation in flow rate (blue circles are sites with pressure compensating emitters, yellow circles have non-pressure compensating emitters)

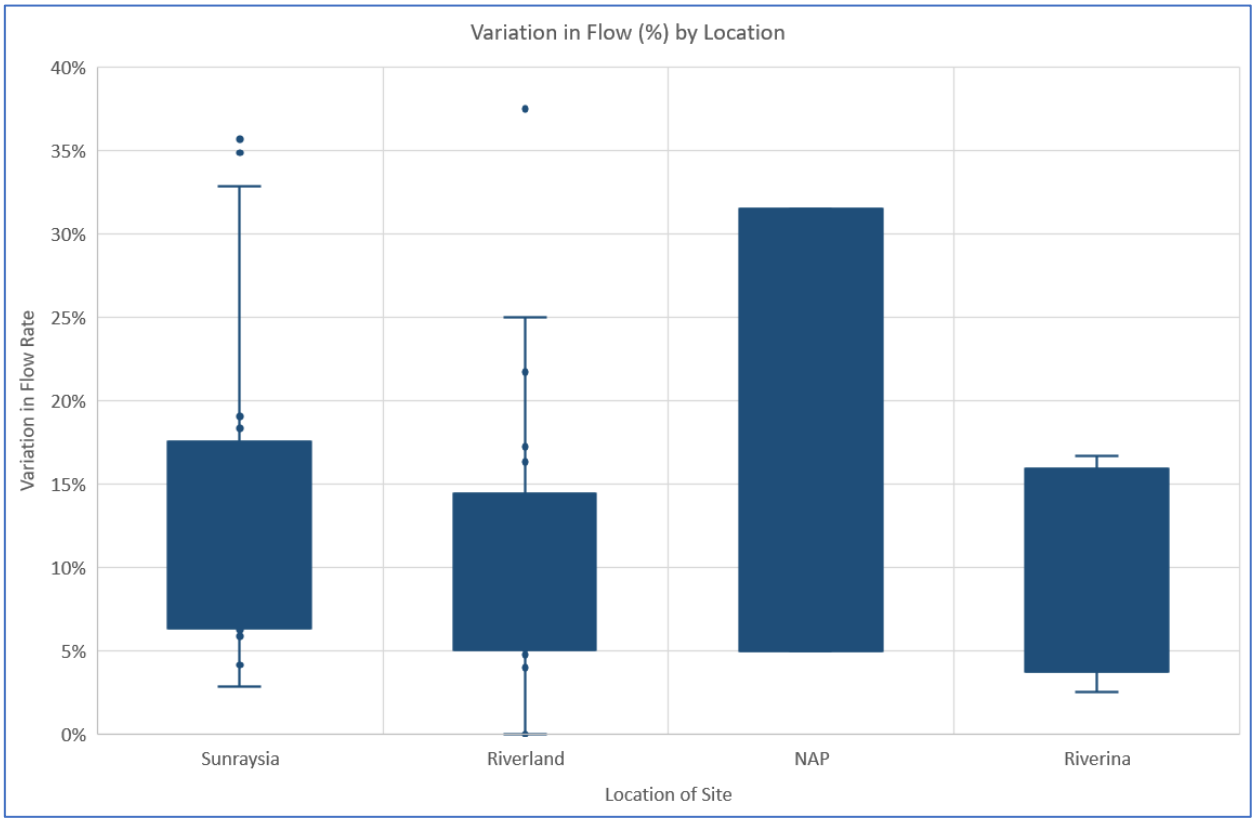


Figure 3 Relationship between orchard location and variation in flow rate

Figure 3 displays another data set, orchard location, displayed as sets using a box and whisker plot, where the large box contains the middle 50% of data points, the whiskers contain the majority of the remaining data, and outliers are shown as isolated dots beyond the whiskers. There are some minor across the regions evaluated, but little clear evidence that one region is superior to the others. The small number of sites in Riverina limited the range of performance identified, whilst in the NAP one site performed very well and the other was quite poor.

A dedicated Almond Irrigation Efficiency website has been established on the ABA website (irrigation.australianalmonds.com.au), with links to be provided from the SARDI and Hort Innovation websites.

This site hosts:

- A description of the methodology used to test drip irrigation system performance;
- Results of the industry wide audit, including a complete set of graphs like Figure 1;
- Results of the best practice management analysis, including the complete set of graphs like Figure 2 and Figure 3, and the Best Practice Management principles determined from this analysis;
- An online Drip Irrigation Evaluation Tool allowing almond growers to enter dripper pressure and flow rate measurements from their own properties and calculate performance of valve units, and benchmark their performance against the industry audit dataset;
- Documents and links to drip irrigation maintenance and monitoring information sources, to facilitate easy access by the almond industry to suitable, high quality information about improving irrigation efficiency.

It is proposed that ownership and ongoing management and upkeep of the website pass to the Almond Board of Australia (ABA), as the representative body for the Australian almond industry toward whom the website is directed. KarBec IT Services, who developed the site, will hold the source code, maintain the site and manage the data collected, including ensuring data privacy. The ABA will work with KarBec IT Services to commission any maintenance activities, and to access anonymous data sets entered by growers using the site to assess their irrigation performance.

A series of extension opportunities (Table 2) were used to raise awareness of the project, distribute results from the industry wide audit, promote Best Practice Management, and advertise the Drip Irrigation Evaluation Tool. Audience numbers reflect registrations for events, and circulation for the newsletter.

Table 2 Industry extension activities during the project

Date	Type	Event/Platform	Audience
Jun. 2019	Industry Newsletter	In a Nutshell, Vol 19.3, Autumn/Winter 2019	1150
31/10/2019	Forum & Field Day	Almond Board of Australia R&D Forum, Loxton, SA	253
Dec. 2019	Industry Newsletter	In a Nutshell, Vol 19.6, Summer 2019-20	1150
3/12/2019	Field Walk	Almond Board of Australia Field Walk, Lake Powell, Vic	29
4/12/2019	Field Walk	Almond Board of Australia Field Walk, Loxton, SA	26
	Online Video	ABA Website (australianalmonds.com.au)	

Outcomes

The major immediate outcome of this project is increased awareness across the almond industry of the wide variability in performance of irrigation systems, and the need to increase maintenance and monitoring of drip irrigation systems in order to achieve optimum yield and return from the use of limited and expensive water resources.

Through the extension activities already undertaken (Table 2) a large proportion of the Australian almond industry has had some exposure to the project and its outputs. The "In a Nutshell" newsletter is distributed to all registered almond growers in Australia (circulation of 1150), with the December 2019 edition being opened a total of 1554 times (ABA, pers. comm.). The Almond Board of Australia R&D Forum is the premier almond industry event, with all the corporate growers represented, as well as many small growers. Board members of the Almond Board of Australia, through whom this project was instigated and to whom the steering committee reported, represent 99% of Australian production (Almond Insights, 2018/19), providing a very high level of exposure of this project to the industry.

The Drip Irrigation Evaluation Tool and associated information resources (irrigation.australianalmonds.com.au) provides the Australian almond industry with access to new information and protocols for testing and managing drip irrigation systems, as an immediate direct outcome of the project.

A further outcome which will arise from almond growers utilising the Drip Irrigation Evaluation Tool is an expected improvement in the efficiency of drip irrigation systems across the Australian almond industry.

The industry audit conducted during this project will serve as a baseline data set for comparison of performance change over time, and the online Drip Irrigation Evaluation Tool will collect data into the future as growers use it to self-assess, allowing ongoing collection of data to validate the expected improvement in drip irrigation system performance.

As a consequence of the improvement in irrigation efficiency, a secondary outcome will be an overall reduction in water applied to existing mature almond orchards, due to growers not needing to over-irrigate valve units in order to meet the water requirements of the trees receiving the least amount of water.

New plantings and maturation of existing young orchards mean that the overall water use of the almond industry is likely to continue to rise in spite of these improvements in efficiency. Despite this, the improved efficiency of irrigation is expected to lead to a further outcome of increased water use efficiency (production per megalitre of water) across the almond industry into the future.

Monitoring and evaluation

The project has performed well, meeting its Key Evaluation Questions, as discussed below.

To what extent has the project increased the adoption of the industry Best Practice Guidelines?

Previously there was some knowledge of irrigation best practice across the almond industry, but there was little information specific to almonds available.

This project has developed specific best practices for drip irrigation in almonds, and made that information available through the Almond Board of Australia's (ABA) website. This website is the primary source of industry specific information for many Australian almond growers.

As a result of this information being made available via the ABA website, many more almond growers will access the information, self-assess their drip irrigation performance, and adopt the industry best practice guidelines developed by this project and made available through the website.

To what extent has the project met the needs of industry levy payers?

Irrigation efficiency is a key issue for almond industry levy payers, especially given the relatively large water requirement of almonds, and current issues of short supply and high cost of water resources.

By identifying common causes of poor irrigation efficiency, assisting growers to self-assess their drip irrigation performance, and providing best practice management guidelines, the project has directly met the needs of industry levy payers for information and tools to improve irrigation performance.

To what extent were the target engagement levels of industry levy payers achieved?

Engagement levels with the industry met targets.

The ABA Research and Development Forum and Field Day, held at Loxton Research Centre and the Loxton Almond Centre of Excellence in October 2019, was the premier industry technical event for the Almond industry in 2019. Over 200 people attended, including many directly involved in almond growing.

The ABA Field walks held at Lake Powell and Loxton in December 2019 were targeted extension events, focussing pest insect management and irrigation efficiency. As a result the 50 or so attendees were specifically interested in these topics.

The "In a Nutshell" newsletter is distributed to every member of the ABA. The two articles published in this newsletter were thus made available to every commercial almond grower in Australia, raising awareness of the project, and alerting growers to the upcoming website where they could learn more.

A further article in "In a Nutshell", and a highlighted link on the ABA web page will further extend engagement with industry levy payers.

Have regular project updates been provided through linkage with the industry communication project?

Regular updates have been provided through the extension mechanisms outlined above. These activities were carried out in liaison with the ABA Industry Development Officers, and formed part of their industry communication project.

Did the project engage with industry levy payers through their preferred learning style?

There are a variety of learning styles, and different people respond better to different learning styles.

The learning styles targeted in this project were written material ("In a Nutshell"), oral communication (ABA Technical Forum) and experiential learning (field walks). This range of presentations undertaken ensured that industry members were given a choice of learning styles.

How accessible were extension events to industry levy payers?

The extension events were held in the Riverland and Sunraysia regions, none were held in the Adelaide Plains or Riverina regions.

The ABA Research and Development Forum and Field Day is a biennial event, most recently hosted in the Riverland region (Loxton). Industry levy payers from all over Australia travelled to Loxton to attend this event. As a package event it was quite accessible to levy payers, representing good value for money, in that one trip provided information in a wide range of areas, as well as industry networking opportunities.

The two ABA field walks were held in the Riverland and Sunraysia regions, the two largest growing regions. The two almond growers known to have drip irrigation in the Adelaide Plains region both attended the Riverland field walk, indicating that this event was accessible for growers from that region. It is not known whether any Riverina growers attended the Sunraysia field walk.

Recommendations

It is recommended that growers should carry out regular system performance assessments, and use the results to monitor for declining performance of valve units which may point to the need for replacement of the dripline. The online Drip Irrigation Evaluation Tool developed in this project is the ideal tool to facilitate this (https://irrigation.australianalmonds.com.au/app.php).

It is also recommended that drip irrigation systems should be flushed more frequently than currently, as insurance against gradual build-up of debris in the system. In time this material will lead to blockages, requiring replacement of the dripline earlier than would perhaps have been necessary if the system were kept cleaner through more frequent flushing. There is evidence that many sites evaluated in this audit were not flushed frequently enough. Information about flushing and chemical treatment of drip irrigation systems is included in the Information section of the website (https://irrigation.australianalmonds.com.au/information.php).

Further investigation into the impact of flushing manifolds on the effectiveness of flushing is recommended. There is evidence in the data collected to suggest that flushing effectiveness of systems without manifolds is superior, as they perform at a similar level to manifold systems, but with far less frequent flushing.

Refereed scientific publications

No refereed scientific publications were produced.

References

Horticulture Innovation Australia Limited, 2017. Almond Strategic Investment Plan 2017-2021, Horticulture Innovation Australia Limited, Sydney, New South Wales.

Skewes, M.A., Meissner, A.P., 1997a. Irrigation Benchmarks and Best Management Practices for Citrus, Technical Report. Primary Industries and Resources SA, Adelaide, South Australia.

Skewes, M.A., Meissner, A.P., 1997b. Irrigation Benchmarks and Best Management Practices for Winegrapes, Technical Report. Primary Industries and Resources SA, Adelaide, South Australia.

Intellectual property, commercialisation and confidentiality

No project IP, project outputs, commercialisation or confidentiality issues to report.

Acknowledgements

The author would like to acknowledge the contribution of Agriculture Victoria (Jeremy Giddings and Maxine Schache), and Netafim Australia (Peter Henry), who provided significant in-kind contributions to this project, greatly assisting in achieving the project aims within the limited budget available.

I would also like to thank the Almond Board of Australia (ABA) for their assistance in many aspects of the project. The ABA Production Committee served as the Project Steering Committee, and members personally provided a number of sites for the on-farm audit. Industry Development Officer Josh Fielke assisted with extension activities associated with the project.

Finally I thank the many almond growers who allowed us to measure their irrigation system performance and include the data in the analysis reported here.

Appendices

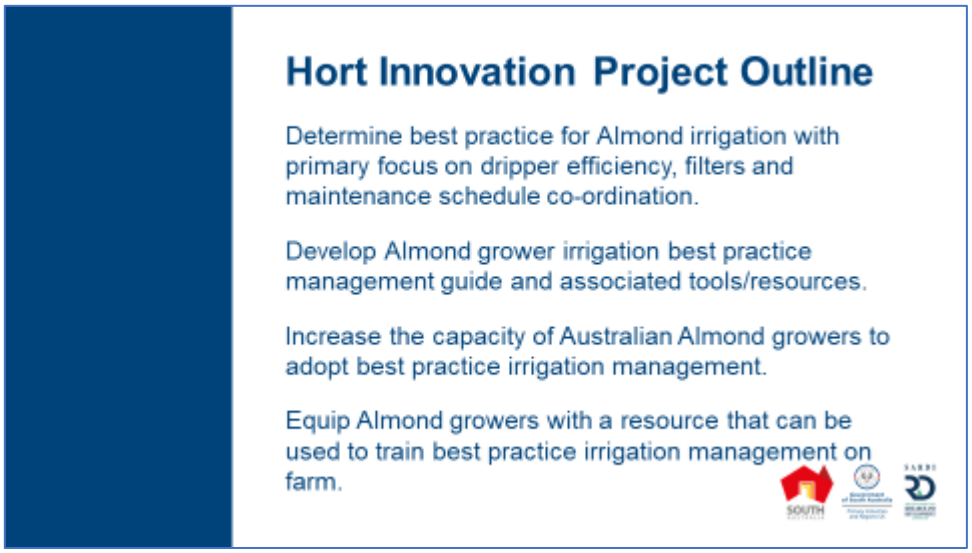
Oct ABA R&D Forum and Field Day Presentation.pdf – printout of the presentation given to the ABA Technical Forum at Loxton on 31st October 2019.

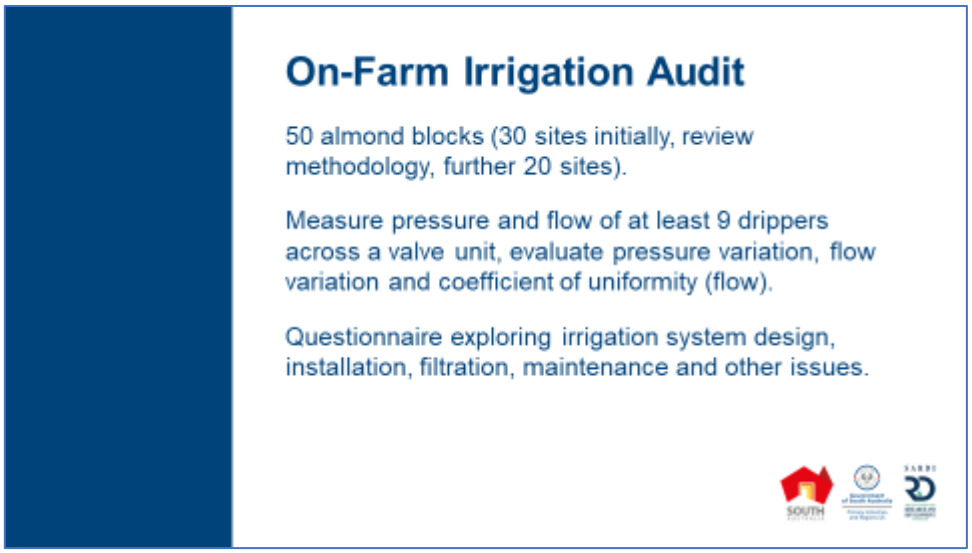
Dec ABA Field Walks Presentation.pdf – copy of the handout used for the two ABA Field Walks, at Lake Powell on 3rd December 2019, and Loxton on 4th December 2019.

irrigation.australianalmonds.com.au – location of the web page containing outputs from the project, including Project Summary and Results, the Drip Irrigation Evaluation Tool, and Information and Resources.

Example Grower Report.pdf – example of a grower report from the Drip Irrigation Evaluation Tool.

Appendix 1 - Oct ABA R&D Forum and Field Day Presentation



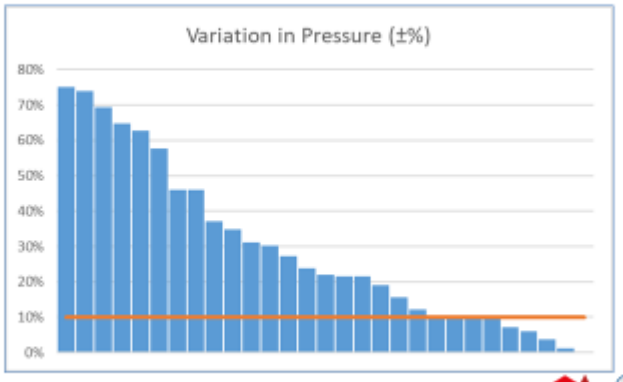


Performance Audit

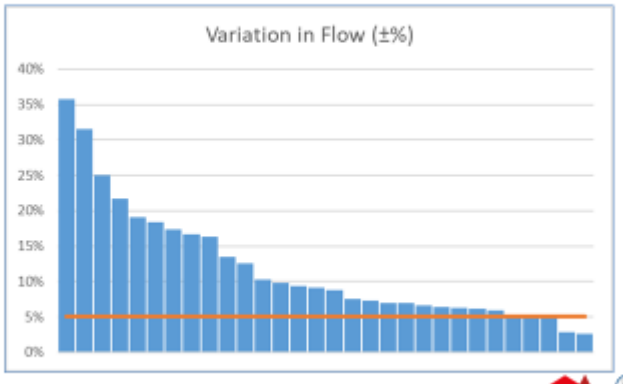
The initial 30 irrigation system evaluations have been completed.

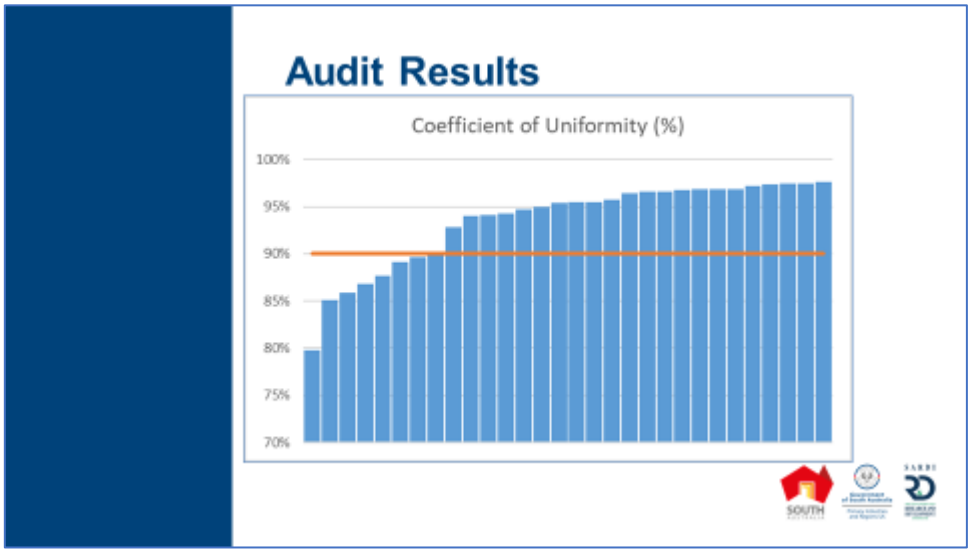
- 1 x Northern Adelaide Plains
- 15 x Riverland (includes 7 x Lyndsay Point)
- 10 x Sunraysia
- 4 x Riverina

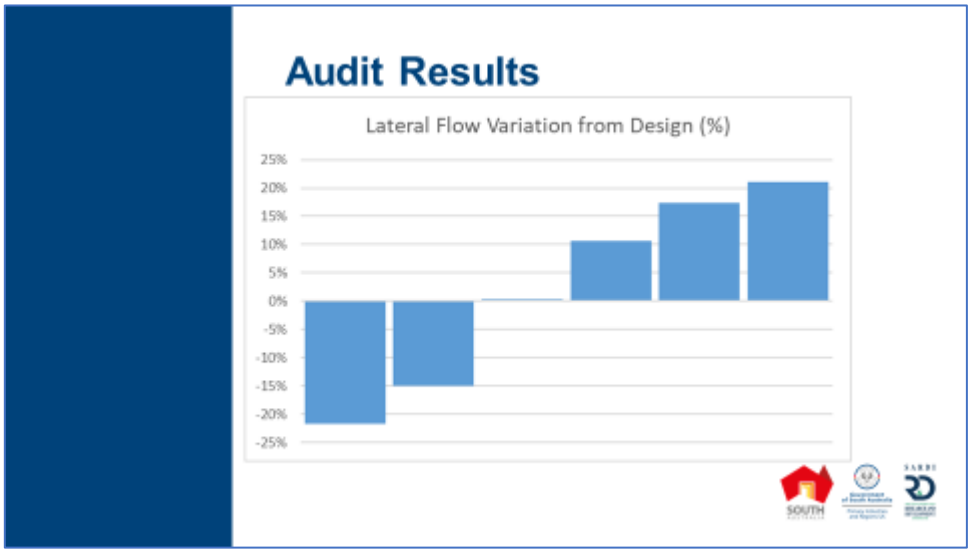
Audit Results



Audit Results




Audit Results
Coefficient of Uniformity (%)
100%
95%
90%
85%
80%
75%
70%


Audit Results
Lateral Flow Variation from Design (%)
25%
20%
15%
10%
5%
0%
-5%
-10%
-15%
-20%
-25%


Audit Results


Audit Results
Variation in Flow (%) by Water Source

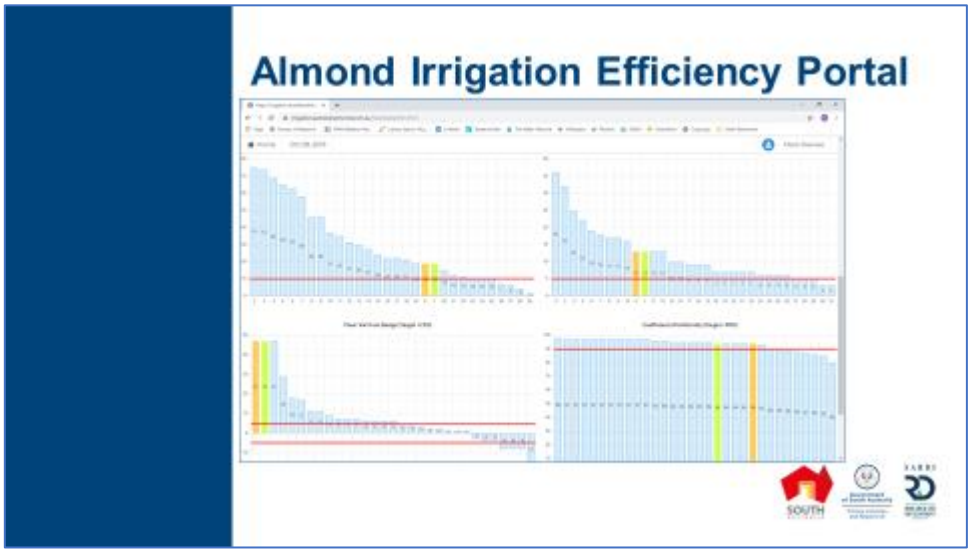

Audit Results
Variation in Flow (%) by Main Filter Type

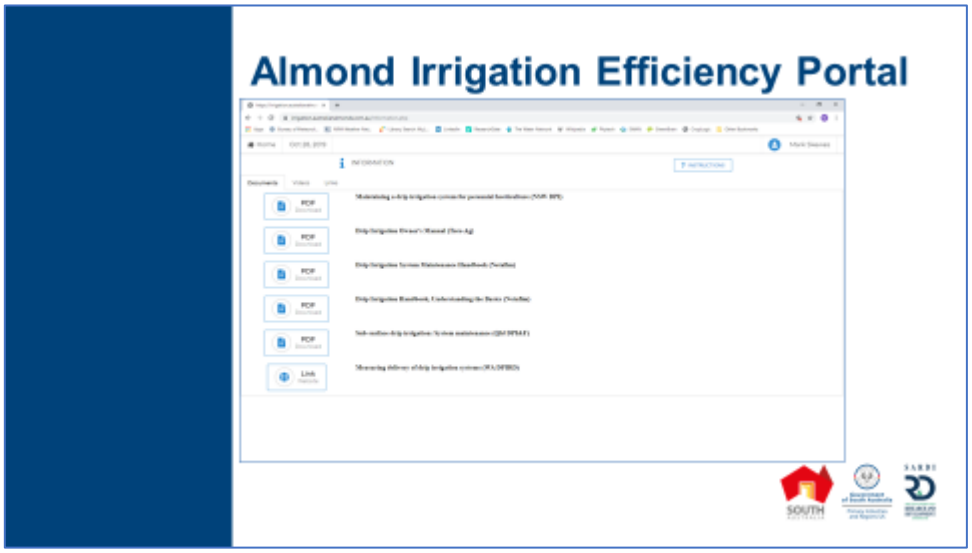

Audit Results
Variation in Flow (%) by Backup Filter Type


Almond Irrigation Efficiency Portal
Irrigation Performance Checker


Almond Irrigation Efficiency Portal
Enter details of your dripper system.


Almond Irrigation Efficiency Portal
Test Results Summary
Full Details of Irrigation Report


Almond Irrigation Efficiency Portal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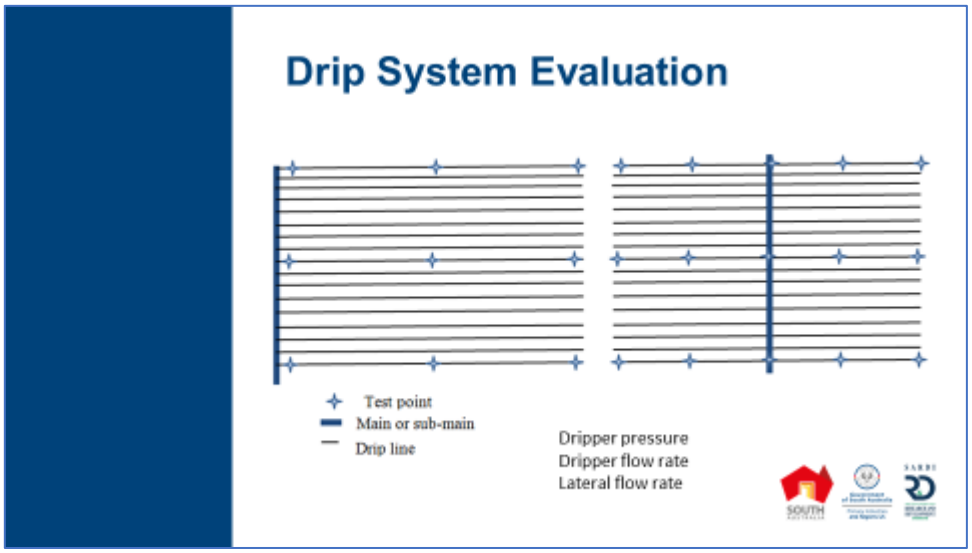
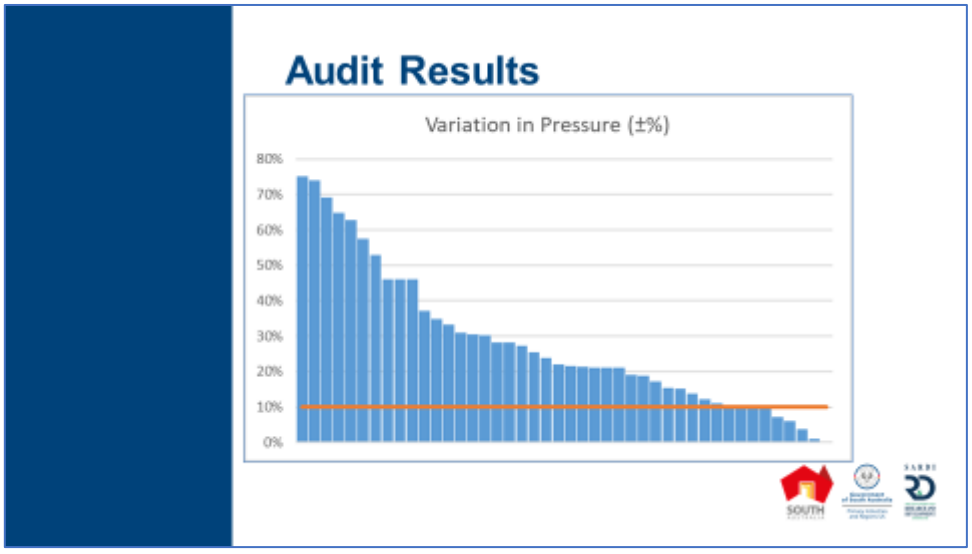
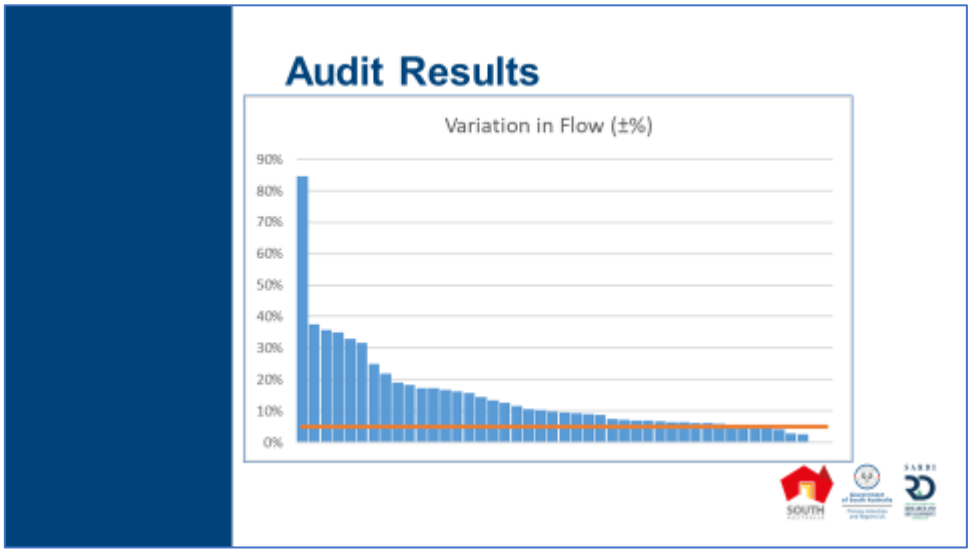
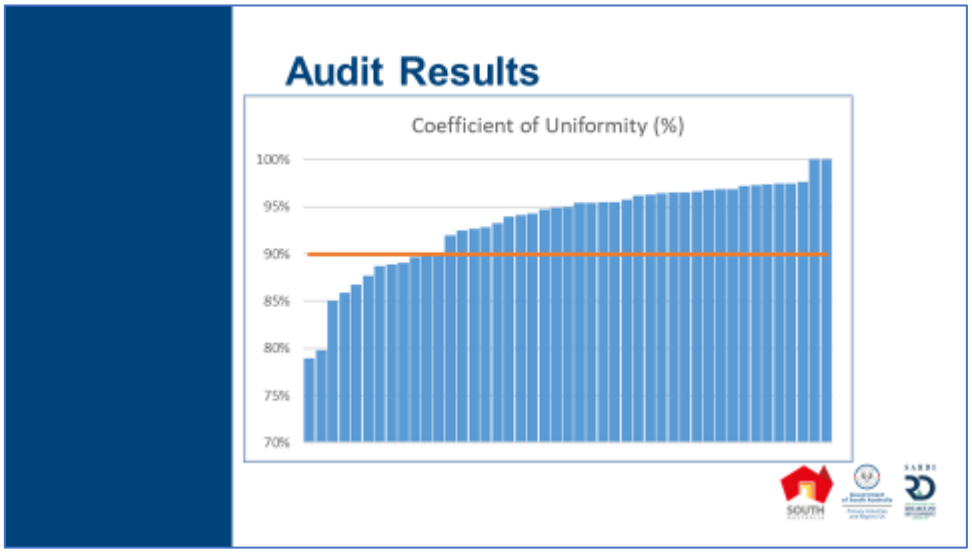
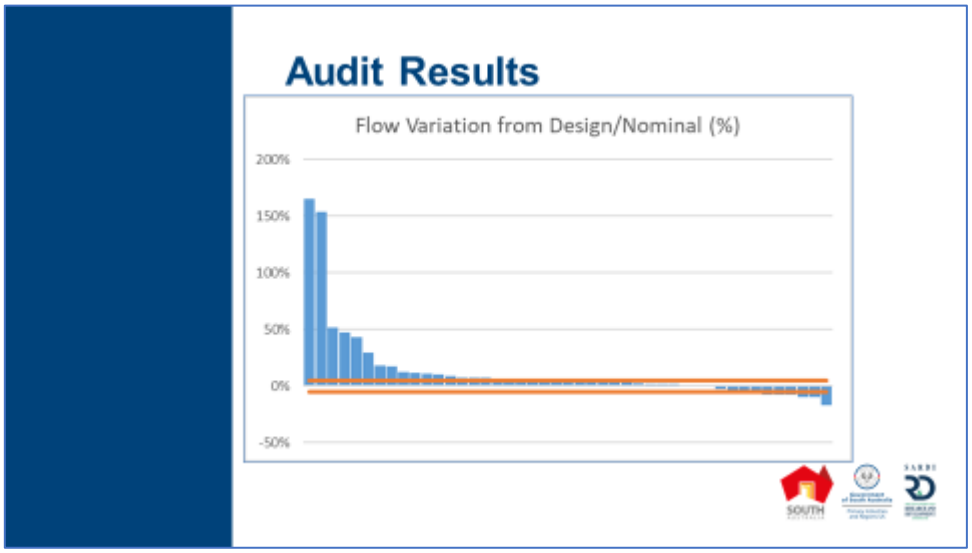
Appendix 2 - Dec ABA Field Walks Presentation

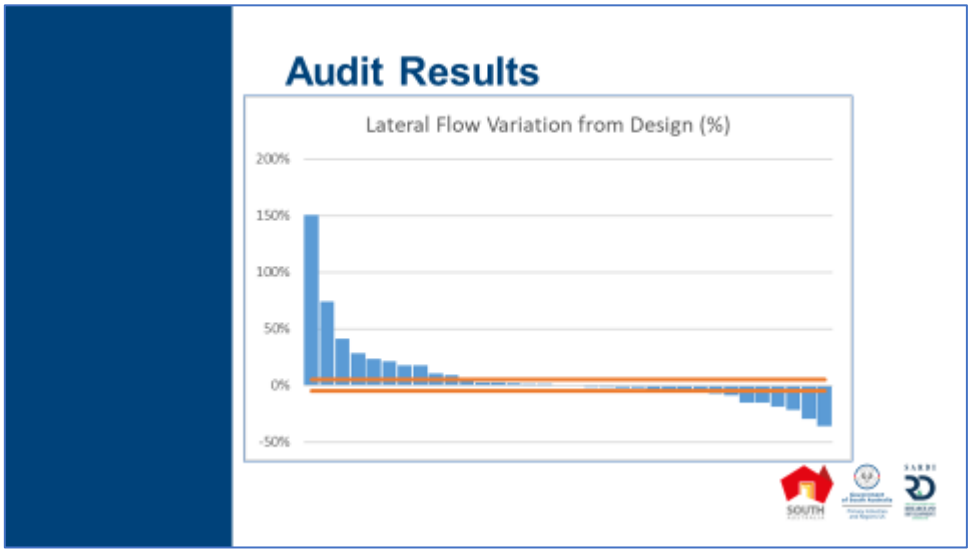


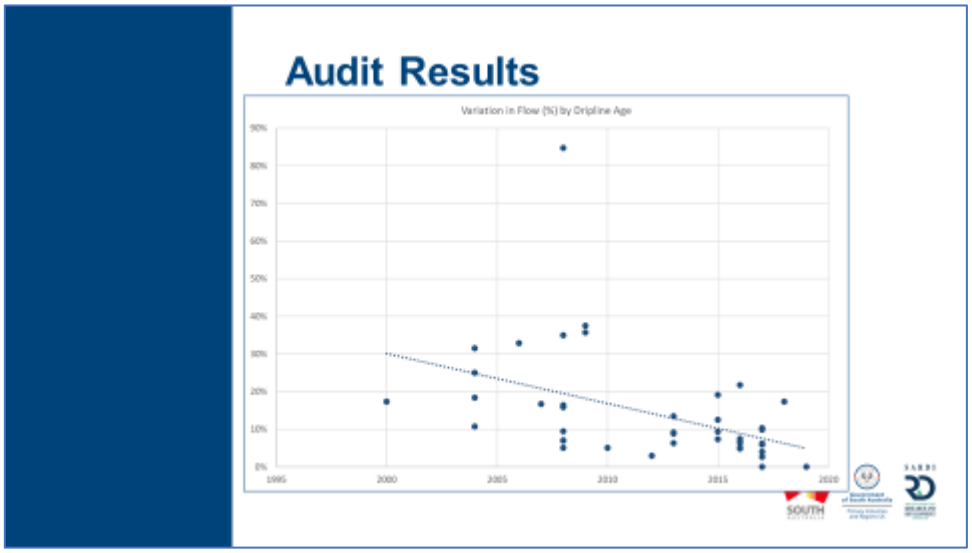


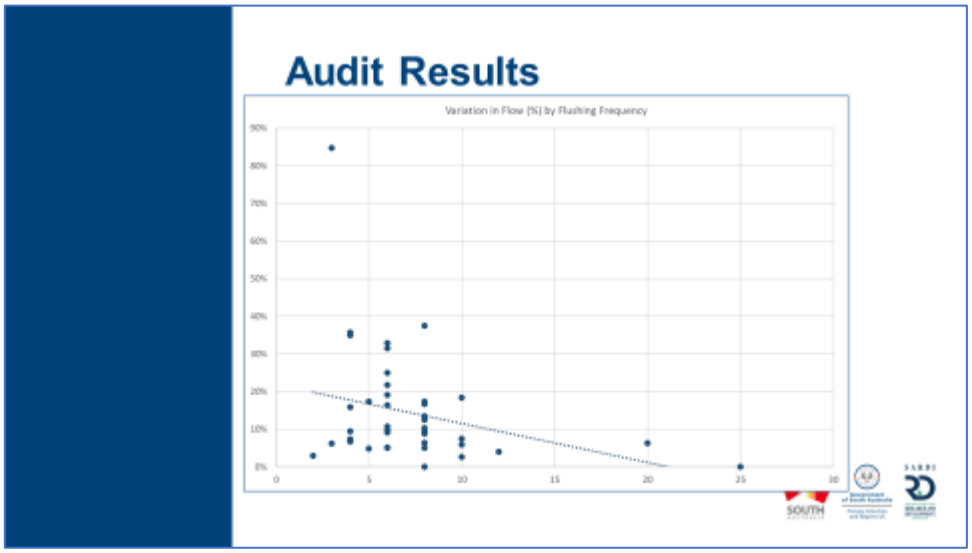

Audit Results
Variation in Flow (±%)
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%


Audit Results
Coefficient of Uniformity (%)
100%
95%
90%
85%
80%
75%
70%


Audit Results
Flow Variation from Design/Nominal (%)
200%
150%
100%
50%
0%
-50%

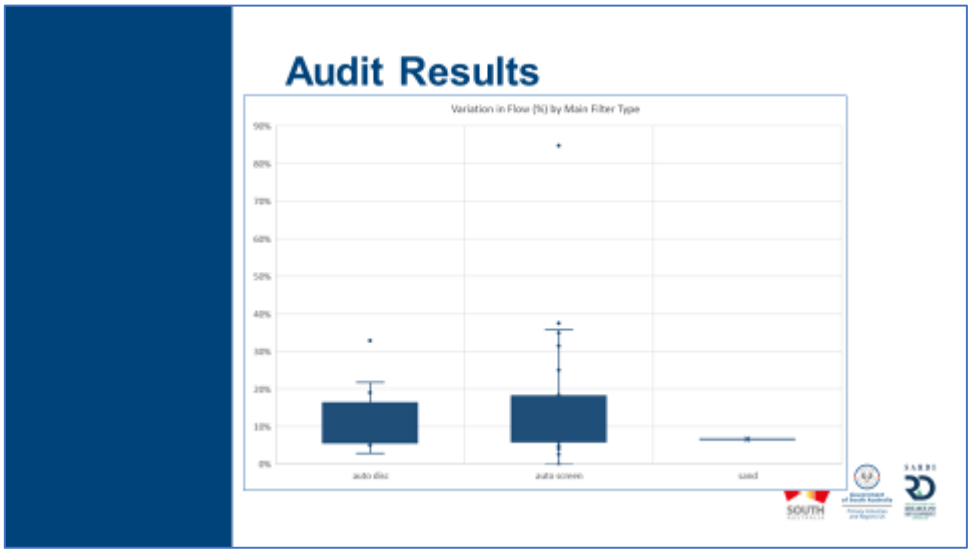

Audit Results
Lateral Flow Variation from Design (%)
200%
150%
100%
50%
0%
-50%

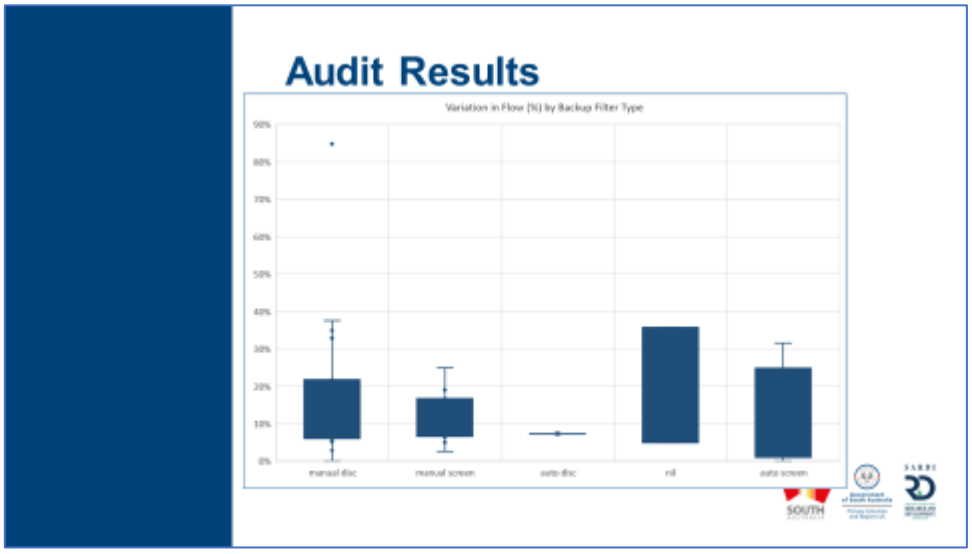

Audit Results
Variation in Flow (%) by Dripline Age


Audit Results
Variation in Flow (%) by Flushing Frequency

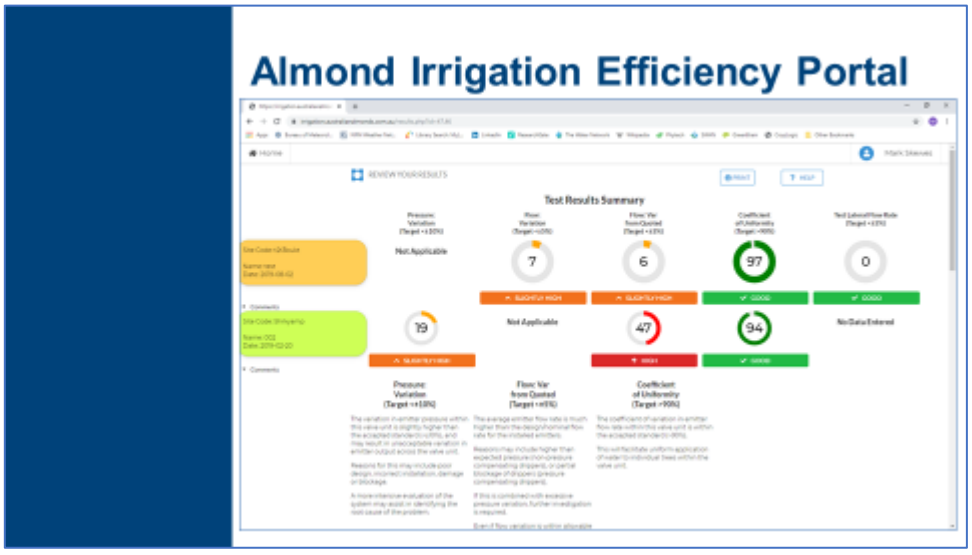

Audit Results
Variation in Flow (%) by Dosing Frequency

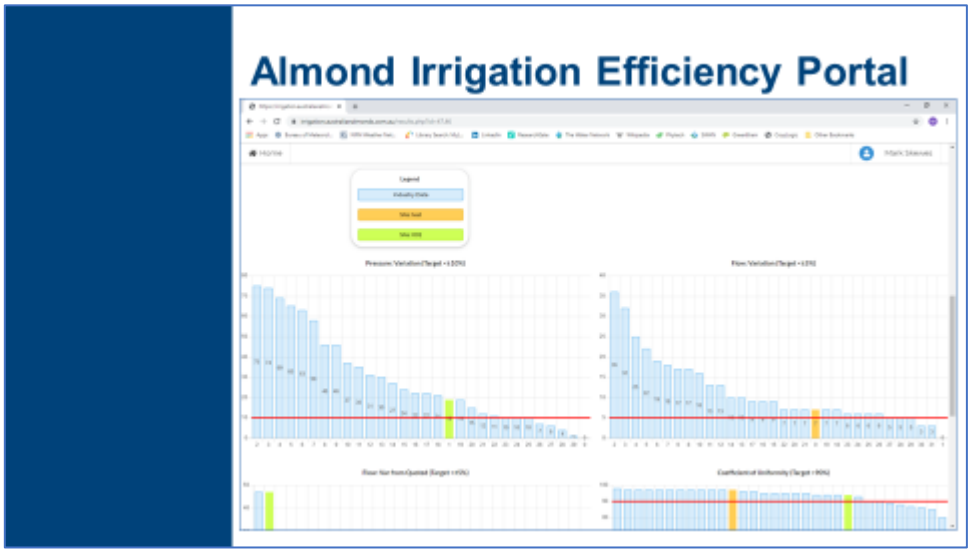

Audit Results
Variation in Flow (%) by Water Source


Audit Results
Variation in Flow (%) by Main Filter Type


Audit Results
Variation in Flow (%) by Backup Filter Type
manual disc
manual screen
auto disc
nil
auto screen


Almond Irrigation Efficiency Portal
Drip Irrigation Evaluation Tool


Almond Irrigation Efficiency Portal
Test Results Summary


Almond Irrigation Efficiency Portal

Appendix 3 - Example Grower Report

Test Results Summary

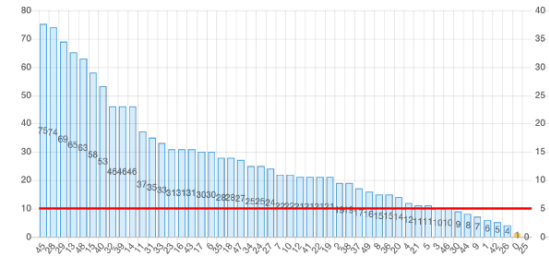
Site Code:
Name:3
Date:21.02.2019

Pressure: Variation (Target <±10%)	Flow: Variation (Target <±5%)	Flow: Var from Design (Target <±5%)	Coefficient of Uniformity (Target >90%)	Test Lateral Flow Rate (Target <±5%)
1	10	Not Applicable	94	-1
✓ GOOD	^ SLIGHTLY HIGH		✓ GOOD	✓ GOOD
The variation in emitter pressure within this valve unit is within the accepted standard (<±10%). This will facilitate uniform application of water to individual trees within the valve unit.	The variation in emitter flow rate within this valve unit is slightly higher than the accepted standard (<±5%), and may result in unacceptable variation in water application to individual trees across the valve unit. Reasons for this may include poor design, incorrect installation, damage or blockage. A more intensive evaluation of the system may assist in identifying the root cause of the problem.	In a non-pressure compensating irrigation system flow rate is determined by pressure. Consult the dripper specifications to determine the appropriate output rate (L/h) for the installed dripper at the average pressure measured.	The coefficient of variation in emitter flow rate within this valve unit is within the accepted standard (>90%). This will facilitate uniform application of water to individual trees within the valve unit.	The test lateral flow rate is close to the expected flow rate based on the number of emitters and the design/nominal flow rate for the installed emitters. This will facilitate uniform application of water to individual trees within the valve unit.

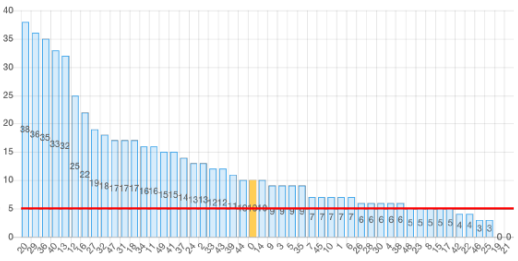
Comparison Tables

Legend

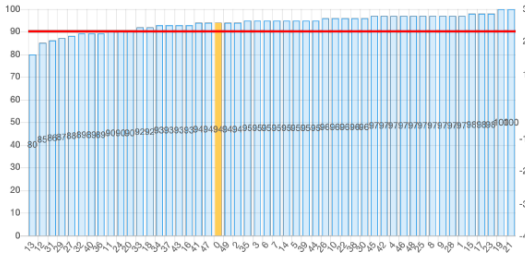
Industry Data | Site:3



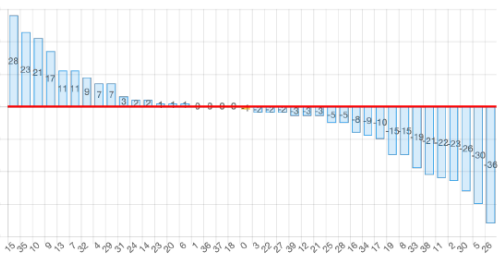
Pressure: Variation (Target <±10%)



Flow: Variation (Target <±5%)



Coefficient of Uniformity (Target >90%)



Test Lateral Flow Rate (Target <±5%)