



FINAL REPORT 2014

For Public Release

Part 1 - Summary Details

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

CRDC Project Number: DAN 1205

Project Title: Promoting Water Smart Infrastructure Investment in NSW (PWSII)

Project Commencement Date: 01/12/11 Project Completion Date: 30/06/14

CRDC Program: 4 People

Part 2 – Contact Details

Administrator: Ms Cara Brooks, Manage External Funding
Organisation: NSW Department of Primary Industries
Postal Address: Locked Bad 21, Orange, NSW 2800
Ph: 02 63913651 **Fax:** 02 63913134 **E-mail:** external.funding@dpi.nsw.gov.au

Principal Researcher: Janelle Montgomery, Project Officer- Irrigation
Organisation: NSW Department of Primary Industries
Postal Address: PO Box 209 Moree NSW 2400
Ph: 0428 640990 **Fax:** n/a **E-mail:** janelle.montgomery@dpi.nsw.gov.au

Supervisor: Anthea McClintock, Team Leader Water Policy Planning and
Development
Organisation: NSW Department of Primary Industries
Postal Address: Locked Bag 21 Orange NSW 2800
Ph: 02 63913423 **Fax:** 2 63913899 **E-mail:** anthea.mcclintock@dpi.nsw.gov.au

Signature of Research Provider Representative: _____

Date Submitted: _____

Part 3 – Final Report

(The points below are to be used as a guideline when completing your final report.)

Background

1. Outline the background to the project.

Promoting Water Smart Infrastructure Investment is a water and energy use efficiency project which aimed to build capacity of cotton irrigators to adapt to reduced water availability and increasing energy costs, to support them in making informed decisions about infrastructure change and to accelerate adoption of irrigation best practice.

The Murray Darling Basin Plan has set sustainable diversion limits on the amount of surface water and groundwater that can be accessed from the Basin. Irrigators may face cuts in water entitlement due to the setting of new sustainable diversion limits in sub-catchment of the MDB. The Australian Government has provided incentives to improve irrigation infrastructure in return for 50 per cent of the water savings (eg NSW's Sustaining the Basin Irrigated Farm Modernisation project and Qld's Healthy Headwaters Program). These programs have resulted in the rapid adoption of overhead pressurised irrigation systems.

A pilot project implemented by NSW DPI in 2009 found that the majority of on-farm infrastructure projects required large capital investment (storage reconfiguration, improvements to water conveyance and system change from furrow to centre pivot, lateral move or drip irrigation) to achieve significant water savings. Whilst improved irrigation infrastructure may include water savings, it can be associated with higher energy use.

This project has provided cotton irrigators with the capacity to make informed decisions about investing in irrigation infrastructure for improved water use and energy efficiency and to accelerate the adoption of best irrigation management practices.

The project included the delivery of training in relevant irrigation technology such as Centre Pivot and Lateral Move (CPLM) infrastructure, irrigation scheduling, irrigation system selection, water use efficiency (WUE) and energy assessment. In addition, an extensive communication strategy was implemented to disseminate information and resources to irrigators to maximise adoption of best irrigation management practice and technologies.

Objectives

2. List the project objectives and the extent to which these have been achieved.

The objectives of Promoting Water Smart Infrastructure Investment are to:

- 1.0 Benchmark irrigation water use efficiency (bales/ML) and whole farm energy use (GJ/Ha, GJ/ML, GJ/bale) for irrigated cotton.
- 2.0 Deliver Irrigation training to irrigators and consultants to increase their knowledge of best irrigation management practice and on-farm energy use and efficiency.
- 3.0 Increase irrigator knowledge of alternative irrigation systems including centre pivot, lateral move and drip irrigation systems, etc.
- 4.0 Coordinate and support forums/field days/conferences to build relationships between researchers and extension staff, irrigators and consultants and to support myBMP.
- 5.0 Water Technical Specialist D&D Team to lead and co-ordinate a cotton industry-wide water use efficiency campaign.

Methods

3. Detail the methodology and justify the methodology used. Include any discoveries in methods that may benefit other related research.

Benchmark irrigation water use efficiency (bales/ML) and whole farm energy use (GJ/Ha, GJ/ML, GJ/bale) for irrigated cotton

- The project benchmarked irrigation water use efficiency for the Australian cotton industry during the 2012/13 season using the on-line irrigation benchmarking program, Watertrack Rapid™. Importantly, Watertrack Rapid™ produces standardised and defined irrigation benchmarks which are essential for meaningful comparisons. The Program has also been used in previous irrigation benchmarking studies conducted by NSW DPI providing consistency across previously benchmarked seasons. Irrigation data was collected by surveying 46 cotton irrigators located from central Qld to Southern NSW. Water use indices, including Crop Water Use Index (CWUI), Irrigation Water Use Index (IWUI) and Gross Production Water Use Index (GPWUI) were calculated. Industry average crop yield, total available water, crop evapotranspiration and on-farm water losses were also estimated. This data provides new benchmarks for the Australian cotton industry to show if, how and at what rate water use efficiency improvements are occurring. These benchmarks enable individual irrigators to compare their own performance to regional and industry averages. More detailed methodology is provided in Appendix 1.
- In collaboration with the National Centre for Engineering in Agriculture (NCEA), this project aimed to increase awareness of on-farm energy use assessments. NCEA have developed a standardised method for assessing on-farm energy use to calculate various benchmarks for comparison. The EnergyCalc Tool developed by NCEA and the iPad App, EnergyCalc Lite were used to collate on-farm energy use information for Level 2 energy assessments and to calculate energy use efficiency benchmarks. Through demonstrations, information resources and video, the project also aimed to help irrigators keep more extensive records and conduct measurements to enable thorough assessments of on-farm energy use. The project included both whole farm (Level 2) and partial (eg. irrigation only, Level 3) energy assessments.
- A Pump Efficiency Monitor (PEM) was developed by NCEA as part of this project and trialled on-farm, on 'Macintyre Downs', Goondiwindi. The PEM continuously measures water flow rate, pressure head, engine and pump speed (RPM) and diesel consumption during a pumping event. These variables are used to examine pump performance to identify peak efficiency, maximum flow rate and any improvements required to reduce energy costs.
- 'Macintyre Downs', Goondiwindi was used as a demonstration farm for on-farm energy use measurement and monitoring. In collaboration with commercial entities the project demonstrated different methods of collecting energy use data from pump sites.

Deliver Irrigation training to irrigators and consultants to increase their knowledge of best irrigation management practice and on-farm energy use and efficiency

- Irrigation training included formal workshops such as NSW DPI's ProWATER modules and the Cotton Industries Cotton and Grains Irrigated Workshop Series. The workshops are delivered in a practical and informal manner and focus on skills that can be taken away and applied. The training workshops are designed as ½ - 1 day workshops, except the Centre Pivot and Lateral Move Training Workshop which is 2 days. They can be delivered on-farm and often include a practical component.

- Training also took the form of farm walks and technology demonstrations. Irrigation technologies such as storage meters, seepage and evaporation meters and mace meters were demonstrated.

Increase irrigator knowledge of alternative irrigation systems including centre pivot, lateral move and drip irrigation systems, etc.

- Training, technical support and extension material was provided to increase industry capacity to adopt best management practice and improve water use and energy efficiency.
- Training has assisted NSW irrigators in their decisions on irrigation infrastructure. A range of workshops were available including an Irrigation Systems, Centre Pivot and Lateral Move Course. The training workshops not only help irrigators make planning decisions, but also ensure they have the ability to manage any new infrastructure they adopt.
- A review of NSW centre pivot and lateral move installation in the Australian cotton industry was conducted and involved a repeat of the survey undertaken by Foley and Raine (2001)¹. This survey was repeated in 2011 across the Queensland Murray-Darling Basin with funding from Healthy HeadWaters Water Use Efficiency project and in 2011-12 across the rest of the cotton regions with funding from the Cotton Research and Development Corporation. The two data sets were combined to provide an examination of changes in design, operation and management of CPLM systems within the Australian cotton industry since the Foley & Raine (2001)¹ survey.

Coordinate and support forums/field days/conferences to build relationships between researchers and extension staff, irrigators and consultants and to support myBMP.

- This project provided an extension and development avenue for the innovative water related research conducted by CSIRO and NCEA. Information on irrigation best management practice and technical advice was communicated via industry newsletters, relevant websites, technical notes and magazines. Case studies and video clips were developed to showcase irrigator experiences and technical resources were developed to support the Water Module of myBMP.

¹ Foley JP and Raine SR, *Centre Pivot and Lateral Move Machines in the Australian Cotton Industry*, National Centre for Engineering in Agriculture, Toowoomba, 2001

Results, Outputs and Outcomes

4. Detail and discuss the results for each objective including the statistical analysis of results.
5. Describe how the project's outputs will contribute to the planned outcomes identified in the project application. Describe the planned outcomes achieved to date.

Objective 1.0: Benchmark irrigation water use efficiency (bales/ML) and whole farm energy use (GJ/Ha, GJ/ML, GJ/bale) for irrigated cotton

Milestone 1.1 Irrigation Water Use Efficiency Benchmarks updated for the cotton industry

- *Updated representative irrigation water use benchmarks (Gross Production Water Use Index) for the cotton industry*
- *One workshop in CQ, St George, Darling Downs, Border Rivers, Gwydir, Namoi, Macquarie and Southern NSW regions to disseminate Watertrack RapidTM reports and discuss results*

Outputs:

Irrigation benchmarks have been established for the Australian cotton industry for the 2012/13 cotton season.

During 2013, irrigation and yield data were collected from 46 cotton farms located from Central Qld to Southern NSW. The web-based benchmarking program Watertrack RapidTM was used to calculate a number of performance indicators. The survey data showed significant variability between individual farms which indicates that there is scope for large improvements in on-farm water management on some cotton farms.

Figure 1 shows the variation in yield, total available water², Crop evapotranspiration (ETc) and on-farm water losses. The industry average cotton yield (based on 46 survey farms) in 2012/13 was 11.14 b/ha, ranging between 7.18 and 14.37 b/ha. On average the total amount of water used on farm to grow that crop, shown as total available water in Figure 1 was 10.16 ML/ha, ranging between 6.61 and 15.47 ML/ha.

The difference between the total available water and crop evapotranspiration provides an estimate of on-farm water losses. The average on-farm water losses were 1.64 ML/ha, or approximately 15 per cent of water used on-farm for the crop. Therefore on average, 85 per cent of total available water was used productively through the crop. However, the data indicates that there are still farms incurring unnecessary water losses. The top 25 per cent of farms with the highest on-farm losses averaged losses of around 3.5 ML/ha, indicating around 65 per cent of their total available water went through the crop in a productive manner.

Watertrack RapidTM combines all on-farm losses into a single figure and includes seepage and evaporation from supply, drainage and tailwater systems, on-farm storages, in-field losses such as deep drainage and rainfall runoff that is not harvested. It allows irrigators to quantify the magnitude of water losses and identify if further investigation is required. Inaccuracies in estimating total available water can easily occur since often this water is not

² Total available water includes irrigation water (water pumped, storage water used, water harvested), rainfall and soil moisture reserves.

metered within the farm. Water monitoring and measurement within the farm is one area for further improvement within the Australian cotton industry.

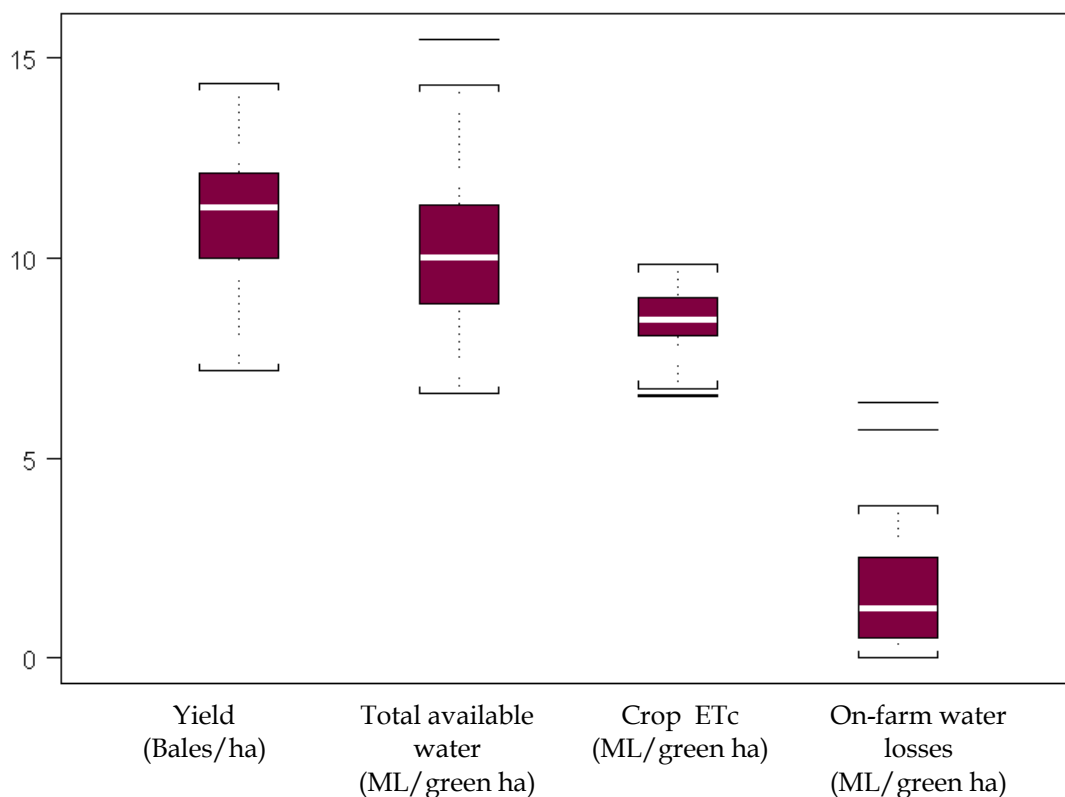


Figure 1: Variation in Total Water Loss compared to Yield, Total Available Water and Crop Evapotranspiration for the Australian Cotton Industry, 2012/13.

Three water use indices, Crop Water Use Index ($CWUI_{farm}$), Irrigation Water Use Index ($IWUI_{farm}$) and Gross Production Water Use Index ($GPWUI_{farm}$) were calculated for each survey farm and the results are presented in Figure 2.

The survey data shows a wide range of irrigation performance. The average $CWUI_{farm}$, which relates total production to the amount of water consumed by the crop (ETc), was 1.31 bales/ML ranging between 0.94 and 1.70 bales/ML.

$IWUI_{farm}$ relates total production to the amount of irrigation water supplied. The average $IWUI_{farm}$ was 1.41 bales/ML ranging between 0.76 and 3.01 bales/ML. However, the amount and timing of rainfall has a significant influence on this performance indicator. Therefore the Australian cotton industry uses the $GPWUI_{farm}$ to benchmark water use efficiency. It relates total production to the total amount of water used (irrigation water + effective rainfall + soil moisture), so can be used to compare the $GPWUI_{farm}$ between seasons and regions.

The average $GPWUI_{farm}$ for the 2012/13 cotton season was 1.12 bales/ML, ranging between 0.73 and 1.43 bales/ML. This figure can be used as a water use efficiency benchmark to which industry can compare its own performance and gauge improvement over time.

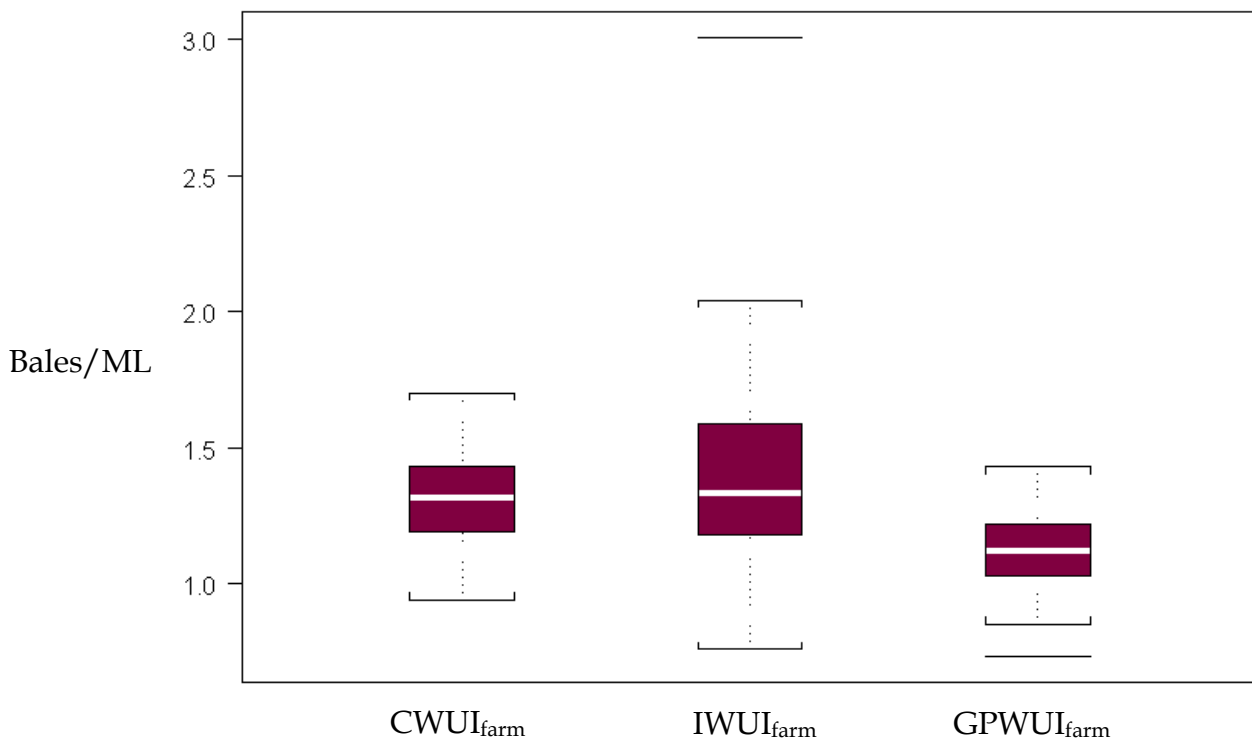


Figure 2: Variation in crop water use indices calculated at the farm level 2012/13.

NSW DPI has completed three surveys for the Australian cotton industry. A comparison between the three seasons is provided in Appendix 1.

In summary, GPWUI_{farm} for the 2006-07 and 2008-09 cotton seasons were 1.17 and 1.14 bales/ML, and both seasons had reduced plantings and cotton prices, and low water availability. In contrast, the GPWUI_{farm} for the 2012/13 cotton season, in which there were record plantings and full production, was 1.12 bales/ML. Statistical analysis was conducted on the dataset and found no significant difference in GPWUI_{farm} between the three seasons, which suggests the cotton industry uses water as efficiently during times of full water availability and production as in times of water shortage.

The results of the 2012/13 water use efficiency benchmarking surveys have been presented to industry at the following forums:

- 17th Australian Cotton Conference, August 2014.
 - Three minute thesis presentation “Water Use Efficiency in the Australian Cotton Industry” delivered to around 300 conference delegates.
 - Paper published in conference proceedings; Montgomery, J., Hoogers, R., Shepherd, K. & Bray, S. (2014). Water Use Efficiency in the Australian Cotton Industry. Proceedings of the 17th Australian Cotton Conference, Broadbeach Qld.
- Spring 2014 Edition of CRDC’s Spotlight Magazine
- Australian Cotton Grower Magazine; article submitted for publication in Oct/Nov 2014 edition.
- Continued promotion of 2012/13 irrigation benchmarks will occur through the CottonInfo e-newsletter and during delivery of relevant irrigation training (eg NSW DPI Pro-Water Irrigation Benchmarking and Water Budgeting) workshops. As the Water Use Efficiency Technical Specialist with the CottonInfo team,

Janelle Montgomery will continue to work with Regional Development Officers (RDO's) since they provide a good avenue for dissemination of industry benchmarks (eg grower groups).

- 2006/07 & 2008/09 Water Use Efficiency benchmarks were included in a review of water use efficiency and productivity trends in the Australian Cotton Industry and published in *Crop and Pasture Science*; Roth, G, Harris, G., Gillies, M., Montgomery, J. and Wigginton, D.W. (2013) 'A review of water use efficiency and productivity trends in Australian irrigated cotton', *Crop and Pasture Science*, Volume 64, Issue 8 Cotton Catchment Communities CRC Research Outcomes and Innovation (Part 2) CSIRO.

Outcomes:

- Australian cotton industry uses its water as efficiently in years of full production as in years of water shortage.
- Irrigation benchmarking established for the Australian cotton industry allows individual irrigators to compare their performance to enable continuous improvement. The Australian cotton industry can use the benchmarks to examine changes in WUE over time.
- Roth, G, Harris, G., Gillies, M., Montgomery, J. and Wigginton, D.W. (2013) 'A review of water use efficiency and productivity trends in Australian irrigated cotton', *Crop and Pasture Science*, Volume 64, Issue 8 Cotton Catchment Communities CRC Research Outcomes and Innovation (Part 2) CSIRO.
 - Most downloaded of all papers in the *Crop and Pasture Science* journal in the last 12 months. <http://www.publish.csiro.au/?nid=40>

The screenshot shows the CSIRO Publishing website for the journal *Crop & Pasture Science*. The page features a search bar, navigation tabs for 'Online Early', 'Current Issue', 'Just Accepted', and 'Most Read', and a sidebar with links to 'Journal Home', 'Content', and 'For Authors'. The 'Most Read' section displays a table of the top two papers:

Rank	Paper Details
1.	<p>Published 18 December 2013</p> <p>Water-use efficiency and productivity trends in Australian irrigated cotton: a review</p> <p><i>Crop and Pasture Science</i> 64 (12)</p> <p>Guy Roth, Graham Harris, Malcolm Gillies, Janelle Montgomery and David Wigginton</p>
2.	<p>Published 06 October 2013</p> <p>IPM in the transgenic era: a review of the challenges from emerging pests in Australian cotton systems</p> <p><i>Crop and Pasture Science</i> 64 (8)</p> <p>Lewis Wilson, Sharon Downes, Moazzem Khan, Mary Whitehouse, Geoff Baker, Paul Grundy and Susan Maas</p>

Plate 1: Crop and Pasture Science Paper Ranking over previous 12 months

Milestone 1.2 Promote energy assessment and reporting tools

- 2 magazine/newspaper articles annually, preparation of fact sheet on energy record keeping, place stories, u-tube clips

Outputs:

A variety of extension has taken place to promote energy assessment and reporting tools including magazine/newspaper articles and production of short YouTube video clips, presentations at grower field days, industry conferences and communications with a variety of farmers and consultants. A list of specific communications examining on-farm energy use, monitoring tools and assessment are provided below:

Magazine Articles

- Bray, S. (2012) 'Diesel to gas conversions cut bills', Agriculture Today, May2012, pp13.
- Jensen, M. and Bray, S. (2012) 'Diesel to gas conversions cut bills', Spotlight on Cotton R&D, Spring 2012, CRDC, in press
- Montgomery J. (2011) 'CRDC to assist farmers to cut water and power usage' Agriculture Today, October 2011, pp10.
- Bray, S. (2012). "Match up to save money", Agriculture Today", October 2012, NSW DPI.
- Giddings, J. (2012). "Coomealla, Curlwaa pump efficiency", Agriculture Today", October 2012, NSW DPI.
- Baillie, G. (2013). "EnergyCalc goes mobile with a 'lighter' version" Spotlight on cotton R&D, Summer 2012/13, CRDC.
- Montgomery, J. (2013). "How good is your water (and energy) use efficiency", Australian Cotton Grower, Dec 2012 - Jan 2013, Vol 33, No. 7, pp 27-28.
- Sandell, G. (2013). "Energy Research on the rise" Spotlight on cotton R&D, Summer 2012/13, CRDC.
- Sandell, G. (2013). "Rising energy costs demand efficiencies", Australian Cotton Outlook, December 2012 pp. 11.
- Montgomery, J. & Szabo, P.M., (2013) "Pump performance evaluation pays off", Spotlight on cotton R&D, Winter 2013, CRDC.
- Montgomery, J. & Szabo, P.M., (2013). "Finding the sweet spot – maximum water using minimum fuel", Australian Cotton Grower, Volume 54, No. 7, Dec 2013 – Jan 2014, pp32-34.
- Montgomery, J. (2013) 'On-farm energy use – Macintyre Downs, an energy assessment demonstration farm" Australian Cotton Grower, Volume 54, No. 7, Dec 2013 – Jan 2014, pp32-34.

Videos

1 Diesel Gas Conversions (2011/12)

Producer: Stuart Bray

Editor: Nick Lee

Interviewer: Stuart Bray

Interviewees: Warwick Wannan and Brad Pollard

Background: Part of a series on Energy. This story looks at a cotton irrigator, Warwick Wannan from Baan Baa near Boggabri, who has converted his diesel pumps from a straight diesel flow, to a mix of diesel and gas which gives him an overall fuel saving of around 15%. We also interviewed the installer of Diesel Gas technologies about how the process is carried out. (Since the story was completed the price of installation has fallen by 50% which takes the payback period from around 12 months depending on the use, to 6 months.

Duration: 3'.50"

Dissemination:

- Posted on Digital Farm TV <http://www.digitalfarmtv.com/cotton>
- Transcript and audio available to develop fact sheets, newspaper stories, radio stories etc.
- Text submitted as an energy story for Ag Today.

2 Energy Assessment on Farm (2011/12)

Producer: Stuart Bray

Editor: Nick Lee

Interviewer: Stuart Bray

Interviewees: Craig Ballie

Background: Part 2 of the Energy series. I/V with Craig Baillie Deputy Director of the NCEA at Toowoomba. He discusses with Stuart Bray the different assessment levels that can be conducted on-farm, what they tell farmers and the management options that irrigators can take to reduce their energy costs.

Duration: 3'.00"

Dissemination:

- Posted on Digital Farm TV <http://www.digitalfarmtv.com/cotton>
- Transcript and audio available to develop fact sheets, newspaper stories, radio stories etc.
- Text submitted to CRDC as input for Energy Story, June Edition.

3 THE POWER OF ONE (2012/13)

Producer: Stuart Bray

Editor: Daniel Mc Ready

Interviewer: Stuart Bray

Interviewee: Doug Truman/ Chris Goulden

Background: Electricity prices have more than doubled on-farm during the last two years. For irrigators who use more than 160,000 Kilowatt hours per year, a power factor indicator is available to be installed on their meter board that tells them how efficiently their pumps are using the power being supplied. If the efficiency reading is low, a capacitor can be fitted that will increase the efficiency of the power use and lower their power bill.

Duration 3' 20"

Proposed Dissemination:

- To be posted on the CRDC website with a link to NSW DPI website.
- Transcript and audio available to develop fact sheets, newspaper stories, radio stories etc.

4 PUMP MONITOR (2012/13)

Producer: Stuart Bray

Editor: Nick Lee

Interviewer: Stuart Bray

Interviewee: Phil Pzabo, NCEA & Hamish Johnstone, 'Macintyre Downs'

Background: Irrigation pumping makes up a large component of on-farm energy use on an irrigated cotton farm. Pump performance evaluation is important to evaluate pump efficiency. NCEA have developed a Pump Efficiency Monitor which was trialled on Macintyre Downs, Goondiwindi.

Proposed Duration: 4'

Proposed Dissemination:

- Posted on Digital Farm TV <http://www.digitalfarmtv.com/cotton>
- Transcript and audio available to develop fact sheets, newspaper stories, radio stories etc.

5 PUMP EVALUATION (2013/14)

Producer: Stuart Bray

Editor: Nick Lee

Interviewer: Stuart Bray

Interviewee: Lance Pendergast, Irrigation Officer Emerald QLD

Background: Tips on how to improve your pump performance.

Proposed Duration: 3'00"

Proposed Dissemination:

- Posted on Digital Farm TV <http://www.digitalfarmtv.com/cotton>
- Transcript and audio available to develop fact sheets, newspaper stories, radio stories etc.

Conference Presentations & Papers:

- Szabo, P., Montgomery, J & Sandell, G. (2013). *Development of a pump efficiency monitor for use in cotton irrigation*, Paper presented at the 2013 IAL Conference, 28-30 May 2013, Griffith, NSW.
- Szabo, P., Montgomery, J & Sandell, G. (2013). *Evaluating pump performance*, Paper presented at the 2013 IAL Conference, Griffith.
- Szabo, P, Montgomery, J., & Sandell, G. (2014). *Development of a Pump Efficiency Monitor for Use in Cotton Irrigation*, Proceedings of the 17th Australian Cotton Conference, Broadbeach Qld.

Industry Presentations

- April 2012 Attended Gwydir Valley Cotton Growers AGM and provided an update on energy use efficiency work in which NSW DPI are involved.
- May 2012 Three farm visits with Gary Sandell (NCEA) to NCEA's On-Farm Energy Use trial farms located at Moree, Breeza and Wee Waa. This has provided informal training about energy use assessment.
- 13 March 2013 - Macintyre Field Days. Presentation on EnergyCalc app.
- 4 April 2013 - Meeting with Hamish Johnson, Macintyre Downs, Michael Scobie, Bo Zhao, Phil Szabo NCEA to discuss EnergyCalc Lite and results of PEM trial.
- 26 February 2014 - Invited Speaker at GVIA (Gwydir Valley Irrigators Association) Field Day – "Practical Experience of Irrigation Technologies". A joint Presentation titled Monitoring and measuring on Farm Energy Use was given by Janelle Montgomery & Phil Szabo, NCEA. Around 120 people attended the field day including irrigators, consultants, agency and agribusiness.
- 2014 CottonInfo Team RDO Energy Training – 'Laurella', Moree.
- 12 March 2014 - Macintyre Valley Field Day – Energy Assessment and Pump Performance.
- 22 July 2014 - Farm Walk – On farm energy monitoring and assessment, Macintyre Downs, Goondiwindi.

Trialling EnergyCalc Lite

Hamish Johnstone, "Macintyre Downs", Goondiwindi, trialled the EnergyCalc Lite mobile App over the 2012/13 cotton season. He updated energy use information into the App as operations took place over the season. However, with the farm in full production and shortage of labour, the inputs into EnergyCalc became lower priority as the season progressed. Hamish made some very useful comments and suggested changes to improve

EnergyCalc Lite so it was more farmer-friendly. These changes were taken on board by NCEA and included in the current version of EnergyCalc Lite. A summary of these changes is provided in Appendix 2.

EnergyCalc Lite was also trialled in collaboration with Dallas Stott, a cotton grower from Whitton in Southern NSW. This involved a single farm visit as Dallas had prepared his energy use figures for various farm operations prior to our visit. He was very impressed with EnergyCalc Lite and was looking forward to using it himself in the future.

The results of on-farm energy use assessments for Macintyre Downs, the Whitton farm and two other cotton farms are provided in Appendix 3.

EnergyCalc Lite was promoted in various written publications along with presentations at field days, farm walks etc.

Outcomes:

- Greater understanding by cotton irrigators of NCEA's standard methods of monitoring and reporting on-farm energy use.
- Improved useability of EnergyCalc Lite
- Increased awareness of EnergyCalc Lite.
- Increased awareness and adoption of energy best management practice.
- Renewed interest by cotton irrigators to evaluate pump performance as evidenced by the following irrigator comments:

"I have a pump that does over 2000 hrs a year, to find a 5 per cent improvement in fuel use would have a significant saving for me" Glen Smith, Goondiwindi

Dear Janelle,

Have read with interest an article in the last Spotlight Magazine that has been written by you called Pump Performance Pays Off. I have always suspected that our pumps are not performing to what they were sold to us. My question is who I can contact in Queensland to have a similar operation carried out here as to what you have carried out at Macintyre Downs.

Look forward to your reply

Don Crothers "Booligar" Dirranbandi 4486

Dear Janelle,

Enjoyed your article in the spotlight with Hamish. Where would I find some more of that type of info?

Cheers

John Norman, Talwood.

Milestone 1.3 Energy Benchmarks established for the cotton industry

- *Level 2 Energy Assessment completed for up to 2 farms using standard assessment and reporting methodology developed by NCEA*
- *Upgrade Pump Efficiency Monitor*
- *Set-up energy use Demonstration Farm to showcase methods for monitoring energy use on-farm.*

Outputs:

Level 2 Energy Assessments

Level 2 Energy Assessments were conducted on four cotton farms between 2012 and 2014. It was difficult to engage growers in a Level 2 assessment as it requires reasonably detailed measurements of on-farm energy use across all machinery operations and water pumping and application. This project found that very few farms are currently recording energy use to this level of detail. The collection of energy use data is time consuming and often involves hand written log books. Further, on larger farms, a greater number of staff may be involved with pumping or machinery operations that can lead to additional recording error. In many cases, keeping accurate records of fuel consumption for individual plant can be difficult. The total fuel delivered to the farm is known, but very few irrigators seem to have records of fuel use of individual farm operations. Even at the pump site, dip stick measurements are not regularly taken and generally no flow meters are installed. The latest model tractors have the ability to record fuel consumption, but irrigators are generally not accessing this information.

One farm who agreed to conduct a Level 2 energy assessment decided to measure fuel use on the field closest to the fuel bowser. He fuelled up after each field operation, and so gathered the fuel use for each operation across the season and extrapolated his results over the rest of his farm.

Where crops other than cotton were also grown, it was often difficult to split the energy used between the different enterprises. Despite that the energy reporting tools used, EnergyCalc and EnergyCalc Lite, have calculators to provide an estimation of energy use across the farm and can be used when measurements are not taken, it was still difficult to engage growers and consultants in this activity.

The results of the four Level 2 Energy Assessments are provided in Table 1. The input data and summary reports from EnergyCalc Lite for each farm are provided in Appendix 3, Tables 1-4. Energy costs associated with the pumping of water onto and around the farm made up over 50 per cent of total on-farm energy use on three of the 4 farms (Refer Appendix 3, Plates 1-4). For the Whitton farm, where water is delivered to the farm through gravity, irrigation made up only 32 per cent of total on-farm energy use.

The on-farm energy use varied between 6 and 12 GJ/ha, with costs ranging between \$208 and \$374 per hectare and diesel energy inputs ranging from 151 to 304 L/ha. The differences were mostly accounted for in the amount of irrigation water used and the delivery system. For example Macintyre Downs, with the highest diesel use per hectare assumes all water was double pumped, that is pumped from river into storage and then re-lifted after an irrigation event, whereas the Whitton farm was able to deliver the irrigation scheme water by gravity alone. The irrigation usage on Sappa was possibly underestimated, as there was no data available on the tailwater return/relift. Sappa relies on bore water pumped with diesel engines. Most of the irrigation water used on Laurella also comes from bores, however all but one are fitted with electric pumps. All farms are irrigated using furrow irrigation. A small area of the Whitton farm is irrigated using bankless channel.

Table 1: Level two energy assessment results

Farm	Total Diesel	Total Electricity	Total ULP	Energy /ha (GJ)	Emissions (kg/ha)	Cost \$/ha
Macintyre Downs	304	0	0	12	821	374
Sappa	184	0	0	7	497	276
Whitton Farm	152	36	0	6	441	208
Laurella	151	1279	45	12	1629	365

One of the aims of this project was to raise interest in energy benchmarking within the Cotton Industry. Similar to the results of energy assessment work previously conducted by NCEA (Baillie & Chen 2008)³, these four farms show a significant variation in on-farm energy use. This variation should draw attention to opportunities for each of the farms assessed to reduce on-farm energy use through relevant means including improved pump performance, irrigation application, or through a change in the farming operations.

Level 3 Energy Assessments

Four Level 3 energy assessments were conducted to examine pump performance. Results from the pump evaluations were entered into IPERT (Irrigation Pump Evaluation and Reporting Tool). The IPERT reports are provided in Appendix 6. The results are summarised and presented in Table 2.

There was a high level of interest in pump performance evaluation. This was expected given that water pumping accounts for the largest proportion of on-farm energy use on irrigated cotton farms. One grower from the Border Rivers reported that a pump site on his farm was operated for almost 2000 hrs over a cotton season. Even a small improvement in pump performance could result in significant energy savings. This project identified a number of farms with interest in investigating pump performance that could be conducted under CRDC's EEIG project 'Improving Energy Efficiency on Irrigated Australian Cotton Farms'.

The four pump tests conducted have highlighted many areas for improvement in energy efficiency. Generally pump stations should be designed to operate at peak efficiency while pumping at their maximum flow rate. Some of the issues identified from the pump performance evaluations include:

- Diesel engines oversized for the task they are required to perform. Ideally the engine should run at 70% to 80% load capacity when pumping maximum water volume.
- The high pump elevation resulting in a high suction lift and in-turn causing cavitation resulting in premature wear on the pump.
- Suction diameters smaller than discharge diameters, a fundamental flaw in the design of a pump station.
- On some electric pumps it has been identified that network charges have increased the cost to pump water by 70 per cent. It is important to ensure that the station is operating under the correct tariff and the pump station is disconnected from the grid when not in use for an extended period of time.

The only way to answer the question 'Is my pumping running efficiently?' is to perform a pump test. This will identify the best efficiency point and maximum water flow rate to

³ Baillie, C and Chen, G (2008), Reducing Energy Input Costs and Association Greenhouse Gas Emissions in Cotton, Australia Cotton Conference, Gold Coast Convention and Exhibition Centre, Broadbeach, Queensland.

provide a management tool for the grower. In addition, appropriate recommendations to reduce energy costs will also be made to the grower.

Table 2: A summary of results from four pump evaluations

Farm	‘Booligar’, Dirranbandi	‘Clyde’, Dirranbandi	‘Macintyre Downs’ Goondiwindi	‘Macintyre Downs’ Goondiwindi
Pump type	China Pump 20-HBC-40	Mixed Flow 26-HBC-30	China Pump 26-HBC-40	China Pump 26-HBC-40
Problem	Only getting 90 ML/d, wanting 120 ML/d.	No specific problem, but being the main pump site which lifts river water into main supply, does a lot of work and needs to be working efficiently.	Using a lot of diesel, needing to know what where to run the pump for best efficiency.	Older pump, probably some wear, interested in how it was performing.
TDH (m)	6.87 m	5.69 m	4.55 m	8.65 m
Flow rate (ML/d)	90 ML/d	105 ML/d	137 ML/d	120 ML/d
Fuel Consumption (L/hr)	23 L/hr	26 L/hr	45 L/hr	43.85 L/hr
Combined Engine & Pump Efficiency	29.6 %	24.9 %	15.11 %	26 %
Pumping Cost to pump 1ML at \$1.20/Litre	\$7.28 /ML	\$7.16 /ML	\$9.44 /ML	\$10.52
\$/ML/m head	\$1.06	\$1.26	\$2.08	\$1.22
Recommendations:	Increase suction side pipe diameter For best efficiency operate engine at 1800 RPM, 70% load with a pump speed of 570 RPM. Increase no. belts to 8 (C-section). Ideally lower pump or raise water level in tail water channel by 0.5 m.	Site better suited to axial pump due to low head (<10m) and high flow requirement.	Under current pump station set-up reducing engine speed to 1550 RPM will result in the engine operating in a more efficient range for the power required, therefore reduce fuel consumption and cavitation with minimal reduction in water flow. The power produced by the current Volvo engine exceeds the power required by the pump in excess of 50%. This causes the engine to operate in an efficient zone. Sourcing an engine that operates at 75% load for the power required by the pump will reduce energy costs.	The river pump is performing reasonably well (Combined efficiency 26%), however, cavitation is likely due to the high suction lift required at this site. Energy costs could be reduced further if an axial pump was installed.

Pump Efficiency Monitor

The National Centre for Engineering in Agriculture (NCEA) developed a Pump Efficiency Monitor (PEM) for use on cotton irrigated farms. The PEM continuously measures water flow rate, pressure head, engine and pump RPM and diesel consumption during a pumping event. These variables are required to calculate combined efficiency, energy costs per megalitre (\$/ML) and per megalitre per meter head (\$/ML/m head). The PEM, therefore, examines pump performance to identify peak efficiency, maximum flow rate and any improvements required to reduce energy costs.

The PEM unit was first trialled during the 2012/13 season at Macintyre Downs, Goondiwindi. The PEM unit was installed on 4 December 2012 on a lift pump (Storage MD3) site. In this first season, several challenges were experienced that delayed the capture of data from the pump site until 27 January 2013.

A second PEM was purchased by NSW DPI and was installed at Macintyre Downs River Pump site on 15th January 2013. At this time, improvements were made to the NCEA prototype to include solar power. Again, some technical issues were faced, including the inability to get an accurate flow rate at the River Pump site.

By the end of the 2012/13 season one pumping event had been successfully monitored, where water flow, suction and discharge pressure, and diesel consumption was continuously measured at MD 3 lift pump using the PEM. A full report of the 2012/13 season results is given in the 2013 IAL conference paper (Szabo, P., Montgomery, J & Sandell, G. (2013). "Development of a pump efficiency monitor for use in cotton irrigation", Paper presented at the 2013 IAL Conference, 28-30 May 2013, Griffith, NSW) provided in Appendix 5.

At the end of the 2012/13 season the PEM units were upgraded to include engine and pump speed sensors. Speed sensors are an important variable to measure when interpreting the PEM output. Diesel consumption, total dynamic head and water flow rate will vary with pump and engine speeds. Collecting all five variables provides valuable insight into the various operating conditions for each pump station, which identifies the best efficiency point for minimum energy cost within the current pump station setup. NCEA investigated the installation of a torque meter to identify individual pump and engine efficiencies, plus produce an accurate calculation for power into the pump. However, the costs were too prohibitive (upwards of \$15,000).

The trial then continued into the following season, 2013/14, capturing data from the majority of pumping events at the lift pump site. The results from the 2013/14 season are provided in the 2014 Australian Cotton Conference paper, Szabo, P, Montgomery, J., & Sandell, G. (2014). "Development of a Pump Efficiency Monitor for Use in Cotton Irrigation", Proceedings of the 17th Australian Cotton Conference, Broadbeach Qld (Appendix 5).

The ability of the PEM to continuously log pump variables not only provides data to assess diesel engine and pump efficiency, but it also provides accurate information concerning energy use for on-farm energy assessments. The trial of the PEM has indicated that large energy and cost savings are achievable. The trial highlights the importance to test each individual pump setup to identify the optimal operating point to achieve maximum efficiency. Significant savings are possible for individual operators and the industry collectively.

Demonstration Farm to showcase methods for monitoring energy use on-farm

“Macintyre Downs” was set up as an Energy-Use Demonstration farm during the 2013/14 season. It involved monitoring two pump sites and collaborating with Goanna Telemetry Systems & Agronics to provide energy use information on their website.

This demonstration continued to trial the PEM. The PEM was installed on the lift pump (Storage 3 No. 8) site on 19 September 13 and data was captured from the majority of pumping events.

Agronics equipped the river pump site in February 2014, installing necessary communications to collect logged data from the Volvo Engine, and pump and water flow from the SunWater Mace meter. However access to this data was hampered due to technical difficulties (eg. ML/day recorded rather than ML/hr, column headings and units unknown in file downloaded from datalogger).

Tom Dowling, Goanna Telemetry Systems provided access to pump and water information on their Goanna Website and in M-Log (the graphic software). This provided real time access to pump information to the grower.

Unfortunately, the farm manager at Macintyre Downs, Hamish Johnstone resigned at the end of 2013, reducing farmer input into the trial despite the new Manager (MCA, Goondiwindi) allowing the demonstration to continue. Hamish Johnstone showed great interest in examining on-farm energy use and provided useful comment on project results and new technologies. However, the work of Agronics and Goanna Telemetry Systems on Macintyre Downs suffered somewhat by lack of grower input at the farm level following the change of management.

In addition to demonstrating on farm energy use and monitoring tools, electronic meters to measure storage volumes were also demonstrated. An Irrimate storage meter was installed in Storage 3, while an Agronics storage meter had been installed in Storage 1 to demonstrate the two meters used for water measurement. These were showcased at the Macintyre Downs Farm Walk.

- 22/07/14 A farm walk was held at Macintyre Downs. It was attended by 25 irrigators/consultants and industry personnel. The following topics were covered by various presenters:

- On-farm energy assessment - current research and performance
- Pump evaluation to find energy savings
- On-farm energy measurement tools eg EnergyCalc Lite
- Equipping pump stations for performance and alarming
- Measuring and monitoring storage volumes



Outcomes of the Farm Walk

An evaluation was conducted at the end of the farm walk and it was found that participants found the day useful and met their expectations, as illustrated in Figure 3. Evaluation was also conducted to determine changes in KASA (knowledge, aspirations, skills and attitude). All irrigators increased their knowledge and understanding of various aspects of on-farm

energy use monitoring and measurement as a result of attending the farm walk as shown in Figure 4.

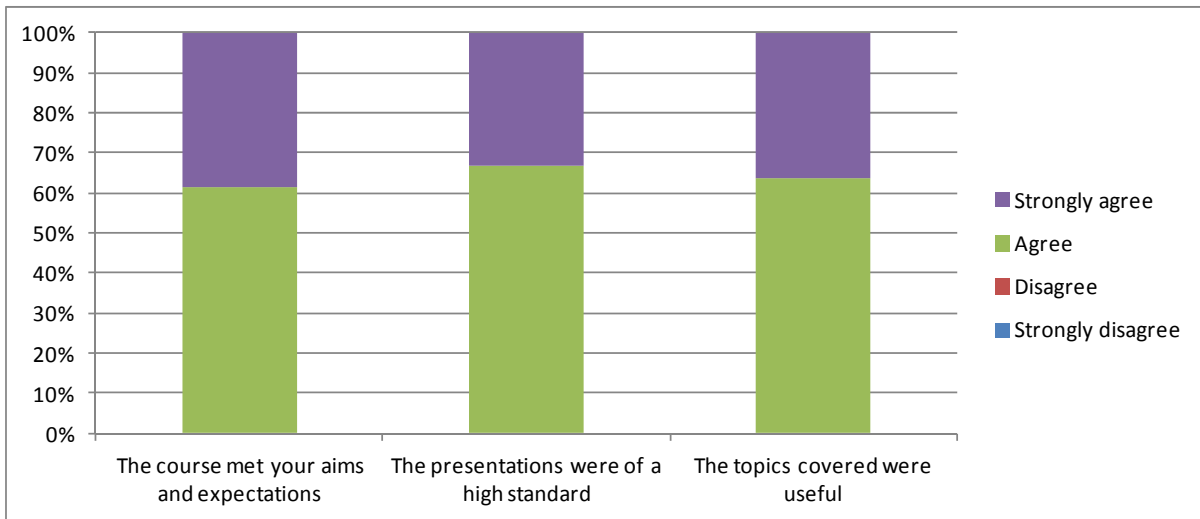


Figure 3: Evaluation of Farm Walk content and delivery.

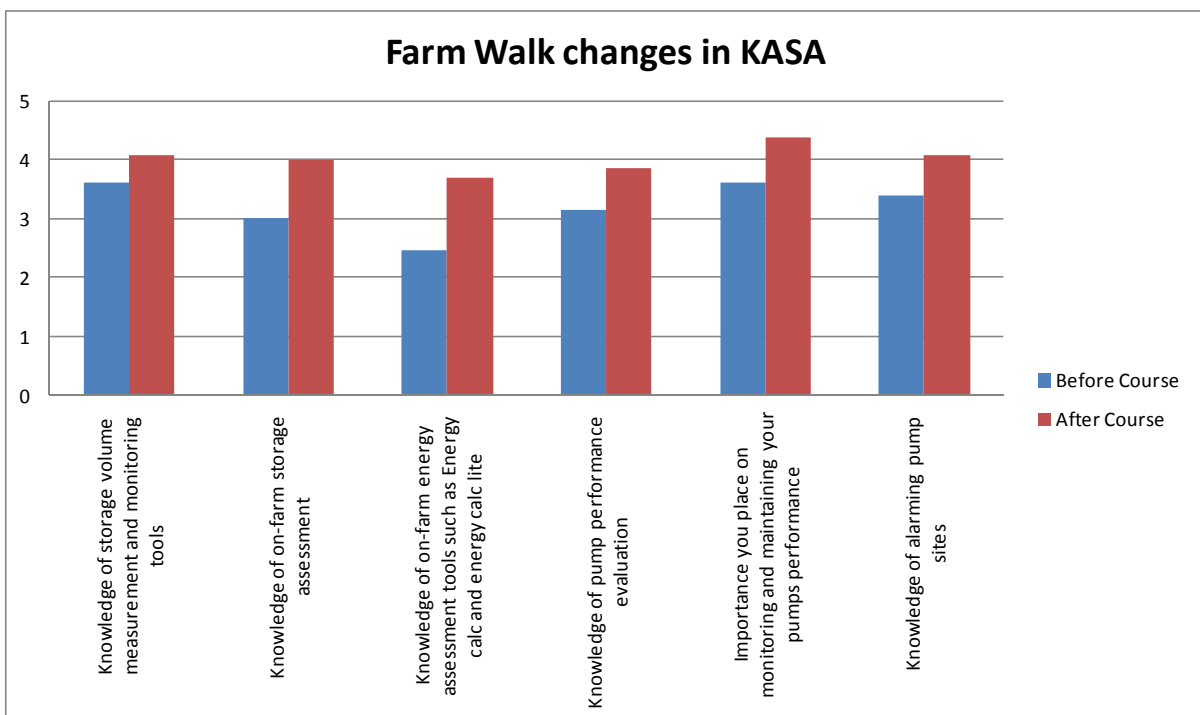


Figure 4: Irrigators change in KASA (knowledge, aspirations, skills and attitudes) as a result of attending the Macintyre Downs Farm Walk (in a scale from 1 to 5 where 1 is very basic and 5 is very good)

Outcomes:

- The need to provide clear benefits of monitoring activities. Irrigators don't want to be monitoring for the sake of data collection.

"As soon as you mention monitoring, growers will shutdown, go to sleep, turnoff".

"You can't be monitoring for the sake of just data collection, you need a good clear productive outcome".

" Growers want an outcome that has benefits for their business. The benefits of any on-farm monitoring need to be clearly spelt out so growers can see how it applies to their situation, they need to see some advantage and value in monitoring, be it energy or water".

Michael Castor, Agricultural Consultant and Cotton Grower, MCA, Goondiwindi.

- This project has shown the need to continue to work with cotton growers to examine on-farm energy use. There is a large range in on-farm energy use and therefore energy benchmarks will allow irrigators to compare their farm's performance to regional and industry averages to investigate potential improvements to reduce energy costs.
- Renewed interest in pump performance evaluations across the industry.
- The Pump efficiency monitor has provided a means for continuous measurement of pump performance variables throughout an entire pumping event, but requires specialist skills to operate, so remains a research tool in its current form.
- Strong collaborative links between NSW DPI and NCEA. The collaboration between NSW DPI and NCEA worked very well. The technical expertise from NCEA was complemented by NSW DPI practical knowledge. NSW DPI also play an important role in securing farm sites and liaising between irrigators and NCEA. The development of the PEM was greatly assisted by this collaboration.

Objective 2.0 Deliver Irrigation training to irrigators and consultants to increase their knowledge of best irrigation management practice and on-farm energy use and efficiency

Milestone 2.1: Delivery relevant irrigation and energy training to irrigators and consultants in NSW regions

- *One workshop in each NSW region (Border Rivers, Gwydir, Namoi, Macquarie, Southern NSW) per year*
- *Improvements in KASA regarding irrigation best management practice*
- *Increased level of adoption of irrigation best management practices*

Irrigation training is a key activity contributing to the capacity building of irrigators and consultants resulting in the adoption of best irrigation management practice.

Outputs:

A total of 26 irrigation training events have been delivered to 342 participants including 253 irrigators, 36 consultants, 13 irrigation retailers and 40 industry personnel. A summary of the training events delivered by NSW DPI for cotton irrigators and consultants is presented in Table 3. A detailed inventory is provided in Appendix 7. Training included the delivery of formal irrigation training (eg NSW DPI ProWATER Workshops, Irrigated Cotton and Grains Workshop Series), the demonstration of irrigation technologies (eg. Seepage and Evaporation Meter, WaterTrack Rapid, CPLM Performance evaluation) and farm walks and farm tours to hear first-hand experiences from other irrigators both within and outside of their own regions.

Outcomes:

Evaluation material that was captured during training events provides evidence of changes to knowledge, aspirations, skills and attitudes (KASA) regarding irrigation best practice.

Training MERI

Course content and delivery was evaluated for the ProWater/Irrigated Cotton and Grains Training workshops, including Centre Pivot and Lateral Move Training Course, Irrigation Scheduling and Irrigation Pumps as shown in Figure 5. The evaluation found that the expectations of the course were met by participants attending the Centre Pivot and Lateral Move (CPLM) and Irrigation Scheduling and that they found the course useful and delivered at a level they could understand. The pumps workshop met the expectation of most participants (80%). Importantly the evaluation did find that the delivery of information could be improved. Up to 30 per cent of participants of the scheduling workshop and 40 percent of the pumps workshop felt the instruction was not of a high standard. This may have been a result of differing skill levels of the participants in attendance at these workshops and the level at which the workshop was pitched.

Evaluation was also conducted to determine changes in KASA (knowledge, aspirations, skills and attitudes) as a result of attending the various training events. Figure 6 provides a selection of training events and their associated KASA evaluation. Workshop participants were asked various questions relating to the workshop, and asked to rate their level of knowledge and skills (on a scale of 1 to 5, where 1 is very basic and 5 is very good) before and after the workshop. The results of this evaluation showed that all irrigators increased their knowledge and skills of various aspects of CPLM design, operation and management, irrigation scheduling and pumps.

Table 3: Inventory of training events delivered between Dec 2011 and June 2014

Training Event	No. Workshops	Irrigator	Retailer	Agronomic Consultant	Irrigation Consultant	Industry	Total
Centre Pivot and Lateral Move	9	139	9	7	5	7	167
Irrigation Scheduling	1	18	1	0	0	0	19
Irrigation Pumps	2	25	0	0	1	0	26
Irrigation Benchmarking	2	5	0	2	0	8	15
On-farm Energy Efficiency	4	14	0	5	5	11	35
KMSI suite of irrigation evaluation tools	2	0	0	0	2	12	14
Surface Irrigation Performance	1	8	0	1	0	0	9
Irrigation Systems	3	42	3	0	8	2	55
Storage seepage and evaporation	2	2	0	0	0	0	1
TOTAL	26	253	13	15	21	40	342

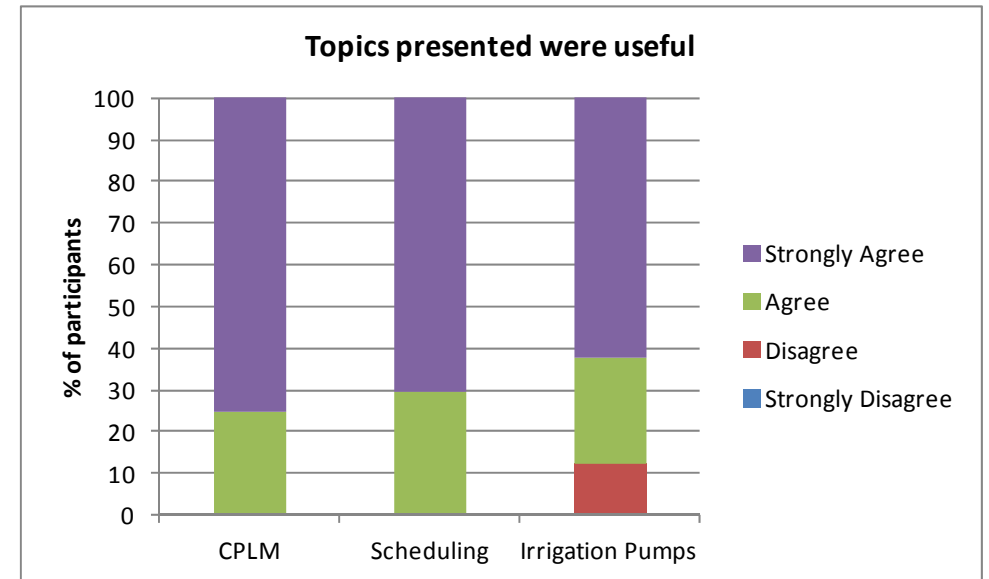
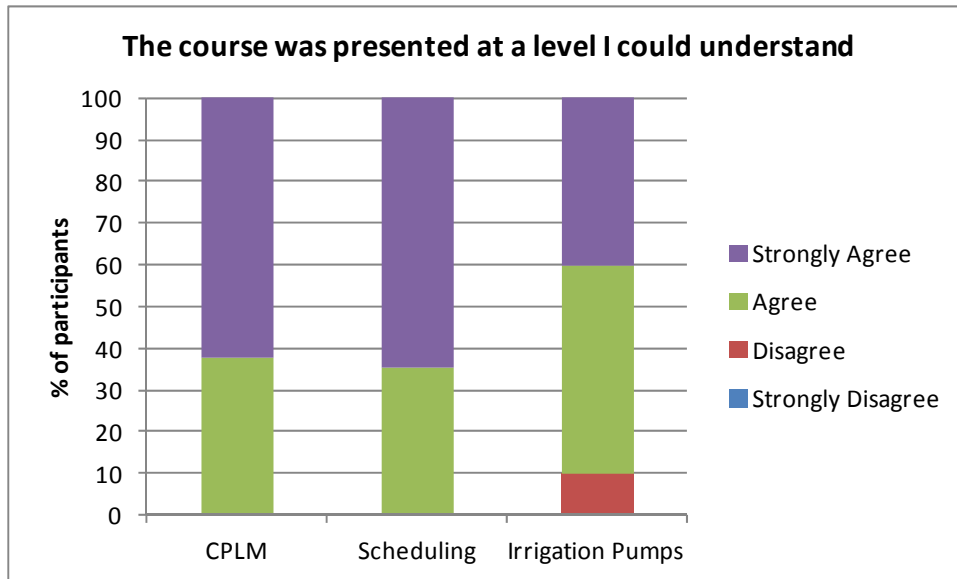
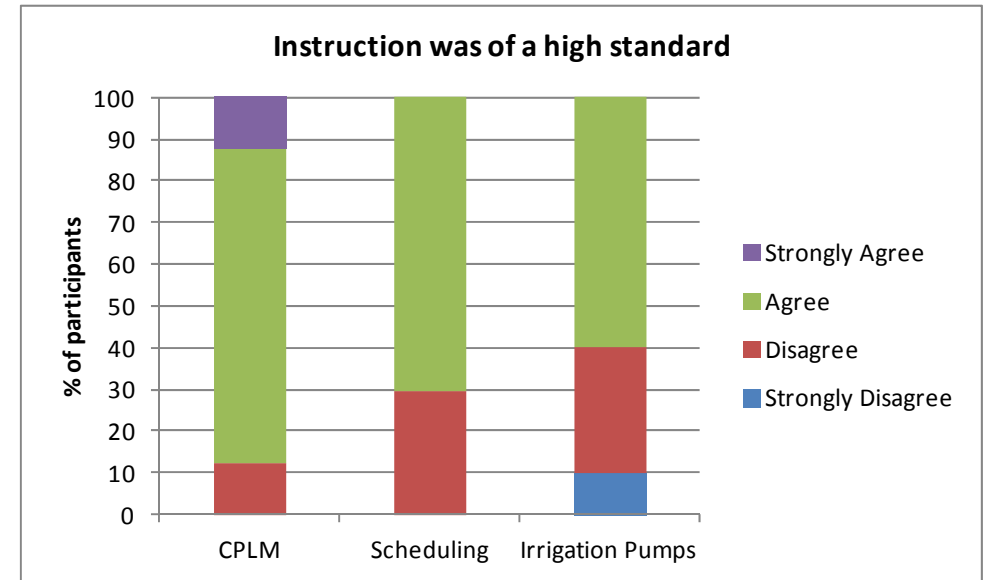
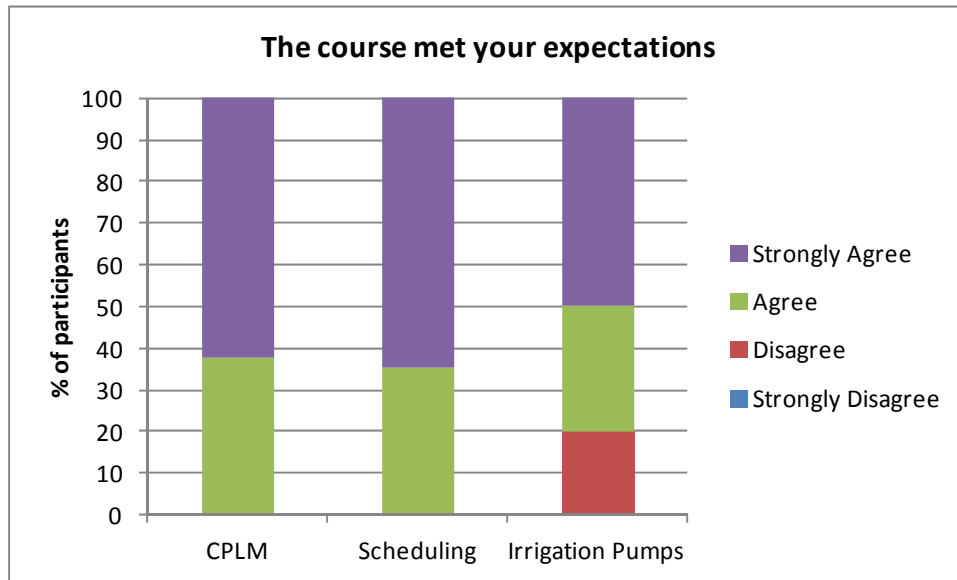
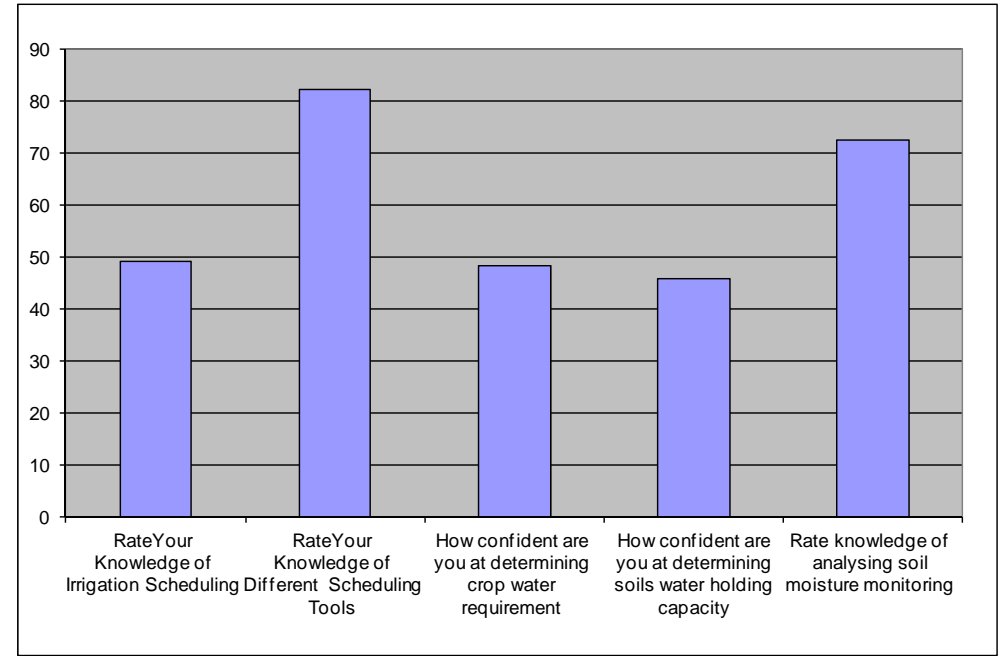
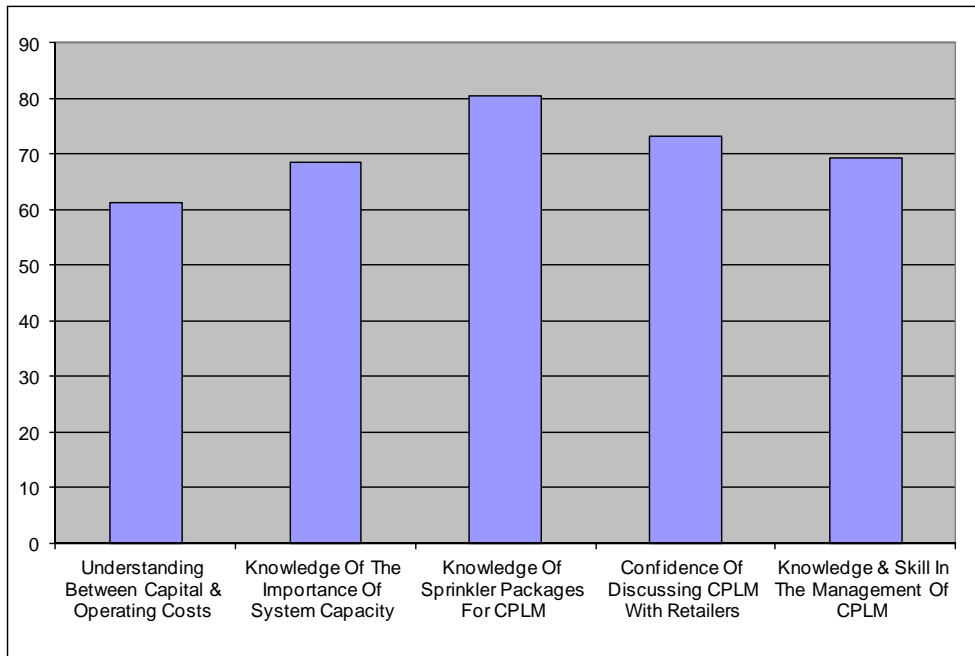
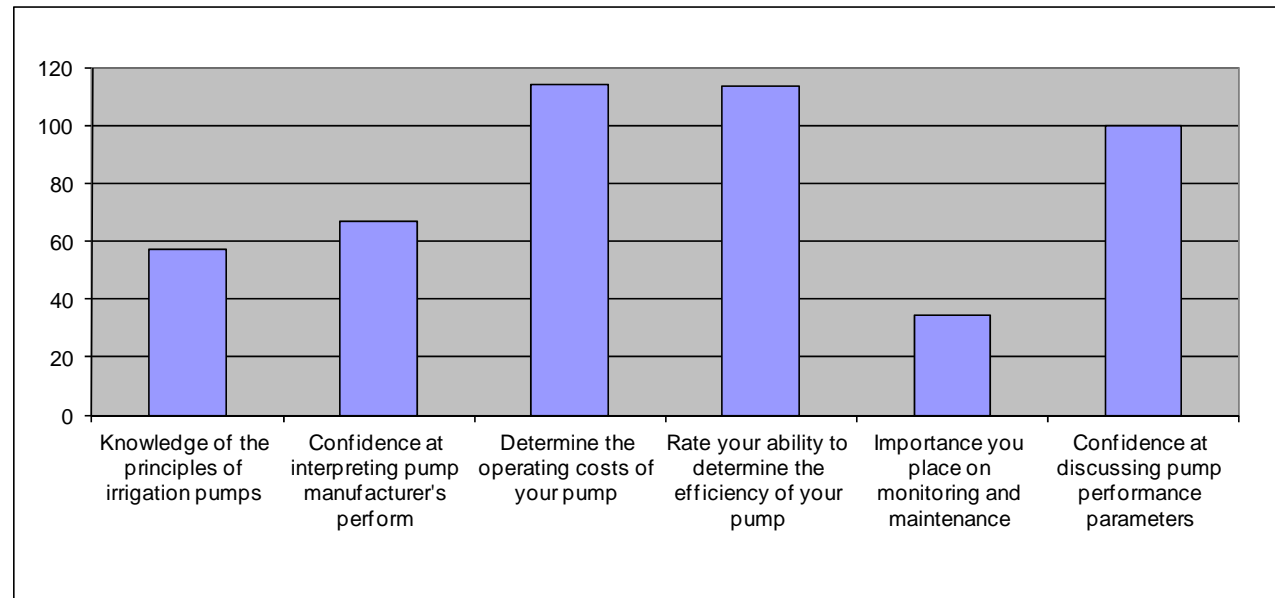


FIGURE 5: Evaluation of course content and delivery for Centre Pivot and Lateral Move, Irrigation Scheduling and Irrigation Pumps Workshops



a) Centre Pivot and Lateral Move Training Workshops

b) Irrigation Scheduling Workshops



c) Irrigation Pumps Workshop

FIGURE 6: Percentage increase in KASA as a result of attending the workshop a) CPLM b) Irrigation Scheduling and c) Pumps

Evaluation of irrigation training has found various outcomes, including:

- Increased awareness and promotion of best irrigation management practice to improve water management on-farm.
- Increased understanding of overhead irrigation system operation and management as a result of attending the workshop.
- Increased understanding of the need to conduct performance evaluations of overhead irrigation systems.
- Increased understanding of field measurements and interpretation of performance audit measures for lateral move irrigation systems
- Improved understanding of the definition of Water Use Efficiency and the associated water use indices and system efficiencies.
- Greater awareness of bankless channel designs and operation.
- Increased knowledge of the principles of irrigation pumps.
- Greater confidence at interpreting pump curves.
- Ability to determine the operating costs of pump.
- Improved confidence at discussing pump performance parameters.
- Increased understanding of energy use assessment and tools.
- Increased understanding of surface irrigation performance.
- Improved understanding of on-farm energy use assessment reporting tools.
- Increased understanding of field measurements and interpretation of performance audit measures for lateral move irrigation systems
- Increased awareness and promotion of best irrigation management practice to improve water management on-farm.

A full evaluation of all training events is presented in Appendix 8.

Milestone 2.2: Engage interested consultants in Energy Use Assessment

- *Consultants engaged in energy assessment training and conducting energy assessments for clients and providing energy use and efficiency information to go towards establishing Cotton industry energy benchmarks.*

While training was offered to consultants, and exposure to on-farm energy assessment and monitoring tools occurred at industry field days and forums, there was no engagement of consultants in on-farm energy use assessment. The only consultant involvement was through Jason Freiburg, Agtronics and Tom Dowling, Goanna Telemetry Systems who investigated ways to monitor pump efficiency as explained in Milestone 1.3 above.

Objective 3.0 Increase irrigator knowledge of alternative irrigation systems including centre pivot (CP), lateral move (LM) and drip irrigation systems, etc.

Milestone 3.1: Delivery of system specific training, field days, etc. to irrigators eg. CPLM National Training Course, PROwater Drip Workshops, etc. in NSW regions

- *Identification of demand and delivery of relevant workshops/courses in each NSW region*

Outputs & Outcomes:

- Technology demonstration – Low Pressure Subsurface Drip Demonstration. Rob Hoogers, IDO, Yanco has been instrumental in the design and installation of a Low Pressure Sub Surface Drip demonstration field at Yanco Agricultural Institute. He has also installed a weather station and soil moisture monitoring equipment.
 - Outcome: This commercially operated demonstration site will be used for farm walks and training to improve irrigators knowledge of drip irrigation systems.
- Nine events were held to help irrigators improve their knowledge and understanding of different aspects of Centre Pivots and Lateral Moves irrigation systems including planning and design, operation, management, system performance and maintenance.

There has been a rapid increase in the number of these machines used in the cotton industry, especially with the availability of funding through the NSW’s Sustaining the Basin: Irrigated Farm Modernisation Program and Qld’s Healthy Headwater Program. Most of the irrigators adopting these machines are changing from furrow irrigation. As the management of a Centre Pivot or Lateral Move Irrigation System involves a significant shift in mind set, these training opportunities are essential for most operators.

- The training events included 5 Centre Pivot and Lateral Move Training Workshops, 2 farm walks, a demonstration of how to conduct a CP or LM Performance evaluation and a workshop focusing on irrigation scheduling under CPLM irrigation systems. The number of participants at each workshop is summarised in Table 4. These events were held in different locations in the Namoi and Macquarie valleys, which is where demand for these courses arose.
- All events were evaluated and the MERI results have been reported in Milestone 2.1 above or in Appendix 8.

Table 4: A summary of CPLM workshops and participant numbers

	No. Workshops	Irrigator	Retailer	Agronomic Consultant	Irrigation Consultant	Industry	Total
CPLM Workshop	5	78	5	0	3	0	86
CPLM Performance Evaluation	1	10	0	0	0	0	10
CPLM Farm Walk	2	37	3	0	2	0	42
Irrigation scheduling under CPLM Irrigation Systems	1	14	1	7	0	7	29
TOTAL	9	139	9	7	5	7	167

- **Outcome:** Over 90 per cent of workshop participants indicated that they did intend to implement the knowledge gained from the Scheduling under CP and LM Irrigation Systems into their business enterprise as illustrated in Figure 7. The types of changes workshop participants said they would implement include:
 - Better scheduling of irrigation
 - More scheduling of irrigations
 - Improve water infiltration
 - Use lower application rates
 - Making the decision to get a machine
 - Sprinklers- Wheel track sprinklers, nozzle packages and sprinkler set up and changes throughout the season, droplet management
 - Use weather based scheduling
 - Understand how timing is compounded with soil type
 - Use of refill points
 - Practical capacity
 - System capacity
 - Wheel track management

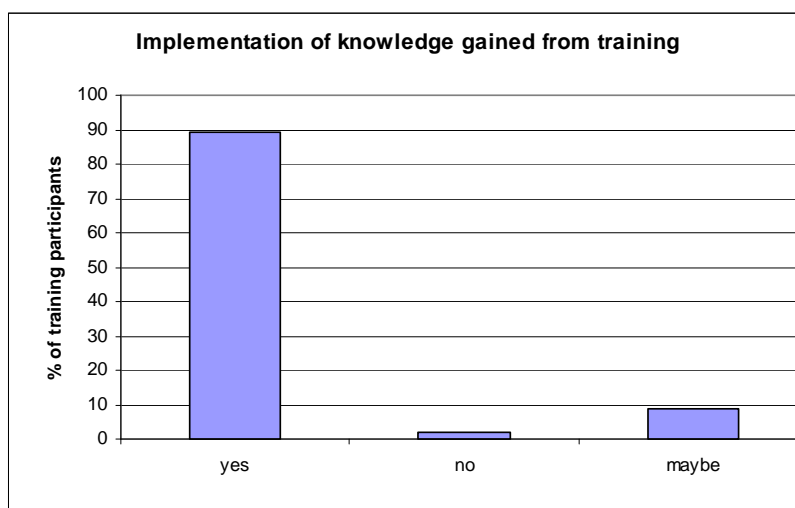


Figure 7: Intentions of course participants to implement the knowledge gained from CPLM training into their business enterprise

- 6 August 2014 17th Australian Cotton Conference. Janelle Montgomery organised a session “Irrigation Systems Efficiency”.



- Presenters included Peter Smith, NSW DPI who provided a summary of the CPLM review, Lousie Gall, GVIA who presented the latest results from an irrigation systems trial and Mike Naylor, Irrigation Consultant, Griffith, Glenn Lyons, Irrigation Consultant, St George and John Waterman, Cotton Irrigator, Dirranbandi all of whom shared their own experience of the design, operation and management of bankless irrigation systems.
 - 3 x 3 minutes theses were also presented on related topics.
 - Around 300 delegates attended the session, which far exceeded our expectations for this workshop. It is an indication of the level of interest in alternative irrigation systems, in particular bankless systems. Irrigators are looking for systems that require less labour input.

- Audio-visual was taken of the presentations and saved as MP3 files. This will provide a useful resource for future extension activities.
- **Outcome:** John Waterman, “Clyde”, Dirranbandi called to tell me that the conference had been well worth attending and contained an excellent mix of topics. After presenting at the workshop, many irrigators pull him up to discuss his bankless development. A number of irrigators have since organised a visit out to Clyde to look at the bankless development.
- Irrigation Systems Workshop was conducted in the Macquarie Valley to 9 participants including 6 irrigators and three retailers. This workshop explores the advantages and disadvantages of various irrigation systems along with planning and design and general operation and management. A similar workshop was also presented by Peter Smith, IDO, NSW DPI at the 2014 IAL Conference to around 25 delegates.
- A Southern and Northern Irrigation Systems Tour was conducted to allow irrigators to get out of their region and look at what other irrigators are doing,
- 31/10/13 Southern Bankless Tour (Edward Joshua, Robert Hoogers and Michael Grabham). A Review of bankless bed irrigation design and operation – the opportunity and the pitfalls
 - Six Macquarie Valley irrigators and 1 irrigation consultant attended a tour to study the design and operation of bankless channel designs in the Southern NSW (Griffith and Darlington Point). The irrigators are currently considering irrigation infrastructure change and were proponents of the Sustaining the Basin: Irrigated Farm Modernisation Program.
 - Three farms in the Northern Riverina were toured to view four different configurations of Bankless Bed and Furrow irrigation. They discussed the benefits and problems associated with making the change to Bankless from siphons hearing first hand from the farmers who had already undertaken the change.
 - Farms visited included:
 - Anthony Ryan "Gogeldrie", - Fresh lasered bankless furrows
 - Dallas Stott, - "1703", Whitton cotton grower with both side delivery Bankless and Dual delivery drive-over bankless
 - Matthew Stott – "Point Farms", Darlington Point farm, GL Bays

Outcomes

- There was good discussion between the irrigators and the growers presenting their farms. They discussed the design and operation of bankless systems; the differences between bankless systems and furrow siphons; how to set up the laser bucket to get a 1:300,000 grade; how to organise the GPS and machinery widths for furrow and bed operations; the difference in irrigation water supply between the two systems; and approaches for dealing with the issue of requiring a lot of water at once.
- The mood was very positive throughout the day. There was great interest and many questions asked to both farm owners and the designer. The interaction within the group was excellent as they sat in various seats in the bus after each stop and were able to compare opinions and lessons learnt. There was significant discussion during the long trip home as to how the systems and designs may be used when they lay out their own systems at home. There was also great interest in the variety of crops grown in the Riverina.
- 10 – 11 December 2013 Northern Irrigation Systems Tour (Janelle Montgomery, Edward Joshua, Robert Hoogers and Bill Williamson).

- Around 40 people attended this tour, comprising around 25 irrigators and the balance irrigation engineers, consultants and industry personnel.
- 5 farms were visited in the St George/Dirranbandi district to show irrigators first hand various irrigation systems, with focus on bankless channel.
- Farms visited included:
 - Robert Gracie “Katoota”, St George - PTBs, Furrow, CP, permanent siphons.
 - Craig Saunders “Thuraggi Overflow”, St George - PTB’s
 - Ed Willis “Bullamon Plains”, Thallon – Bankless channel
 - Simon Graham “Cubbie”, Dirranbandi – PTB’s
 - John Waterman “Clyde”, Dirranbandi – Bankless Channel
- **Outcomes**
- *“Thanks for organising the tour of Queensland irrigators, we found it extremely interesting and useful. It has challenged us to look at our systems in more depth.”, Irrigator*
- The following is an extract from STBIFM Update Bulletin 20th December 2014. ‘Seeing is believing’ is one way irrigators described the recent tour north to look at irrigation systems in the Border Rivers and Southern Queensland irrigation areas.

DPI recently took a group of irrigators, designers and irrigation consultants involved in the STBIFM program on a study tour of a variety of surface irrigation systems in the north. The group left Dubbo at 5.30am and made it to the first stop at ‘Clyde’ station: a 16,000 ha property near Dirranbandi which includes 4,000ha of irrigation of which 1,100ha is a bankless head ditch style system, known locally as a Glenn Lyons (GL) bay.

John Waterman, the Manager, discussed how the topography of ‘Clyde’ pushed the limits of design but they are now growing their third cotton crop on the first stage of their bankless development.



Irrigators on the first day of the northern tour at ‘Clyde’ near Dirranbandi. Image: S. Priest

Next stop – ‘Cubbie Station’. ‘Cubbie’ is arguably the most well known irrigation property in Australia. It is a 20,000ha irrigation development using ‘PipesThrough the Banks’ (PTBs) on a 32m spacing.



The tour group was in awe of the magnitude of the ‘Cubbie’ operation and were treated to the insights of developing and operating such an enormous enterprise by Simon Graham, the Operations Manager.

Glenn Lyons explains the bankless channel design on ‘Clyde’. Image: S. Priest.

After overnighting in St George the troop headed to 'Katoota', owned and operated by Rob Gracie. 'Katoota' has a variety of soil types from heavy to hard setting red soils that require frequent irrigation. Rob successfully operates a number of different irrigation systems including centre pivots, PTBs and a novel and innovative permanent siphon system. To contend with soil variation and frequent irrigations, Rob has installed permanent siphons laid horizontally through the head ditch bank. Rob was happy to share his experiences on all of the systems.

Craig Saunders of 'Thuraggi Overflow' near St George and Justin Shultz of 'WaterBiz' showed the group around a siphonless irrigation system using PTBs with variable flow rates on a 12 m spacing.

Mr Saunders emphasised the importance of understanding what's happening to your water when you irrigate.



"If you don't know, then employ someone to help you.

"A better understanding of soil infiltration rates enables us to optimise our flow rates and run times which has resulted in water savings, labour savings and increased yields," Mr Saunders said.

Craig Saunders (right on bank) and Justin Shultz (far right) speak to the tour group on the irrigation
Image: S. Priest.

The final stop at 'Bullamon Plains' was the icing on the cake. 'Bullamon Plains' is owned and operated by Bill and Ed Willis who won the 2011 Cotton Grower of the Year and the 2006 High Achiever of the Year. The 2,000 ha irrigation development comprises 500 ha siphons and 1,500 ha of bankless GL bays.

The Willis' have trialled various bankless designs, including rooftop and Ed explained how the present design has evolved.

"We can now irrigate the entire irrigation area in four days.

"My advice to irrigators looking to implement a bankless system is to consider the size of the steps between fields, the depth of launch bays, the need for wide drains and the inclusion of rat walls under cement slabs, Mr Willis said.



The tour group at 'Bullamon Plains' about to head home. Image: S. Priest.

Every irrigator found the tour a great experience and valued the opportunity to talk to irrigators who have overcome a range of issues successfully through careful planning and trial and error.

Janelle Montgomery, tour organiser and DPI Irrigation Officer said the tour was a great way for DPI to provide an opportunity for our irrigators to see these operations first hand.

“Learning from other irrigators is a huge advantage,” she said.

“There were lots of opportunities to ask questions and then to discuss what they had seen further amongst themselves and with the other designers and consultants during the travel time.

“This was a very effective alternative to traditional training to build the knowledge and skills of the participants and show that infrastructure does not just mean pivots and laterals,” Ms Montgomery said.

Here is what was said. . .

“The most useful part of the tour for me was the choice of quality farms.” Irrigator

“The most useful thing was comparing the slight variations implemented by the different growers using the same systems.” Irrigator

“I found just looking at and comparing the different types of designs very valuable.” Irrigator

“It was one of the best and most informative field days I have ever been too.” Consultant

- 12/03/14 Macintyre Valley Field Day, Goondiwindi.
 - 120 irrigators, consultants, agency and agribusiness personnel attended the field day that started with a visit to “Turkey Lagoon” to inspect a bankless channel development.
 - Water measurements, energy use, CRDC Energy Project and STBIFM Project were discussed.



Outcomes

- 3 or 4 people approached Janelle Montgomery afterwards and said they found her talk very interesting and there was further interest in pump evaluation from irrigators throughout the day.

“Just wanted to say what a great job you did at MVCGA Field Day, you speak so assuredly and with a practical edge, very refreshing!” Irrigator, Goondiwindi

Milestone 3.2: Case studies of successful uptake of alternative systems including WUE and Energy Use and efficiency information.

- *Completion of one case study for each relevant alternative system from experienced growers*
- Assisted the farm owner/manager at “Turkey Lagoon” with water measurements over the season and developed a case study of the operation (see Appendix 9). <https://www.mybmp.com.au/myinfo/article/docs/Bankless%20channels%20fact%20sheet.pdf>
- In collaboration with NSW DPI’s Sustaining the Basin: Irrigated Farm Modernisation Program various case studies have been developed for a variety of irrigation systems. They include:
 - Anthony Barlow “Wyadrigah”, Mungindi. Converting furrow irrigation system to lateral move. http://www.dpi.nsw.gov.au/_data/assets/pdf_file/0007/437317/Case-study-Barlow.pdf
 - David Coulton “Getta Getta” North Star. Converting furrow irrigation system to lateral move. http://www.dpi.nsw.gov.au/_data/assets/pdf_file/0004/360940/Case-Study_Converting-a-furrow-irrigation-system-to-a-centre-pivot_I-and-I_Final.pdf
 - Tony Quigley “The Wilgas” Nevertire. Upgrading Lateral Move Irrigation System. http://www.dpi.nsw.gov.au/_data/assets/pdf_file/0011/513596/Case-study_Tony-Quigley_Macquarie_web_100414.pdf
 - Peter Maxwell, “Top River”, Gunnedah. Lateral Move Irrigation System. http://www.dpi.nsw.gov.au/_data/assets/pdf_file/0007/515239/Case-study_Peter-Maxwell_Namoi_web_30041414.pdf
 - Andrew Watson “Kilmarnock” Boggabri. Lateral Move Irrigation System. http://www.dpi.nsw.gov.au/_data/assets/pdf_file/0003/513597/Case-study_Andrew-Watson_Namoi_web_100414.pdf
- A variety of resources have been developed to provide information on alternative irrigation systems. Along with the case studies mentioned above there has also been a number of magazine articles and videos produced including:

Magazine articles

- Montgomery, J. 2012. ‘Assessing benefits of irrigation systems’, North West Magazine, Monday 12th March 2012 pp6.
- Montgomery J. (2012) ‘Water use efficiency of centre pivot and lateral move irrigation systems’, Agriculture Today, May2012, pp13.
- Grabham, M. 2012. “Bankless and pushing it up the hill”, Agriculture Today”, October 2012, NSW DPI.
- Strang, M. & Montgomery, J. (2013) “Getting the schedule right: New guidelines needed for centre pivot and lateral move irrigation systems”, Spotlight on cotton R&D, Winter 2013, CRDC

Videos

- **Commissioning your Pressure system**
Producer: Stuart Bray
Editor: Nick Lee
Interviewer: Stuart Bray
Interviewees: Martin Mead, Farm Manager Auscott Narrabri

Background: Water use Efficiency series. Interview with the manager of Auscott Narrabri about the importance of commissioning pressure systems to ensure they meet manufacturers' specifications, and meet irrigators' expectations in achieving improved water use efficiency compared to furrow irrigation. Advantages of pressure over furrow systems were discussed, including fertiliser application, and reduced labour costs and supervision.

Duration: 4.'00"

Dissemination:

- Posted on Digital Farm TV <http://www.digitalfarmtv.com/cotton>
- Transcript and audio available to develop fact sheets, newspaper stories, radio stories etc.

○ **Changing Irrigation Systems**

Producer: Stuart Bray

Editor: Nick Lee

Interviewer: Stuart Bray

Interviewee: Dr Joseph Foley, University of Southern Qld

Background: Story on the change in mindset to adapt and manage a new irrigation system eg changing from furrow irrigation to a pressure system.

Proposed Duration: 4'

Proposed Dissemination:

- To be posted on the CRDC website with a link to NSW DPI website.
- Transcript and audio available to develop fact sheets, newspaper stories, radio stories etc.

○ **Understanding the Capacity of your Pivot**

Producer: Stuart Bray

Editor: Nick Lee

Interviewer: Stuart Bray

Interviewee: Dr Joseph Foley, University of Southern Qld

Background: When there are heat wave conditions and the evaporation rate starts exceeding the application rate and there's no rain in sight, irrigators get nervous. Therefore to prepare for these conditions farmers need to know the capabilities and management techniques to get the best out of their machine.

Proposed Duration: 4'

Proposed Dissemination:

- To be posted on the CRDC website with a link to NSW DPI website.
- Transcript and audio available to develop fact sheets, newspaper stories, radio stories etc.

○ **Evaluating the performance of pivots**

Producer: Stuart Bray

Editor: Nick Lee

Interviewer: Stuart Bray

Interviewee: Lance Pendergast, Irrigation Officer Emerald QLD

Background: All machines wear over time and some may not have been installed correctly in the first place therefore it is important to regularly check on the performance of pressure systems to ensure that they are maintaining their uniformity of distribution

Proposed Duration: 4'

Proposed Dissemination:

- Posted on Digital Farm TV <http://www.digitalfarmtv.com/cotton>

- Transcript and audio available to develop fact sheets, newspaper stories, radio stories etc.
- **Performance Evaluation from a growers point of view**
 - Producer:** Stuart Bray
 - Editor:** Nick Lee
 - Interviewer:** Stuart Bray
 - Interviewee:** Anthony Consolo Emerald QLD
 - Background:** Emerald Irrigator, Anthony Consolo talks about some of the symptoms that growers see that alert them to a problem with the performance of their system.
 - Proposed Duration:** 4'
 - Proposed Dissemination:**
 - To be posted on the CRDC website with a link to NSW DPI website.
 - Transcript and audio available to develop fact sheets, newspaper stories, radio stories etc.
- A full list of communications is provided in Appendix 4.

Milestone 3.3: Completion of CPLM Survey in NSW regions

- *Completion of CPLM industry survey*
- A DRAFT Centre Pivot and Lateral Move Industry Review is complete.
 - Smith, P., Foley, J., Priest, S., Bray, S., Montgomery, J., Wigginton, D., Schultz, J and Van Niekerk, R. (2014) “A Review of Centre Pivot and Lateral Move irrigation installations in the Australian Cotton Industry”, NSW Department of Primary Industries.
 - The draft document has been reviewed by NSW DPI Irrigation Researcher, Economist and Team Leader. It is currently with NCEA for approval. Once this is returned the final document will be sent to NSW DPI Communications Unit to design and publish. It will be available as an e-publication and promoted through NSW DPI, CRDC and the CottonInfo team.
 - The draft publication is attached to this Final Report.
 - The objectives of the report are to:
 - Identify the perceived benefits and limitations associated with the use of CPLM irrigation systems
 - Contribute to better informed investment decisions on the uptake of CPLM machines.
 - Increase grower understanding of the management practices required to use CPLM machines.
 - Based on information gathered from the CPLM review, a list of recommendations that should be considered by growers interested in investing in CPLM systems has been created. They include:
 - System capacity is critical. Managed system capacity in particular needs to be high enough to satisfy peak crop demand and your irrigation management, while minimising capital and operating costs.
 - It is important to ensure that operating pressure is minimised while still allowing optimum system performance. Energy costs are an increasing component of operating costs and may affect the financial viability of these systems.

- Expect it will take several years before you get the best performance out of a CPLM system. There will be a significant time investment in planning and setting up the system and learning to manage it.
- Learn as much as possible from growers and consultants operating CPLM machines, both with your region and in other regions.
- Attend as many information events as possible, such as field days, farm walks and the National CPLM Training Course.
- Adequate field drainage is needed under CPLM systems.
- Both sprinkler and LEPA systems are used successfully and efficiently by growers, although moving plate sprinklers were much more popular within the survey group. Choice of emitter system should be based on a wide range of factors, information sources and discussions with growers using each type of emitter.
- Carefully plan the system to ensure it suits the soil type and performs as required without excessive capital or operating costs. Sorting out potential design or management issues during the planning phase, possibly with the help of a consultant, will be significantly more cost effective than trying to rectify poor designs after installation.
- The performance of systems should be checked after installation and at regular intervals. Flow rate and pressure should be checked using calibrated sensors to ensure that mounted sensors are accurate. Uniformity, application depth and travel speed should be measured and the control panel calibration checked. Some suppliers do not calibrate control panels in the field.
- Get good advice on the financial, management and tax implications of such a large investment.

Further Outcomes:

- It is apparent that the number of CPLM systems used within the cotton and grains industry has significantly increased since 2001. With the accelerated adoption under infrastructure programs has come more questions surrounding design, operation and management of CPLM irrigation systems.
- Cotton irrigators considering infrastructure change have an increased understanding of overhead irrigation system operation and management as a result of attending training. They better understand the importance of planning and design. They are now armed with the questions they need to know when talking with designers if investing in a centre pivot or lateral move irrigation system.
- Irrigators changing from furrow to overhead irrigation systems are more aware of the need to change their mindset i.e. irrigating with smaller amounts of water more frequently.
- Increased awareness of the need to conduct performance evaluations of overhead irrigation systems.
My machine didn't meet the design specifications and further work was needed to bring it up to spec – my advice is to commission your machine before final payment. Irrigator, Namoi Valley.
- Increased understanding of field measurements and interpretation of performance audit measures for lateral move irrigation systems
- While infrastructure funding appears to have resulted in the adoption of centre pivot and lateral move irrigators, their suitability to cracking clay soils, where surface irrigation is highly efficient is still questioned.
- There is considerable interest in Bankless Channel irrigation systems. This is a prime example of where a technology is being adopted ahead of the research. Growers who have implemented this irrigation system have anecdotal evidence that they have no yield

penalty and water use is similar to their furrow system. They believe they are achieving energy efficiencies (anecdotally) with the improved efficiency of machinery operations. The greatest driver for adoption of this technology is labour shortages.

- According to Graham Cook “Turkey Tagoon’ the benefits of a bankless system include:
*“Labour savings: not so much the labour in starting siphons, but the labour involved with putting siphons out, putting rotabucks in, working rotabucks and shifting siphons.
“Energy efficiency of the long runs with our tractor operations and spraying. It’s at least 20 to 25 per cent more efficient without any doubt at all with our tractors being able to just lift up and turn around both ends, rather than having to back-back at a head ditch.”
“We can’t see any disadvantages in yield loss yet and water savings still need to be measured. We expect there are some water savings just by the amount of water flowing, irrigations are quicker and we wouldn’t have the evaporation of the smaller siphon fields. Our siphon fields are half the length of the bankless and eight hours a set whereas on our 1400m bankless bays, we are getting them through in five hours, there has got to be some water saving there.”*
- The following email was in response to an article examining WUE in the Australian Cotton Industry:

Hi Janelle,

As an industry we still have a long way to go. WUE is a lot more than running down to the local irrigation store and buying a lateral move or centre pivot.

Many who have done this now face very large power bills and have not really improved WUE. In 15 or 20 years they will then have to replace the machine.

In the correct lighter soils the sprinkler alternative is the way to go. Changing away from surface irrigation in our heavy cracking soils is not.

Bankless channel irrigation is going backwards in irrigation technology and performance to save labour. I don’t believe it is the most appropriate answer either. As an industry we need to be concentrating on automation of furrow irrigation, I’m intending to do just that!

Thanks again and keep up the good work.

Regards

Jim Purcell

Director/Engineer

Aquatech Consulting Pty Ltd

Objective 4.0 Coordinate and support forums/field days/conferences to build relationships between researchers and extension staff, irrigators and consultants and to support myBMP.

Milestone 4.1: Relevant forums/field days/conferences coordinated and supported

- *Attendance and/or assistance at one forum/field day/conference with special reference to myBMP*

Milestone 4.2: Contact with CSIRO, NCEA, NSW Primary Industries and other relevant irrigation researchers maintained

- *Regular contact with NCEA to promote new irrigation technologies*
- *Regular contact with CSIRO to promote irriSAT and other relevant technologies for continuing trials and/or commercialisation*

Outputs and Outcomes

The Promoting Water Smart Infrastructure Investment project team has been involved in a variety of field days, conferences and industry forums. A complete list of these is provided in Appendix 4, Communications – conference papers, industry meetings and presentations. Strong collaborative links have been fostered throughout this project with a range of cotton extension, development and research organisations including:

- ***National Centre for Engineering in Agriculture***
 - On-farm energy monitoring and energy assessments.
 - Collaboration on joint publications including conference papers and industry magazine articles.
 - 9/02/2012 Michael Scobie, NCEA provided NSW DPI Irrigation Officers with a demonstration of the KMSI tools, including the Ready Reckoner, IPART and EnergyCalc.
 - Outcome: Increased understanding of KMSI tools available and ability to show them to interested consultants and growers. Rod Jackson, IO, Narrabri, demonstrated the evaporation ready reckoner to a local Irrigation Consultant who was interested in using it to calculate seasonal evaporation rates and look at evaporation remediation options
 - NCEA Energy Assessment training for Cotton Info Team.
- ***CSIRO***
 - NSW DPI provided local support to CSIRO's 2011/12 IrriSAT trial, by engaging irrigators and consultants and producing extension material.
 - Magazine articles and conference papers have been written in collaboration with CSIRO.
 - NSW DPI was instrumental in gaining industry support for the IrriSAT technology trial. As a result of NSW DPI efforts around 100,000 Ha of cotton in northern NSW were monitored with the IrriSAT technology.
 - 5/11/2011 CSIRO researchers John Hornbuckle and Richard Soppe travelled to northern NSW to conduct a series of meetings with irrigators and consultants interested in participating in the 2011/12 IrriSAT trial. Eleven meetings were conducted (1 in Mungindi, 7 Gwydir, 3 Namoi). Participants included 15 consultants and 16 irrigators.

- Outcomes: There was significant interest across all three regions and strong interest and support for the CRDC IrriSAT project. Steve Madden, cotton consultant from the Namoi Valley brought 15 clients to one meeting. As a result, 10 of them signed up to the trial. Steve contacted us later to sign up all his clients (approximately another 20) having seen great potential with the technology for benchmarking.
- Tony Taylor and John Norman of Norman Farms were very excited to trial the technology for the first time this season. John Norman had seen an IrriSAT presentation at the 2011 Macintyre Valley Field Day and CCA meeting in Goondiwindi.
- NSW DPI organised a successful visit by John Hornbuckle to wrap up the 2011/12 IrriSAT Trial, which took place on 18, 19 & 20 September 2012. Dr Hornbuckle met with 6 consultants from the Gwydir Valley, 15 irrigators and 1 consultant from the Namoi Valley and 3 irrigators from Walgett. Irrigators were presented with the crop benchmarking data collected to date.

“The time spent with John Hornbuckle to go through our yield data was extremely worthwhile. It enabled us to compare each field’s water use efficiency and to benchmark this versus other growers in the Namoi Valley as well as growers in other river valleys such as the Gwydir.

With the Murray Darling Basin Plan yet to be finalized and the possibility of there being less water available to irrigate in the future, benchmarking water use efficiency between irrigators serves as an invaluable tool to assess if an irrigator’s operation is using water efficiently. If the operation is not functioning efficiently then the owner/manager can look at ways of improving water use efficiency”. Toby Moore, Irrigator, Walgett.

- NSW DPI & CSIRO developed a CRDC preliminary funding proposal to continue IrriSAT research in the Australian cotton industry. We were asked to submit a Full Research Proposal which was successful. The new project will run from July 2014 – June 2018.
- Water & irrigation research. NSW DPI maintains links with cotton researchers such as Dr Rose Broderick and Dr Onoriode Coast located at ACRI, Narrabri to discuss developments with their research and issues irrigators are facing in terms of water management eg scheduling under lateral move irrigators.
- 18/07/13 Meeting with Dr Mike Bange and Dr Rose Broderick to discuss Irrigation Scheduling methods and current research.
- 24 – 25 July 2013 – Attended Southern Cotton Expo where the 3rd Edition of WATERpak was launched. Also conducted farm visits to examine bankless layouts and irrigation research issues for the southern cotton systems. Met with CSIRO irrigation researchers toured the Griffith CSIRO research facilities and discussed future projects.
- **CottonInfo Team**
 - Participate in the CottonInfo Team teleconferences & team meeting.
 - Assisted with Area Wide Management groups
 - Cotton Industry Gals monthly lunch meeting, Moree. Representatives from BRG CMA, Wincott, Crop Consultants, CGS, GVIA, DECC & NSW DPI meet to discuss cotton, water, vegetation issues, funding grants, work activities.
 - Outcome: Maintain industry networks, regular contact with key industry representatives to keep abreast of industry issues, non-duplication of work activities, support and collaboration where needed.

- Southern Cotton Expo, Griffith. Janelle Montgomery assisted in launch of Waterpak and Rob Hoogers organised farm tour for NSW DPI & CRDC representatives to examine irrigation layouts used in cotton production systems.
- ***NSW Sustaining the Basin: Irrigation Farm Modernisation (STBIFM)***
 - PWSII is closely aligned to the STBIFM project. NSW DPI staff deliver training and extension to help irrigators make more informed decisions about infrastructure change.
- ***QLD DAFF***
 - Irrigation Officers based in NSW & Qld keep contact through email, phone calls, industry meetings & conferences and the CottonInfo Team.
- ***Cotton Grower Associations***
 - Various dates: NSW DPI Irrigation Officers attend local Cotton Grower Association meetings
 - Outcome: Provide an update to cotton growers on project outputs and establish interest in various project activities. For example, CPLM review and energy use assessments.
 - Technology demonstration – Soil Moisture Monitoring Equipment. Rob Hoogers, IDO, Yanco gave a presentation on soil moisture monitoring for improving WUE at two pre-season grower meetings (total of 76 irrigators).
 - Outcome: 27 per cent of attendees indicated that they will be installing soil moisture monitoring equipment this season.
 - 18/03/2013 Macintyre Field Day. Presentation EnergyCalc Lite App (Michael Scobie, NCEA)
 - 13/03/2014 Macintyre Field Day. Presentation Bankless Channel Irrigation Systems
- ***Gwydir Valley Irrigators Association***
 - Guest speaker at GVIA Field Days (Janelle Montgomery, NSW DPI, Richard Soppe, CSIRO, Craig Baillie & Phil Szabo, NCEA) eg 19/01/2012 Gwydir Valley Irrigators Association Field Day. NSW DPI arranged for Richard Soppe, CSIRO to present information on IrriSAT technology and Craig Ballie, NCEA to present information on energy use efficiency.
 - Outcome: Approximately 70 irrigators/consultants attended the field day. They were provided with an update of the Promoting Water Smart Infrastructure Project in terms of on-farm energy assessment activities and the IrriSAT trial.
 - Steering Committee member on Irrigation Systems and optimisation trials (Janelle Montgomery).
 - GVIA & Cotton Info Team Soil Properties workshop, Auscott.
- ***21/03/12 Cotton CRC Science Forum.***
 - Janelle Montgomery gave a presentation showcasing outcomes of the Water Smart Cotton and Grains Project. This included the irrigation benchmarking data collected by NSW DPI.
 - Outcome: Dr Brian Hearn (retired Cotton Scientist) congratulated NSW DPI on the excellent irrigation benchmarking work conducted within the Australian cotton industry. He was very excited about the improvements in water management that have been made in the Australian Cotton Industry and

the progress made in methods to collect and collate irrigation benchmarks IWUI, GPWUI and CWUI.

- **CRDC**

- **11/03/14 IRRICOM (communication of irrigation research in cotton) Workshop.**

- The aim of the workshop was to bring together irrigation research to identify current and future tools in the irrigation toolbox to optimise yield and water use efficiency. The specific objectives of the workshop are:
 - To gain an understanding of current and future technologies and tools for irrigation management in cotton.
 - To develop a blueprint for an integrated irrigation framework that will fully service future needs of cotton irrigation systems.
 - To identify gaps and future opportunities for research into irrigation scheduling.
 - To prepare a manuscript on cotton irrigation scheduling tools and technologies.
- 27 representatives from CSIRO, NSW DPI, NCEA, CRDC, Cotton Australia, Qld DAFF, Qld DERM and GRDC attended.
- A Forum Report was written up by Janelle Montgomery, NSW DPI, Lance Pendergast, Qld DAFF, Rose Brodrick, CSIRO & Jane Trindall, CRDC.
- The two key workshop outcomes were to:
 - Develop a Journal article to review irrigation technologies with all workshop participants to contribute.
 - Develop a PRP on an Integrated system for irrigation scheduling of cotton.

- **22/03/12 WATERpak upgrade.**

- NSW DPI asked to sit on Waterpak Upgrade Committee, consisting of representatives from CSIRO, NCEA, CRDC & DEEDI. Janelle Montgomery and Rod Jackson attended the meeting to provide guidelines and structure for upgraded WATERpak.

- **PISC**

- 1 – 2 May 2013 Water Use in Agriculture National Forum, Adelaide
- The National Forum attracted around fifty delegates from thirty organisations involved with the delivery of the Water Use in Agriculture RD&E Strategy.
- Janelle Montgomery was asked to go along as a CRDC representative.
- Established working groups to advance some key opportunities eg irrigation modernisation.

- **QLD DERM**

- 28 – 29 May 2013 Australian Cotton Trade Show
 - Joint trade stand, NSW DPI & QLD DERM to promote irrigation modernisation.
- Northern Murray Darling Basin Water Seminar.
- 2013 Australian Cotton Research Conference. Janelle Montgomery chaired the Stress Physiology Session.

- Australian Cotton Industry Awards and Cotton Collective. Participated in the Finalists Forum.
- **NSW DPI Cotton Projects**
- Sykes, J., O’Keefe, K. and Hoogers, R. (2013) Moving in and out of cotton – Identifying farming systems issues in southern NSW irrigation areas (Proposal 1) NSW Department of Primary Industries
- Sykes, J., O’Keefe, K. and Hoogers, R. (2013) Moving in and out of cotton – Identifying farming systems issues in western NSW irrigation areas (Proposal 2) NSW Department of Primary Industries
 - Water use efficiency information was collected and included in both projects.

Objective 5.0 Water Technical Specialist CottonInfo Team

Milestone 5.1: Lead and co-ordinate a cotton industry-wide water use efficiency campaign

- *Increase GPWUI by 1.5 per cent annually as a result of adoption of water BMP*

Outputs and Outcomes

Lance Pendergast and Janelle Montgomery share the role of Water Technical Specialist for the CottonInfo Team. NSW DPI took on the role on 1 January 2013. The industry wide water efficiency campaign for the 2013/14 season was slow and steady, as the CottonInfo team were still finding their feet. However, the following activities provided input towards this milestone:

- Developed a calendar of water related activities and aligned potential resources currently available or that need to be developed.
- Attended the Cotton Info Team workshop, Sydney on 25th – 27th June 2013 where some progress was made in developing campaigns for the 2013/14 season.
- Provided significant input to the water section of the CottonInfo strategic plan.
- Provided updates for the water sections of the 2013 and 2014 Cotton Production Manual.
- Involved with reviewing chapters of WATERpak prior to launch.
- Developed information resources for e-newsletter and CottonInfo Fact sheets (Appendix 10) when necessary.
- Reviewed water questions of Cotton Industry Survey 2013/14.

Milestone 5.2: Lead myBMP Water Module

- *Increase the number of growers meeting the requirement for Level 2 myBMP Water module*

Outputs and Outcomes

As water technical specialist with the CottonInfo team and in collaboration with Lance Pendergast, QDAFF, NSW DPI lead the cotton industry's myBMP Water Module. We are the key contact for any water enquiries. The following activities were conducted to achieve this milestone:

- Relevance of current water best management practices and achievability were checked.
 - For the 2013 review the decision was made not to have any level 4 water BMP's therefore level ranking was changed and some Level 4 BMP's eliminated. Level 1 legal requirements also needed to be checked for updates. Resources were checked and new resources added such as WATERpak, 3rd Edn.
 - The 2014 review was similar but a teleconference with Rachel Holloway, Cotton Australia, provided new insight to grower interpretation of some best practices. A thorough review of each standard took place as a result of time spent with Rachel.
- Answered grower and industry enquiries such as:
 - What are the impacts of water quality (salinity) on cotton production.
 - Do you know what the figure from BMP is for runoff from cotton fields that should be captured and contained on farm? Is there an irrigation and dryland figure?
 - What programs are available to record my water information over the season?

6. Please describe any:-

- a) technical advances achieved (eg commercially significant developments, patents applied for or granted licenses, etc.);**
- b) other information developed from research (eg discoveries in methodology, equipment design, etc.); and**
- c) required changes to the Intellectual Property register.**

Nil

Conclusion

7. Provide an assessment of the likely impact of the results and conclusions of the research project for the cotton industry. What are the take home messages?

Promoting Water Smart Infrastructure Investment has made a significant contribution towards building the capacity of Australian cotton irrigators to adapt to reduced water availability and rising energy costs. Through a comprehensive capacity building program including training workshops, technology demonstration and the development and dissemination of a range of extension material, irrigators have increased their knowledge and understanding of a variety of irrigation systems, in particularly centre pivot, lateral move and bankless irrigation systems. Evidence of this is provided through the projects monitoring, evaluation, reporting and improvement (MERI) strategy that was conducted throughout the project. Promoting Water Smart Infrastructure Investment has provided support and information to growers considering infrastructure change, helping them to make informed investment decisions.

Irrigation training with a focus on alternative irrigation systems was a significant output of this project with a total of 26 training events delivered to 253 irrigators, 36 consultants, 13 irrigation retailers and 40 industry personnel. Evaluation from these workshops showed participants gained a better understanding of irrigation best practice and importantly better understood the planning and design of various irrigation systems as a result of this training. They were armed with greater knowledge as to which questions to ask when considering irrigation infrastructure change.

An important output of this project is the publication “A Review of Centre Pivot and Lateral Move irrigation installations in the Australian Cotton Industry”. In collaboration with Qld DERM and NCEA, this publication examined the changes in centre pivot and lateral move installations since the previous review conducted in 2001 by Foley and Raine. It has identified the perceived benefits and limitations associated with the use of CPLM irrigation systems and will contribute to better informed investment decisions on the uptake of CPLM machines.

Another major output of this project has been the establishment of irrigation benchmarks for the 2012-13 season. This season had record plantings as a result of full storage dams and good allocations. It provided for a good comparison to the two previous studies where irrigation benchmarks were collected. 2006-07 and 2008-09 were dry seasons with low water availability, low cotton prices and very low irrigated cotton plantings.

The 2012-13 benchmarks are important to show how the cotton industry was performing in terms of water use efficiency and whether cotton irrigators are able to manage water efficiently when their farms were close to full production.

The Gross Production Water Use Index ($GPWUI_{farm}$) for 2012-13 was 1.12 bales/ML. Statistical analysis on the data sets found no significant difference in $GPWUI_{farm}$ across the survey years. While this indicates little change in $GPWUI_{farm}$ since 2006-07, importantly cotton irrigators were managing much larger cotton areas and handling larger volumes of

water. This suggests the cotton industry uses water as efficiently in times of full availability and production as in times of water shortage. There was however, considerable variation in $GPWUI_{farm}$ between individual farms which indicates scope for further efficiency gains.

Interest in alternative irrigation systems is increasing and there has already been an expansion of centre pivot and lateral move installation within the Australian cotton industry. This has been spurred on from irrigation modernisation funding. Irrigators adopting pressurised irrigation systems often face increased energy costs. Therefore, this project has promoted on-farm energy assessment, along with the benefits of benchmarking energy use efficiency alongside water use efficiency.

The interest to undertake Level 2 energy assessments was not as large as that for Level 3 energy assessments particularly pump performance evaluation to identify energy savings with water pumping. Macintyre Downs was set up as a demonstration farm to showcase on-farm energy use monitoring and measurement. A pump efficiency monitor was trialled which continuously measures water flow rate, pressure head, engine and pump RPM and diesel consumption during a pumping event.

The ability of the PEM to continuously record various pump and engine operating parameters provides the necessary data to assess diesel engine and pump efficiency. This trial highlights the importance of testing each individual pumping station to identify the optimal operating point to achieve maximum efficiency. Significant energy savings are possible for individual operators and the industry collectively.

This project has shown the need to continue to work with cotton growers to examine on-farm energy use. There is high variability in on-farm energy use. Energy benchmarks will allow irrigators to compare their own performance to regional and industry averages to investigate where potential improvements may exist. However, there are practical difficulties (eg tracking fuel records to machinery operations, splitting fuel use between different farm enterprises) in collecting Level 2 energy assessment data which appears to be a barrier to adoption of on-farm energy assessments.

The Promoting Water Smart Infrastructure Investment project team has been involved in a variety of field days, conferences and industry forums. Strong collaborative links have been fostered throughout this project with a range of cotton extension, development and research organisations. NSW DPI continues to build a wide network including key industry organisations and personnel with which they have a strong rapport.

Extension Opportunities

8. Detail a plan for the activities or other steps that may be taken:

- (a) to further develop or to exploit the project technology.**
- (b) for the future presentation and dissemination of the project outcomes.**
- (c) for future research.**

This entire project has focused on communication and adoption. It has employed a variety of extension and development techniques to achieve the project objectives.

The 2012/13 Irrigation Benchmarks and CPLM review could benefit from further extension to promote the results and outcomes. CottonInfo fact sheets and e-newsletters could be used to promote the outcomes. The CPLM review will be summarised for publication in the Australian Cotton Grower Magazine and the IAL Journal. The CPLM review has an extensive data set which could lend itself to further analysis in a future project. The

Australian Association of Cotton Scientists Cotton Research Conference also provides a good platform for peer review of project outcomes.

**9. A. List the publications arising from the research project and/or a publication plan.
(NB: Where possible, please provide a copy of any publication/s)**

B. Have you developed any online resources and what is the website address?

A variety of publications have been produced throughout this project. They include newspaper and magazine articles, conference papers, a peer reviewed journal paper and short videos.

A complete list of publications is provided in Appendix 4.

Part 4 – Final Report Executive Summary

Promoting Water Smart Infrastructure Investment is a water and energy use efficiency project designed to build the capacity of cotton irrigators to adapt to reduced water availability and increasing energy costs. It has helped irrigators make informed decisions about infrastructure change and to accelerate adoption of irrigation best practice.

Water availability is often limited for cotton production. Irrigators also face further potential cutbacks with the implementation of the Murray Darling Basin Plan so must continue to improve their water use efficiency (WUE).

An important outcome of this project has been to establish water use efficiency benchmarks for the Australian Cotton Industry which enables the irrigated cotton industry to monitor and determine the rate of change over the years. At a farm level, this allows irrigators to compare their own performance with industry benchmarks and identify potential improvements. The collection of high quality WUE data is also essential for sound evidence-based policy decisions. For these reasons, the collection of robust irrigation benchmarking data for the Australian cotton industry should continue.

The Gross Production Water Use Index ($GPWUI_{farm}$) is used to benchmark WUE. The $GPWUI_{farm}$ for the 2012/13 season was 1.12 bales/ML. This figure can be used to compare benchmarks previously collected for the 2006-07 and 2008-09 seasons, which were 1.17 and 1.14 bales/ML, respectively. Interestingly, the seasonal conditions varied considerably for the years the data was collected. The 2006-07 and 2008-09 had reduced plantings, low water availability and cotton prices. In contrast 2012-13 saw record plantings and full production. Despite this, statistical analysis found no significant difference between the three seasons indicating that the cotton industry is achieving similar water use efficiency in years of full production to that achieved in years of low water availability. However there was significant variation in $GPWUI_{farm}$ between individual farms, indicating scope for further efficiency gains.

The Australian Government is providing incentive funding to modernise on-farm infrastructure. While this provides an opportunity for Australian Irrigators, it has resulted in the rapid expansion of overhead pressurised systems that are associated with higher energy costs.

After years of improving water use efficiency, attention must now be placed on energy use, and on-farm energy use efficiency. Benchmarks for energy use efficiency should be established to complement water use efficiency, as this will maximise the efficient use of water and energy on-farm through continuous improvement.

This project has increased the awareness of on-farm energy assessment through training and on-farm demonstrations. While energy benchmarks have not yet been established, this project has heightened interest in this area, particularly Level 3 energy assessments (eg Pump performance evaluation). A Pump Efficiency Monitor (PEM) was developed by the National Centre for Engineering in Agriculture (NCEA) and has had initial trials on cotton farms. The PEM continuously measures water flow, hydraulic head, engine and pump RPM and diesel consumption during a pumping event. This information is used to examine pump performance and identify areas for efficiency improvements.

Four level 2 energy assessments were conducted which showed a wide range in energy use between the farms. The energy use varied between 6 and 12 GJ/ha, with costs ranging between \$208 and \$374 per ha. Diesel energy inputs ranged from 151 to 304 L/ha. Energy benchmarking is a critical step to improving on-farm energy use. This project has shown the

need to continue working with cotton irrigators to examine on-farm energy use. High variability in energy use between farms is evident in the assessment results, which highlights opportunities for energy savings. Similar to WUE benchmarks, energy use efficiency benchmarks allow irrigators to compare their own performance to regional and industry averages and to investigate the potential for improvements. However, practical difficulties in collecting Level 2 energy assessment data appear to be a barrier to adoption of on-farm energy assessments. Further research could investigate improved methods for keeping on-farm records of fuel and electricity use, or more easily accessing and collating energy use data already available, such as that from tractor performance monitors.

Irrigation training with a focus on alternative irrigation systems was a significant output of this project with a total of 26 training events delivered to 342 cotton irrigators, consultants, retailers and industry personnel. Evaluation from these workshops showed participants had a better understanding of irrigation best practice and importantly better understood the planning and design of various irrigation systems. They were armed with greater knowledge as to which questions to ask when considering irrigation infrastructure change.

A significant output of this project is the publication “A Review of Centre Pivot and Lateral Move irrigation installations in the Australian Cotton Industry”. In collaboration with Qld DERM and NCEA, this publication examines the changes in centre pivot and lateral move installations since the previous review conducted in 2001 by Foley and Raine. It has identified the perceived benefits and limitations associated with the use of CPLM irrigation systems and will contribute to better informed investment decisions on the uptake of CPLM machines.

The Promoting Water Smart Infrastructure Investment project team has been involved in a variety of field days, conferences and industry forums. Strong collaborative links have been fostered throughout this project with a range of cotton extension, development and research organisations. NSW DPI continues to build a wide network including key industry organisations and personnel with which they have a strong rapport.

Contact:

Janelle Montgomery, Project Officer-Irrigation, NSW Department of Primary Industries

Mob: 0428 640990

Email: janelle.montgomery@industry.nsw.gov.au