



FINAL REPORT

Part 1 - Summary Details

Cotton CRC Project Number: 5.01.13

Project Title: Advancing Water Management in NSW

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Project Commencement Date: 01.07.06 **Project Completion Date:** 30.06.2008

Cotton CRC Program: Adoption

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1. Executive Summary

Advancing Water Management in NSW was initiated by industry and government in recognition of the importance of investing in a highly effective extension team to assist the cotton industry improve water use efficiency. In 2006 NSW Department of Primary Industries and its team of experienced cotton irrigation extension officers received funds from the Cotton Research Development Corporation, Cotton Catchment Communities Cooperative Research Centre, and both the Namoi and Border Rivers Gwydir Catchment Management Authorities to undertake intensive water use efficiency extension in NSW cotton growing valleys.

The adoption of water management technology and irrigation best management practices are key drivers in generating greater water use efficiency. In order to stimulate adoption and initiate practice change a multitude of extension techniques were utilised. These included:

- Delivery of irrigation training
- Technology demonstration
- Dissemination of fact sheets and case studies
- Consultant support
- Water use efficiency benchmarking
- Dissemination on cost benefit analyses

The *Irrigated Cotton and Grains Workshop Series* and the *Centre Pivot Lateral Move* training courses were delivered to 250 cotton and grains growers. There is documented evidence that the training resulted in growers having a greater knowledge and understanding of irrigation best practice, and has led to genuine practice change. Increased adoption of technology, better water management techniques, and investment in new infrastructure has improved whole farm water use efficiencies.

The irrigation training led to many growers applying for water use efficiency incentives available from Catchment Management Authorities. The increased knowledge, awareness, skills and attitudes acquired at the training workshops allowed growers to recognise strengths and weaknesses in their water management practices. Training also helped growers identify where investment would lead to the greatest increase in whole farm water use efficiency. Border Rivers Gwydir CMA assessed approximately 80 water use efficiency incentive applications. 66 applicants successfully secured funding for a variety of on-farm WUE activities, including the purchase and/or upgrade of soil moisture probes, storage surveys, field and storage EM surveys, storage deepening or reconfiguration, supply and tail water system upgrades. Similarly the Namoi CMA and CCCRC granted funds to 9 applicants resulting in excess of 5111Ha coming under best practice water management.

A second outcome from the irrigation training was an increase in awareness of the Cotton BMP program. Each of the Irrigated Cotton and Grains workshops has specific linkages to the Cotton BMP Land and Water Module. Growers were encouraged to consider the advantages of obtaining formal recognition of their best practice. Between October 2006 and July 2008 Cotton Australia conducted a total of 35 and 20 Land and Water Pre-Certification Audits (PCA) in the Namoi and Gwydir Valleys respectively. Based on these PCA numbers, in the Namoi the *Advancing Water Management* project contributed to an additional 13,614 ha being managed and irrigated according to best practice.

Technology demonstration of Irrimate™ hardware and WaterTrack™ Optimiser software were initiated to showcase how decision support tools could assist growers to manage and measure water more efficiently. Knowledge and awareness of surface irrigation performance evaluation particularly has increased and practice change is now being documented within the cotton industry. Many growers have begun to reconfigure fields to minimise losses, shorten irrigation times, and optimise field application efficiencies. The demonstration of the WaterTrack™ software and storage seepage/evaporation meters also increased awareness of the magnitude of storage losses currently being experienced on irrigation farms. A growing number of irrigators are now either raising storage bank heights or consolidating water storage to minimise evaporative losses.

In an effort to stimulate adoption of current industry standards for recording water use efficiency, project staff conducted personal interviews on 42 farms from Emerald in central Queensland to Hillston in southern NSW to establish current WUE benchmarks for the cotton industry.

Benchmarking facilitates continuous improvement in management and water use. The results revealed that the average WUE for the 2006-07 season was 1.31 bales/ML (water pumped) or 1.13 bales/ML (including stored soil moisture and effective rainfall). The results also highlighted that the top 20% of growers achieved a WUE around 1.5 bales/ML. A paper was presented at the 2008 Australian Cotton Conference, and based on the response from industry, the benchmarking study and information generated has been very well received.

In an effort to increase both growers' and industry's awareness and knowledge of the financial benefits of investing in technology adoption and practice change, a number of economic case studies were produced with the assistance of a NSW DPI economist. Economic articles were posted on the irrigated cotton and grains website and published in the Australian Cotton Grower magazine. Materials were also distributed at irrigation training workshops and at various farm walks and field days.

In 2003 the *Whole Farm Salinity Management Strategies for Cotton Production in the Macquarie Valley*, CRDC Project Number: CRC 51C established five long term monitoring sites in the Lower Macquarie Valley. These sites are allowing the long term monitoring of deep drainage and changes to the salt store in the major irrigated cotton growing soils. In 2006 and 2007 members of the *Advancing Water Management Project* team collected and tested soil samples at these monitoring sites to build a long term picture of potential soil degradation and productivity decline due to poor water quality and irrigation management. An examination of the 2007 soil and water analyses suggest that sodium and chloride concentrations increase during the irrigation season but decrease during the winter (non-irrigation season). Presumably this is due to leaching of the salts out of the crop root zone with winter rainfall. In time, it is likely that they will move into groundwater reserves. However, there is considerable variation among locations due to variation in soils (texture, ESP etc.) and cropping systems. A technical paper will be published and presented at an industry forum in 2009.

2. Background

Although the cotton industry is recognised as a leader in the adoption of technology to increase farm productivity, recent surveys (Tennakoon and Milroy 2003) indicated that there is plenty of scope for improving water use efficiency (WUE). At the time estimates of whole farm water use efficiency ranged between 40-68%.

Opportunities for immediate gains in on-farm WUE exist where technology and management change is adopted to reduce storage evaporative and seepage losses, optimise surface irrigation performance, and to time irrigations according to crop demand.

This extension project was developed in response to industry and government recognising the importance of investing in a highly effective extension team to encourage technology adoption and management change to drive water use efficiency improvement in the cotton industry. The project involves the collaboration of NSW Department of Primary Industries (NSW DPI) with The Cotton Research and Development Corporation (CRDC), Cotton Catchment Communities CRC (CCC CRC),) both Border Rivers Gwydir and Namoi Catchment Management Authorities and local irrigators and consultants. The project was developed to lift industry water use efficiency through a coordinated industry approach to advisory and education/training services in water use efficiency (WUE). It includes demonstrations and trials and delivery of the Irrigated Cotton and Grains Irrigation Workshop series that incorporates Cotton industry's BMP guidelines and assists CMAs achieve Catchment Action Plans and Investment Plan targets relevant to the cotton industry. It is contributing to a 15% increase in whole farm water use efficiency within the cotton industry over the next five years.

In 2006 the agencies listed above pooled resources to:

- Employ a full time extension hydrologist in the Namoi to lead the project
- Employ a full time water use efficiency officer in the Gwydir valley

- Purchase capital equipment and software for demonstration purposes.
- Support the training of extension staff in new water management technology
- Employ the services of an economist to conduct cost benefit analyses
- Support general operating expenses of NSW DPI water extension team based in cotton growing valleys.

3. Extension Methodology

Within the *Advancing Water Management in NSW* (AWM) project a variety of extension techniques were deployed to increase capacity within the irrigated cotton and grains industries to adopt management change and technology to improve water use efficiency. These include:

- **Group Facilitation** – Extension staff liaised with local agribusiness consultants to encourage clients to participate in irrigation training. Most consultants are aware of their client’s knowledge and skill gaps. Consultants were therefore utilised to promote, facilitate, and on occasion, assist in the delivery of irrigation training. Technology demonstration sites were also established where possible using cluster groups associated with an individual consultant.
- **Technology Development** – Demonstration sites were established in a number of valleys to showcase the benefits of new emerging irrigation management technologies, including software to measure on farm water use and optimise surface irrigation efficiencies.
- **Programmed Learning** – Specifically this involved the delivery of irrigation training to growers, consultants and irrigation suppliers. Courses delivered included; Irrigated Cotton and Grains Workshop Series and the CRCIF Centre Pivot and Lateral Move National Training Course. NSW DPI CottonCRC waterteam staff also delivered a number of soils courses for irrigators in the Namoi valley.
- **Information Access** – Articles and fact sheets produced by team members have been uploaded to the Irrigated Cotton and Grains website. This allows individuals and groups to access a broad range of information at a time that suits them.
(<http://www.cottonandgrains.irrigationfutures.org.au>).
- **Individual Consultant Support** – In conjunction with the CCCRC funded *Knowledge Management in Irrigated Cotton and Grains Project* considerable time and effort was invested in upskilling agribusiness consultants working in the irrigated cotton and grains industries. The aim of this initiative was to build capacity within the irrigation service industry to:
 - Ensure growers have access to the latest technical advice on new emerging technologies in water measurement and monitoring.
 - Facilitate the adoption of best management irrigation practice
 - Provide a greater range of irrigation services to improve water use efficiency

4. Project Outputs and Outcomes

The existence of individual CCCRC CMA sub-contracts with their own objectives and milestones in addition to those originally agreed to under the original CRDC AWM project potentially adds enormous complexity to this report. Milestone reports that address each CMA’s specific milestones have previously been completed in the nominated time frames. To circumnavigate unnecessary duplication and repetition, this final report will address the core objectives outlined in the contract variation agreed to and signed off by the CCCRC in March 2008.

Essentially both the Namoi and Border Rivers Gwydir CMA sub-contracts focussed on the delivery of irrigation training, technology demonstration, generating water use efficiency benchmarking data, and ultimately achieving improvement in cotton industry water use efficiency. This report will document significant outputs and subsequent outcomes aligning to these main objectives.

4.1 Management Tasks and Responsibilities

Objective 1 – Enhancing industry and catchment related project outcomes

The project received funding in May 2006 to enable the purchase of Irrimate™ water measurement equipment, water management software, technical training of project staff, and importantly to recruit both an Extension Hydrologist to lead the project (based at Narrabri), and a Water Use Efficiency Officer at Moree.

Unfortunately the recruitment of an extension hydrologist proved to be very difficult due to the large demand for hydrologists, mainly driven by the boom in the Australian mining industry. While the position was advertised on three separate occasions between June 2006 and December 2006 management received only a very limited number of applications from unsuitable or ineligible candidates.

As a result of not being able to recruit an extension hydrologist, the project leadership was transferred to the Namoi District Irrigation extension Officer, Rod Jackson in February 2007, who had transferred from NSW DPI Griffith to the Australian Cotton Research Institute, Narrabri in October 2006. Janelle Montgomery was appointed as the Water Use Efficiency Officer based at Moree in November 2006.

A number of important tasks were undertaken to ensure project guidance. These include:

- Establishment of a steering committee comprising representatives from NSW DPI, Australian Cotton Growers Research Association, CCCCRC, CRDC, Namoi and Border Rivers Gwydir CMAs, and the Gwydir Valley Irrigators Association.
- Development of individual workplans
- Developing a communications plan
- Formulating a monitoring, evaluation and reporting plan

Detailed monthly reports were provided to the CottonCRC documenting AWM project activities and outcomes relating to the CottonCRC strategic plan. Six monthly reports were also forwarded to the CMAs.

4.2 Supporting Cotton BMP and CMA Initiatives

Objective 2 – Increase grower knowledge and adoption of BMP's and property plans to meet CMA targets for salinity, land capability and property planning.

CCCCRC regional and water team workplans were developed as a blueprint for collaboration with Cotton Australia and the CMAs in the promotion and facilitation of grower adoption of the Cotton BMP program and the uptake of CMA water use efficiency incentives and property plans.

The following extension activities were conducted in partnership with Cotton Australia Grower Services Managers (GSMs) and CMA support officers:

- The delivery of BMP irrigation training and property planning workshops
- Provision of technical advice in Cotton Australia's BMP Land and Water Module Workshops
- Publication and dissemination of extension materials
- Field days and farm walks
- Technology demonstrations

The irrigation training led to many growers applying for water use efficiency incentives available from Catchment Management Authorities. The increased knowledge, awareness, skills and attitudes acquired at the training workshops allowed growers to recognise strengths and weaknesses in their water management practices. Training also helped growers identify where investment would lead to the greatest increase in whole farm water use efficiency.

Technical support was provided by AWM project staff to CMA officers responsible for the assessment of water use efficiency incentive applications and subsequent dissemination of cash payments. This support ensured that:

- Only projects demonstrating adoption of best practice were funded
- Each on-farm project generated the maximum amount of water use efficiency improvement
- The estimates of water savings or percentages gains in water use efficiency were realistic.

Border Rivers Gwydir CMA assessed approximately 80 water use efficiency incentive applications. 66 applicants successfully secured funding for a variety of on-farm WUE activities. These included; the purchase and/or upgrade of soil moisture probes, storage surveys, field and storage EM surveys, storage deepening or reconfiguration, supply and tail water system upgrades.

Similarly the Namoi CMA granted funds to 9 water use efficiency applicants resulting in approximately 5111Ha coming under best practice water management.

Incentive schemes are listed on the irrigated cotton and grains website <http://www.cottonandgrains.irrigationfutures.org.au/>. During the project regional promotion of WUE incentives occurred in regional newsletters such Cotton Tales, CCA meetings and during training, farm walks and planning workshops.

A second outcome from the irrigation training was an increase in awareness of the Cotton BMP program. Each of the Irrigated Cotton and Grains workshops has specific linkages to the Cotton BMP Land and Water Module. Growers were encouraged to consider the advantages of obtaining formal recognition of their best practice. Between October 2006 and July 2008 Cotton Australia conducted a total of 35 and 20 Land and Water Pre-Certification Audits in the Namoi and Gwydir Valleys respectively. Based on these PCA numbers, in the Namoi the *Advancing Water Management* project contributed to an additional 13,614 ha being managed and irrigated according to best practice.

Unfortunately while there were clear gains in growers adopting irrigation best practice (see section 4.4 *Irrigation Training*), not all growers were willing to sign up to the Cotton BMP program, even for a Pre-Certification Audit (except where incentive money was available). Reasons for grower resistance included:

- Currently do not see a need for it. As those in the cotton industry would know, BMP was originally born out of the pesticide contamination issues of the 1990's.
- Too difficult. Certification process too long and time consuming.
- Do not perceive a value to their business.
- Current BMP program is redundant as a new program is about to be launched.

Clearly these attitudes within the cotton industry need to be addressed, particularly as a new revised, Cotton BMP is about to be rolled out. With this in mind, a number of project staff provided technical support and advice to the Cotton BMP Manager of Cotton Australia in the drafting of the revised Cotton BMP Program.

A number of field days/farm walks were coordinated in partnership with the CMAs to increase community awareness of research projects currently underway examining important natural resource management issues.

Maules Creek Ground Water Study - February 2008

A farm walk and seminar was coordinated by AWM project staff at Maules Creek near Boggabri. The aim was to communicate preliminary findings of a CottonCRC/Namoi CMA funded ground water study being conducted in the area by the Water Research Laboratory, University of New South Wales. The day was well attended by 35 local growers as well as a number of industry representatives.

The irrigation industry representatives asked plenty of questions of the speakers about the significance and implications of the findings so far. Cooperation was typified by many growers offering to help with their pumping operations to ensure accurate measurement of groundwater levels.

‘It was good to see scientists coming out to the farmers, and talking to them on farm, bringing them up to date and involving them in data collection and the project’ - John Clements CEO of Namoi Water.

Figure 1: Dissemination of preliminary ground water research results at Maules Creek in February 2008.



Lower Gwydir Surface Flow and Ecology Forum - July 2008

Janelle Montgomery coordinated the Lower Gwydir Surface Flow and Ecology Forum. The 2 day community forum focused on research projects on the aquatic ecology and management of the Lower Gwydir Channels and wetlands. The forum was hosted by the Moree Plains Shire Council and Border Rivers Gwydir CMA, and sponsored by Department of Environment and Climate Change, Murray Darling Basin Commission, University of New England, Gwydir Valley Irrigators Association, NSW Department of Primary Industries and the Cotton Catchment Communities CRC. The forum and field trip was attended by 60 agency and department staff, researchers, extension staff, including 20 landholders which were a mix of irrigators, dryland farmers and graziers.

Outcomes:

Based on the narratives and grower comments below outcomes of the forum included:

- Greater interaction and communication between researchers and extension officers
- Greater understanding by growers of the importance of surface flows to river health
- Increased cross-organisation / cross-departmental awareness and understanding of surface flow and wetland management.

There was extensive media attention with the Forum with a news report on the local Prime News (15th July), 5 interviews for the ABC Rural Report and 2 interviews with the Forum Convenor, Dr Glenn Wilson (UNE) during the Morning Show on local ABC radio and articles in a number of local and regional newspapers

Evaluation responses showed that:

- 86% of respondents now had an increased understanding of ecology in the Lower Gwydir Wetlands,
- 79% now had an increased understanding of the importance of surface flows,
- 89% now had a an increased understanding of ecology of Lower Gwydir streams, and
- 92% of respondents had an increased awareness of what research has taken place in the Lower Gwydir.

Narratives from the forum included:

- *If I learnt anything from the forum it is that we are ALL involved in this complex issue. (irrigator)*
- *Provided an opportunity for researchers to meet each other and landholders/mgt and chat about issues of concern and share knowledge in an informal situation.*
- *Great to meet and hear from so many groups of people passionate about seeking the best management options for the lower Gwydir and about working together to achieve that objective.*
- *The forum had a great to mix of researchers, managers and landholders together to share views/facts/opinions. Things are always changing i.e. science, therefore need to be kept updated*
- *The format of two days (a day of talks, then a field trip to sites and hearing landholders speak) was great. Insightful but not too overwhelming*

Figure 2: Forum participants alongside the Gwydir River



Figure 3: Cotton Catchment Communities CRC Participants at the Lower Gwydir Surface Flow and Ecology Forum



4.3 Technology Demonstrations

4.3.1 Irrimate™ - Surface Irrigation Performance Evaluation

Objective 3 – Increased awareness and efficiency at the field scale

Objective 5 – To increase water use efficiency

Objective 7 - Evaluate whole farm water monitoring and budgeting

Objective 10 – Increase grower knowledge of new technology and decision support systems for irrigation management.

During the 2006-07 and 2007-08 cotton seasons project staff in the Namoi and Gwydir valleys worked with a select number of growers and consultants to demonstrate the water use efficiency benefits of conducting surface irrigation performance evaluation.

Irrimate™ is an assortment of electronic tools to measure water on and off fields, and water advancement timing. The data collected enables an assessment of how much water has infiltrated the field. Software is then used to simulate different management options to minimise losses and improve irrigation efficiency.

In the 2006-07 cotton season 47 furrow irrigation evaluations were successfully conducted by the Cotton CRC Water Team across 9 farms located in the Gwydir and Namoi Valleys. Results of the Irrimate™ assessment of irrigation efficiency are illustrated in figures 4 and 5.

Figure 4: Measured Field Application Efficiencies

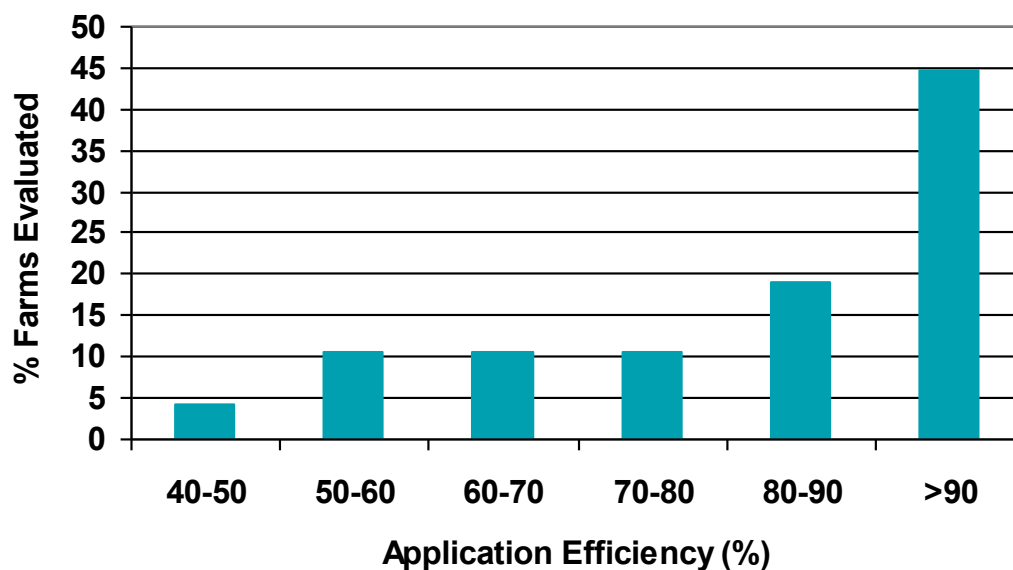
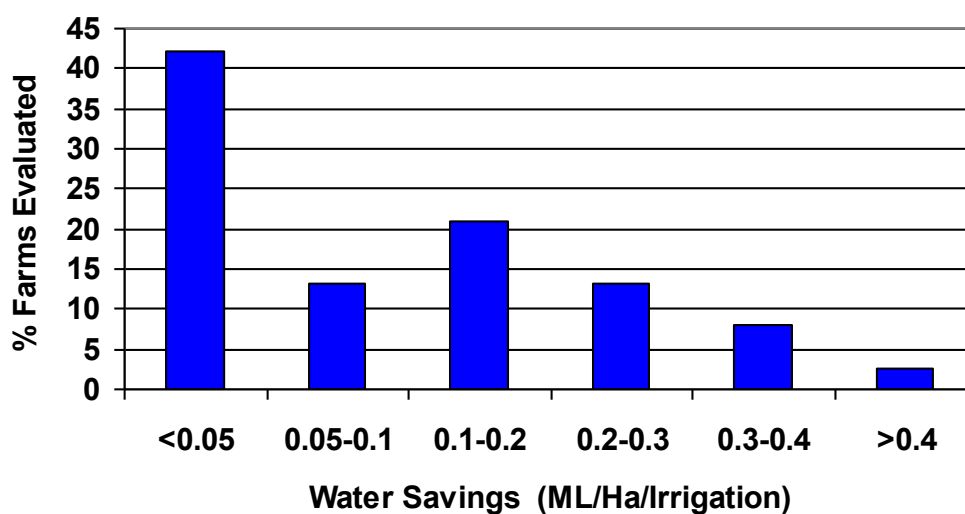


Figure 5: Potential Water Savings



These results support the following statements:

- There is still considerable room for improving irrigation performance of furrow irrigation systems within the cotton industry. About 35% of the events had Field Application Efficiency below the standard benchmark of 80%.
- Importantly 45% of the irrigation events measured had Field Application Efficiency greater than 90% and again proves furrow irrigation can be efficient.
- Irrigators should continue to explore the opportunity to optimise their existing furrow irrigation systems before investing in expensive pressurised systems.
- Simple low cost management changes (e.g. improving flow rates and changing the time siphons are pulled) can often improve furrow irrigation performance.

Increased knowledge of furrow irrigation performance and practice change is demonstrated by the grower comments below.

What was the most important thing you learned from this work?

Grower 1 – ‘These trials reinforced the need to match infiltration requirements and system delivery, but to not exceed this in order to optimise efficiency. The information has also been useful to see the relationship between our probe readings and the amount of water we pump and will lead to better future production through better decisions about water availability.’

Grower 2 – ‘The effectiveness of the irrigation applied - this in a field that we had shortened to increase efficiency - we hoped! It exceeded my expectations by considerably reducing watering time (water on field) and reducing the amount of total water required over all - the information obtained from the measurements and models showed that we attained our aimed application (refill) without large seepage losses.’

Consultant 1 – ‘That our existing practice was indeed accurate for this farm. Reinforced that what we were doing was efficient. Can move ahead and concentrate on other things as we now know how efficient we are.’

Consultant 2 – ‘The irrigation performance evaluations were not only beneficial to the client whose farm you worked on, but also to me as I was able to extend the relevant information to other growers I work with. Many of the results from the evaluations reinforced other research and our ideas and so I was able to relay that to growers with more confidence after working with you. Also, once I had let other growers know what you were doing and why, they would often ask me for results or discuss the results that were relevant to their farms.’ Rob Holmes, Moree Consultant

What will you do because of these results?

Grower 1 – ‘We have started to steepen grades or split fields in order to speed up flow down the field. We have also reinforced promptness in workplace, as it is vital to manage the irrigation precisely in order to maximise performance.’

Grower 2 – ‘We will continue to shorten fields to less than 700 metres, continue with double siphons for all in crop irrigations and try techniques to further improve water use efficiency - i.e., make the water go further.’

Consultant – ‘Continue paying attention to detail with regard to measuring and monitoring crop water use and aim to match irrigations to water use so as to remain as efficient as possible.’

What was the most challenging aspect of this work?

Grower 1 – ‘Matching the area irrigated efficiently with the labour component required careful consideration. It is important to run water by the clock and not by the sun. For example we only allow water to be in the taildrain for 1 hour before changing, or even changing instantly on long runs.’

Grower 2 – ‘Getting irrigators to pull siphons early enough! But we did actually improve the watering operation because the water came out more evenly reducing the need to be always checking and stopping and starting rows.’

Consultant – ‘To now extend this to other farmers. Get them to measure and manage their irrigations. Some farmers need to know what they are missing out on in \$\$ or bales/ha so they can then do the sums to see if it is practical to move to shorter irrigation times.’

The results from the irrigation evaluations have been reported in the December 2007 issue of the Australian Cotton Grower Magazine, posted on the Cotton and Grains Irrigation Website <http://www.cottonandgrains.irrigationfutures.org.au/news.asp?catid=3> and were discussed in the 2007 winter issue of the CRDC Spotlight magazine.

Barriers to Adoption

While the project achieved some increase in adoption, a number of important barriers to adoption were identified. These include:

- Grower scepticism of the SIRMOD model (“Black Box” mentality)
- Questions were raised as to how representative the measured area (8 furrows) was to the whole field.
- Cost of Irrimate™ service. Most evaluations in 2007-08 in the Namoi were financed by the CMA. Again growers need to be convinced of how the service will generate additional farm income. Evaluations in the Gwydir were readily accepted as demonstration sites; however

independent uptake of the technology was slow. Even with the availability of BRG CMA incentive funding, less than 5 farms applied for funding towards surface irrigation performance evaluation. A similar story was experienced in the Namoi.

- Cost of infrastructure change. New siphon, head ditch and field configurations. The drought has severely limited the average grower's ability to invest in new infrastructure.
- Increased labour requirement. As quoted in one of the comments above. There is a perception by many growers that optimisation invariably requires reduced run times and higher flow rates - hence greater labour requirements.
- Optimisation recommendations too hard or impractical
- Time lag/delay in receiving irrigation optimisation recommendations from service providers.

While the uptake of Irrimate™ was less than expected, Aquatech Consulting recently made the comment that many irrigators had learned about irrigation optimisation through “osmosis”. Via the smaller number of irrigators that had adopted the Irrimate™ a larger number of irrigators had in fact changed management practice such as improving flow rates and/or reducing cut-off time to improve application efficiency.

Recommendation

Reduced farm incomes, coupled with chronic labour shortages have reduced the cotton industry's ability to embrace the benefits of furrow irrigation performance evaluation. Research and development needs to focus on technologies that will allow the automation of furrow irrigation systems to reduce labour costs.

4.3.2 WaterTrack™ Optimiser

Objective 4 – Increased awareness of distribution losses

Objective 5 – To increase water use efficiency

Objective 7 - Evaluate whole farm water monitoring and budgeting

Objective 10 – Increase grower knowledge of new technology and decision support systems for irrigation management.

This software package allows irrigation managers to monitor water movements around the farm and identify how much water is available on a daily basis. It provides a daily water balance for each component of the irrigation system – storage, distribution and field. The program is able to predict crop water use and calculate evaporation and seepage losses in different components of the irrigation system. At the end of the season detailed reports can be generated allowing crop, field irrigation, and storage and distribution efficiencies to be evaluated. The software can also calculate various water use efficiency indices enabling relative performance to be benchmarked over time.

Software was purchased in July 2006 and training was provided to NSW DPI staff in both July and November 2006.

The software was utilised on a total of 4 demonstration farms in the Namoi and Gwydir valleys. Table 1 and Figure 6 illustrate the type of information WaterTrack™ Optimiser generates.

Table 1: Partitioned Farm Water Losses


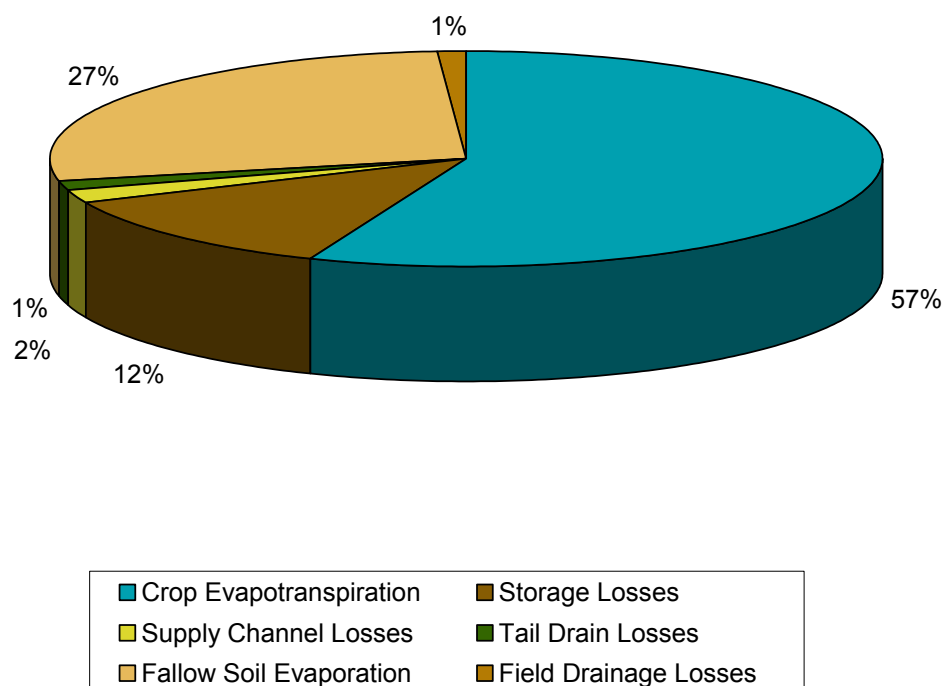
SEASONAL STORAGE AND DISTRIBUTION LOSSES		
		2nd September 2006 - 31st March 2007
		Border Rivers Farm
		Namoi Farm
		ML
		ML
Total Water Supplied to the Farm		5666
Storage Losses		
	Seepage	156
	Evaporation	1049
Total Storage Losses		1205
Supply Channel Losses		
	Seepage	15
	Evaporation	120
Total Channel Losses		135
Tail Drain Losses		
	Seepage	4
	Evaporation	72
Total Drain Losses		76
Total Storage and Distribution Losses		1416

Figure 6: Whole Farm Water Balance (Namoi valley farm)



To evaluate the usefulness of the software, and the benefits to the irrigator, a series of questions were put to the growers who cooperated in the trial.

Co operators Comments

What was the most important thing you learned from this work?

It quantified our losses and confirmed where our greatest losses come from - namely storage losses. It also confirmed that the way we are irrigating is pretty well best practice, and there wasn't a lot we needed to do to improve in this area.

Practice Change - What will you do because of these results?

We are more mindful of how we manage our storages to minimize evaporation and at the moment we are also trying to avoid wetting empty storages again to minimize losses from wetting a dry storage (there is always a quantity of water you cannot empty out of a storage). In the future I think it will be important to quantify and justify our water use and use a standard method of calculating water use numbers across the industry. I will be trying to collect more water use data through the season with this in mind.

What was the most challenging aspect of this work?

There is quite a bit of work involved in setting up a farm in the software and there is ongoing data required to keep it up to date. I still have not got to the point where we have been able to use the predictive capability of water track and you need to be using it very regularly to be able to navigate your way around it.

Communication

Results of the software demonstration were communicated to industry via:

- Discussion at the 2007 Lower Namoi Valley Field day
- Watertrack™ demonstration meeting at 'Garalema', Moree.
- Publication in Australian Cottongrower magazine – December 2007
- Uploading material to *Irrigated Cotton and Grains* website.

<http://www.cottonandgrains.irrigationfutures.org.au/news.asp?catid=3>

Barriers to Adoption

While most would agree that the information generated by the software is highly useful in assisting irrigators to improve water use efficiency, unfortunately the wider industry adoption of the WaterTrack™ Optimiser software has been lower than expected. Within the Namoi valley the initial impetus for uptake of the software was mainly driven by the availability of CMA water use efficiency incentives. The BRG CMA received only one application for funding uptake of Watertrack™ Optimiser. Now that CMA funds have been exhausted or severely limited, and farm income has been curtailed by the effects of the drought, adoption has slowed considerably. Based on discussions with growers and consultants the current barriers to adoption include:

- Cost of the software
- Operational complexity
- Highly labour intensive
- Consultants do not have enough time to provide the service
- Consultants are uncertain growers would have the capacity to pay.

Recommendation – Those developing water management software and decision support tools need to consider the following:

- **Minimise the purchase cost or licence fee. If access to the tool is expensive then it has to be demonstrated that the potential benefits from improved water management exceed the annual cost.**
- **Reduce the operational complexity so 'average' irrigators or consultants have the confidence and ability to operate the software.**
- **Reduce the labour input where possible. Adaptation of existing remote sensing technologies is desperately required to gather the necessary input data to minimise labour input by the grower or consultant.**

- **Growers and consultants need to be included more in the development phase. It's important to know what the industry needs and in what format or skill level.**
- **Too often decision support tools require input data that is not easily accessible by the average grower. Typical examples include soil moisture, which is usually expressed as a deficit (mm) or Plant Available Water (mm). Unless a soil characterisation has been conducted in the field in question then it usually comes down to an educated guess by the grower or consultant. Growers often see decision support tools as too hard. If adoption is to succeed then the input data needs to be both easily collected and low cost. Further research and development of technology is urgently required to allow these types of parameters to be determined more easily.**

4.3.3 Irrimate™ Storage and Seepage/Evaporation Meters

Objective 5 – To increase water use efficiency

Objective 7 - Evaluate whole farm water monitoring and budgeting

Objective 10 – Increase grower knowledge of new technology and decision support systems for irrigation management.

Storage Meter Demonstration

Electronic Irrimate™ Storage Meters were set up on 2 farms each in the Gwydir, Macquarie and Namoi valleys to demonstrate to growers how the technology could provide a continuous record of storage water volumes. Accurate water measurement is essential for water use benchmarking and water budgeting for seasonal crop plans.

The storage meters require calibration using an accurate depth-to-volume and surface area relationship (storage curve). The value of having their storage surveyed was clearly identified as some irrigators found a 20 per cent difference in estimated (gauge board readings) and actual storage volumes.

Growers immediately recognised the benefits of having a continuous record of storage volume and the ease of collecting this data with the push of a button (no more tape measures). A number were so impressed they applied for CMA funding to secure their own electronic meters and have had their other storages accurately surveyed. Consultants involved with the demonstrations are also now recommending this technology to other clients.

Seepage/Evaporation Meter Demonstration

An Irrimate™ Seepage/Evaporation Meter was installed into 2 storages in the Gwydir, 1 storage in the Border Rivers Catchment, and 4 storages in the Namoi valley. The ability of the technology to estimate both seepage and evaporative losses in water storages make them an essential tool in achieving greater storage efficiencies and ultimately greater whole farm water use efficiencies.

Grower comment - 'It quantified our losses and confirmed where our greatest losses come from.....we are more mindful of how we manage our storages to minimise evaporation.'

Recent detailed measurements of storage losses confirm that the greatest improvements in whole farm water use efficiency will come from minimising evaporative losses.

Recommendation – Future extension programs should target on-farm storage management and infrastructure improvement to generate significant improvements in cotton industry water use efficiency.

4.4 Irrigation Training

Objective 5 – To increase water use efficiency

Objective 6 – Implementation of water management training

The delivery of irrigation training allowed project team members to communicate to industry key messages on how to improve water use efficiency. Greater knowledge, awareness, skills and improved attitudes to saving water have lead to demonstrated practice change.

By its nature training also contributed to achieving outcomes related to other AWM project objectives. The linkages are described in Table 2.

Table 2: Irrigated Cotton and Grains Workshop Delivery - NSW

Workshop Module	Specific Linkages to other AWM Project Objectives	No. of Workshops	No. of Participants
Irrigation Benchmarking and Water Budgeting	Objective 3 - Increased awareness and measurement of water use efficiency at the farm scale Objective 7 – Evaluate whole farm water monitoring and budgeting. Objective 10 – Increase grower knowledge of new technology and decision support systems for irrigation management.	7	82
Scheduling I	Objective 10 – Increase grower knowledge of new technology and decision support systems for irrigation management.	3	28
Irrigation Pumps	Objective 3 - Increased awareness and measurement of water use efficiency at the farm scale Objective 3 - Increased water use efficiency within the cotton industry Objective 9 - Improve grower awareness of costs for practices and systems that improve WUE.	3	20
Surface Irrigation Performance Evaluation	Objective 10 – Increase grower knowledge of new technology and decision support systems for irrigation management.	2	19
Total		15	149

4.4.1 Irrigated Cotton and Grains Workshop Series

The Irrigated Cotton and Grains workshop series was delivered by project staff in the Border Rivers, Gwydir and Namoi valleys. The Workshop Series was developed following consultation with industry through the first phase of the Irrigation Knowledge Management. A key recommendation of this phase was the development of concise, detailed, practical irrigation training, targeted at a level suitable for consultants and managers to give Cotton and Grain Industry personnel the opportunity to learn new skills and techniques.

The Cotton and Grains Irrigation Workshop Series consists of 7 workshops on a range of irrigation related topics. They include:

- Benchmarking and Water Budgeting
- Scheduling I
- Scheduling II

- Pumps
- Surface Irrigation Performance Evaluation
- Storage and Distribution Systems
- Metering

The workshops are mapped to nationally recognised competencies and link to the Cotton BMP program. At each of the workshops growers were made aware that attendance and subsequent completion of key tasks would assist each of them gather evidence of best management irrigation practice to satisfy elements of the Cotton BMP Land and Water module. Where possible, CMA staff and the Namoi CCCRC BMP officer were present to promote the benefits of Cotton BMP and to assist growers through the certification process.

Unfortunately the slow progress in the development of the workshops within the Knowledge Management Project restricted the speed in which the training could be rolled out to industry. Reasons for the delay in workshop availability documented in the Knowledge Management Final Report include:

- ‘It was assumed that the existing NSW DPI WaterWise course could be easily refined. However it was soon realised that the WaterWise course materials were only mapped to level 3 competencies, and not at the level 4 and 5 required for managers and decision makers.’
- ‘The original WaterWise course was classroom based not practically based and was too general in nature.’

The first Irrigated Cotton and Grains workshops became available for delivery by AWM staff in mid 2007 and training proceeded in earnest from September 2007 to April 2008. Regrettably three of the workshops only became available for delivery in June 2008. This reflects the non delivery of the *Storage and Distribution*, *Scheduling II*, and *Metering* workshops. Having said this, it is envisaged that these workshops along with the others listed above will continue to be delivered on demand to cotton and grains growers in ensuing years.

While the non-availability of the workshops for delivery in the first half of the project was frustrating for project staff and funding partners, the positive feed back received from industry participants who attended the training during 2007-08 validated the strategy undertaken by those involved in the Knowledge Management Project. The training was indeed more practical, concise, and aimed at a higher level of management. To have delivered training at a lower level would have been counter productive and not met industry requirements.

The AWM project also funded and produced a promotional DVD of interviews from irrigators and consultants discussing the benefits of attending the training workshops. The DVD was played at the CCCRC stand at the recent 2008 Australian Cotton Conference. Regrettably no registrations for the training were received.

Training Outcomes

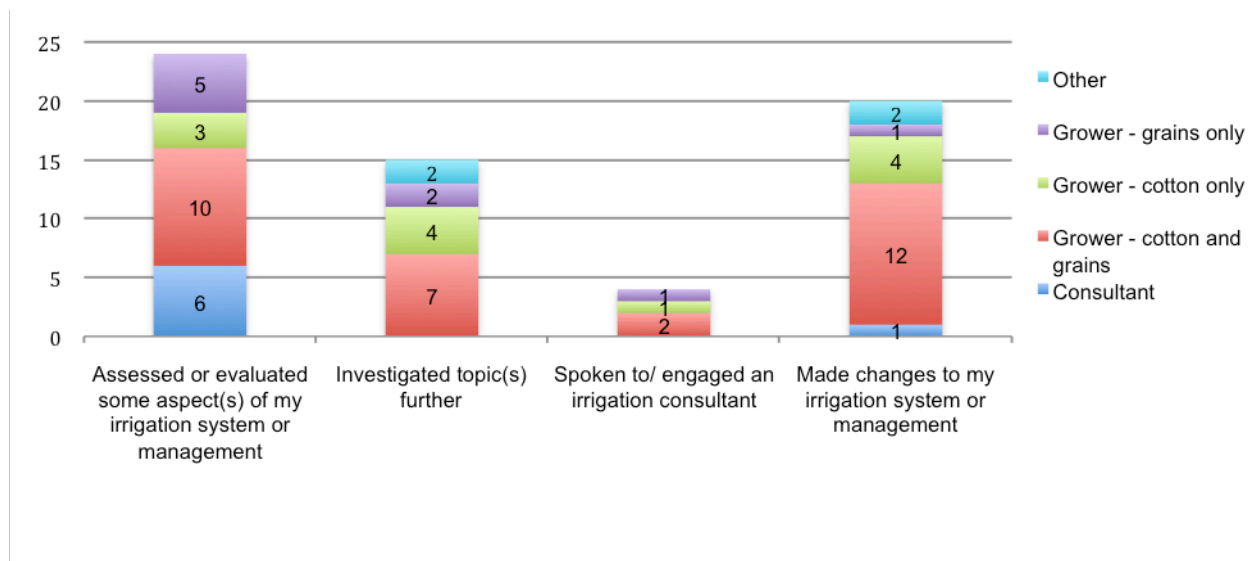
The knowledge, attitudes, skills and aspirations acquired by participants in the training series has been documented in the Survey Report conducted by Jeff Coutts commissioned by the Knowledge Management Project. A random, stratified phone survey was conducted across consultants and irrigators in the cotton and grains industries. Fifty percent of the 100 respondents were chosen from those who had undertaken some training activities within the KM project and the other 50% randomly across the remainder of the industry.

Figure 7: Value of the Workshop Series to Participants



(Source: Coutts, J and R, 2008. Knowledge management in irrigated cotton and grains – Phase 2. Evaluation report. p.18.)

Figure 8: Actions taken as a result of attending training



(Source: Coutts, J and R, 2008. Knowledge management in irrigated cotton and grains – Phase 2. Evaluation report. p.18.)

The following is an extract from Coutts (2008)

The majority of respondents (40) indicated having implemented some changes in practice which were already improving water use efficiency. These changes included the adoption of technology to better measure and monitor water use and improved irrigation layouts.

'I have put in a proper storage meter – we used to use a ruler, so we get a better result now. I'm going to be putting in an evaporation meter which will help me decide if we store the water or use it before it evaporates'.

A further 10 respondents indicated specific measures that they planned to undertake in the near future as a result of the training to improve water use efficiency

There were also some comments by consultants who felt the training had improved the quality of advice they were able to give to clients.

'The advice we give is more professional. It is better for the environment and better for water use efficiency.'

Documented Practice Change

Narrative 1: Angus Moore attended an Irrigation scheduling workshop delivered in September 2007 at Wee Waa. Angus used the new found knowledge, skills and new found confidence in soil moisture technology in applying for a Namoi Catchment Management Authority irrigation efficiency grant. Based on what he had learnt and subsequent post training advice Angus purchased and installed 2 soil moisture capacitance probes on his 370Ha irrigation farm. Angus estimates this initiative will have the potential to increase the farms irrigation efficiency by around 15%.

"It made me realise that scheduling was an extremely important tool that would help us make the most of what we have and use water more effectively"

Figure 9: Angus Moore next to a crop of cotton managed using soil moisture monitoring probes.



Narrative 2: As a result of attendance at the same workshop, another grower indicated that he was going to make a more concerted effort to improve WUE by improving his irrigation scheduling. Since he had stopped using his neutron probe 3 years ago, he admitted that he had fallen into 'bad habits'. The training highlighted how much water he was potentially wasting. He is now endeavouring to recommission his neutron probe and is committed to investing the time to do the readings.

Narrative 3: Ralph Grey attended an irrigation pump workshop coordinated by NSW DPI irrigation extension staff at Mungindi in March 2008. During the workshop at Ralph's property it was discovered that his pump installation was inefficient and costing him more to operate compared to that of an efficient pump. Ralph has indicated he is presently reconfiguring his pump to save costs and to improve farm profitability.

"As a result of the workshop I attended we identified that this pump is not performing to the efficiency that we expected. We've identified that it has an excess fuel use - at the current price of diesel it would equate to about \$20,000 per annum, and when the engine cost about \$23,000 that's a significant fuel saving we hope to make"

Figure 10: Ralph Grey and colleagues inspect a river pump at his property near Mungindi.



As a result of the course 5 other participants said they were going to measure the efficiency of their own pumps.

Narrative 4: Phillip Woodlands has been working in the irrigation industry for over 50 yrs. He attended a benchmarking and water budgeting workshop

"Most of us have measured our crop yield and the amount of fertiliser and compared this with our neighbours, but not many have actually measured the amount of water that moves around the farm. The Benchmarking workshop showed me how to compare my yields with other growers in the industry, and with the results I got last year I can see I am in the top ten percent, which makes it all worthwhile".

The following evaluations further support the increase in knowledge, awareness, skills and attitudes acquired by growers and consultants who attended the training workshops.

Surface Irrigation Performance Evaluation – Moree April 2008

Key facts:

- 8 people attended the Surface Irrigation Performance Evaluation workshop, 6 irrigators and 2 consultants.
- No participants were familiar with Sirmod output

- 3 participants were familiar with the Irrimate™ equipment
- 75% of growers moved from a low understanding to a medium understanding of surface evaluation.
- 75% rated furrow irrigation performance evaluation as important.
- All participants had an increased understanding of surface irrigation performance evaluation as a result of attending the workshop.
- 40% indicated that they have had fields assessed using Irrimate™, while the remaining 60% said they would be likely to undertake Irrimate™ efficiency assessments.

Surface Irrigation Performance Evaluation – Merah North April 2008

- Training workshop was conducted to increase the awareness irrigation variables that influence surface irrigation performance. Attended by 2 consultants and 7 growers
- 75% of growers moved from a medium understanding to a high understanding of surface evaluation.
- On rating the importance of evaluation 80% agreed that it was an important objective to have.
- 50% indicated that they have had fields assessed using Irrimate™, **while the remaining 50% said they would do Irrimate™ efficiency assessments on select fields if there were funds available.**

4.4.2 Centre Pivot Lateral Move Systems Training

The Centre Pivot Lateral Move (CPLM) Systems national training package has been developed by the Cooperative Centre for Irrigation Futures (CRCIF) of which NSW DPI is a core partner. This course has been developed for consultants and grower-managers currently using or contemplating purchasing a centre pivot or lateral move systems with an overall objective to improving on-farm irrigation performance and farm profitability. During the life of the *Advancing Water Management in NSW* project this course was successfully delivered to 103 industry players (e.g. irrigators, consultants and irrigation resellers).

Table 3: Centre Pivot Lateral Move (CPLM) Systems Training - Delivery

Date:	Location	Participants
20 th – 21 st Sept 2007	Goondiwindi	14
26 th – 27 th Sept 2007	Gunnedah	33
28 th – 29 th Feb 2008	Moree	20
10 th - 11 th June 2008	Hillston	19
25 th - 26 th June 2008	Gunnedah	17
Total CPLM workshops & participants	5	103

Both the Moree and Gunnedah CPLM courses generated considerable interest in machine performance evaluation. As a result additional farm walks were held to demonstrate the method to assess machine performance.

Outcomes

Greater knowledge, awareness, skills and attitudes of CPLM best practice irrigation management

The series of courses within the Border Rivers, Gwydir, Namoi and Lower Lachlan valleys received overwhelming endorsement from the irrigators who attended. Typical responses recorded include:

“I learnt an enormous amount – certainly enough to allow me to analyse the pros and cons of installing one on my property”.

“I will be going home and doing some crop water use sums to see if my system can handle a summer crop”

“I wish I had of been able to do this course before I purchased my pivot. Although, I’m happy with the machine I have, but I would have had a better understanding during the design and planning phases. I would have known what questions I needed to be asking”.

“We are looking at putting in a centre pivot and found the course most valuable in helping us decide whether or not to go ahead with it”.

“I’d like to send some of my staff to future courses. I have travelled from Roma for the course and the trip has been well worth it.”

Practice Change - Increased irrigation application efficiencies of existing CPLM machines

A number of participants stated that they would seek to assess the relative performance of their own CPLM machines.

“I gained a lot of information about full setting up of pivots and calibrating to maximise efficiency”.

“I didn’t realise these machines needed checking, I assumed once installed they would be doing what the specs said. I’ll definitely be carrying out an evaluation on my machine at home.”

Narrative 1: A system performance evaluation of a centre pivot machine was conducted by NSW DPI irrigation staff at the training workshop at ‘Midway’ Gunnedah. It was discovered that the system capacity at 8.6mm/day was inadequate to cope with peak crop water requirements. In addition, distribution uniformity (a measure of efficiency) was 74%, will below the industry benchmark of 90%. Based on the knowledge acquired in the training the manager has reportedly overhauled the aging machine to achieve a minimum operating efficiency of 90%.

Figure 11: CPLM Evaluation day farmwalk participants inspect a centre pivot near Gunnedah.



Narrative 2: A system evaluation day was conducted at ‘Keytah’ Moree in November 2007. A new lateral move machine was found to be performing below industry benchmarks for application efficiency. The owner subsequently instructed the supplier to rectify setup and infrastructure problems as identified by NSW DPI irrigation staff. In addition, an irrigation consultant from Tamworth was engaged by another 3 irrigators to conduct performance audits on their overhead machines. The following detailed narrative was documented by David Wigginton, NSW DPI.

Evaluation Narrative:

Title: Better management of Lateral move
Type of Change: changes in on-farm practice, changes in KASA, changes in participation
Recorded By: David Wigginton
Date: 29/02/2008

Story:

Nick is an agronomic consultant in the Gwydir Valley of NSW. He has been advising on irrigated crops for 8-9 years, and currently provides an irrigation scheduling service on a range of crops, primarily using C-probes.

One of the farms on which he works has recently purchased a Lateral move machine, which irrigates 1200 acres. Nick was keen to get a better understanding of how to manage irrigation under this machine and, in particular, to be able to check the machine performance and make appropriate recommendations.

Nick became involved with the Consultant Support Program component of the Irrigation Knowledge Management project. Following the initial development of an action plan for the 2007-08 season, Nick liaised with NSW DPI staff and a special event was organised to undertake a Lateral Move Evaluation as a demonstration and learning exercise. A number of other local consultants and growers were also invited to this event.

The demonstration day was attended by 20 participants (approximately ½ growers, ¼ consultants, ¼ service providers) all of whom helped conduct a catch can trial, check pressures, flow rates and machine speed to evaluate the performance of a lateral move machine. Attendees helped to collect and record performance data, before the group then undertook the basic analysis together.

Some of the participants comments collected during the day included:

“I didn’t realise these machines needed checking, I assumed once installed they would be doing what the specs said. I’ll definitely be carrying out an evaluation on my machine at home.”

“Its little things like tyre pressure that can affect performance that I hadn’t even thought of”

“It’s been a very worthwhile morning and shown me how simple, but important these checks can be. I’m interested in attending the CPLM training course.”

Following this event, Nick has revisited the test results and visited the machine with the grower in order to work through the results and make some changes. He intends to perform another evaluation to validate that the changes have improved the machine performance.

“The most important thing I think we learned is that you personally have to check all the items off that influence the application rate and uniformity, don’t take the installers word for it that it has been setup correctly” Nick

“Maybe worth getting a consultant in to assess the machine independently when the machine is commissioned.” Nick

“The changes we have made are: Correct the tyre pressures, calibrate the control panel to the actual application rate and repair nozzles that were broken or incorrect to the nozzle chart.” Nick

“I have measured flow rate and carried out calculations which I have used to calibrate the machine to the control panel.” Nick

Figure 12: Measuring sprinkler discharge to determine application efficiency at ‘Keytah’ Moree.



Outcome: Increased private sector knowledge and skills resulting in greater delivery of irrigation services.

As a result of the CPLM evaluation training, Mitch Carter AIMS Consultancy Wee Waa is planning to provide centre pivot and lateral move efficiency evaluation services to growers in the Namoi valley.

The *Irrigated Cotton and Grains* workshop training series was promoted by:

- Distributing flyers via mail to all registered Waterpak holders
- Writing advertorial media articles highlighting the positive feedback of growers who had attended the training.
- Advertisements of proposed courses in local newspapers
- Publicity at Cotton Consultants and local Cottongrower Association meetings, industry forums such as the Cotton CRC Science Forum and regional field days.
- Liaising with CMA staff to identify growers who had an obligation to attend training after cash incentives had been granted to upgrade irrigation infrastructure.
- Impending course dates were also posted on both the CottonCRC and Irrigated Cotton and Grains and CRCIF websites.

While the promotion initiatives listed above would appear to be far-reaching, the additional training demand and hence registrations proved to be somewhat limited. More success was achieved in working with individual agricultural consultants to encourage growers to participate, and therefore delivering courses on demand where a need had been identified.

Recommendation – Future extension projects and initiatives should use the irrigation training resource package developed by the Knowledge Management Project as a platform for

increasing grower knowledge and skills in the use of technology and management practices that generate greater water use efficiency.

Recommendation – Promotion of the training needs to be undertaken in partnership with industry and not left solely to government agencies. As suggested by the *Knowledge Management Final Report*, an annual calendar of training events should be considered (to complement the on-demand model). The use of consultants as trainers should also be fostered.

4.5 Water Use Efficiency Benchmarking

Objective 5 – To increase water use efficiency

Benchmarking seasonal irrigation water use is crucial if an irrigation enterprise is going to improve their water use efficiency. Knowing how you are performing compared to your region or wider industry facilitates continuous improvement in management and water use.

Unfortunately irrigation benchmarking data has in the past not been well recorded. Compounding the lack of data, performance indicators used are generally not well defined and calculations have often been inconsistent across the industry making individual comparison meaningless. In consultation with CRDC and the CCCRC, the AWM project team undertook a benchmarking study using WaterTrack™ Rapid, (a new online benchmarking tool) with an aim to:

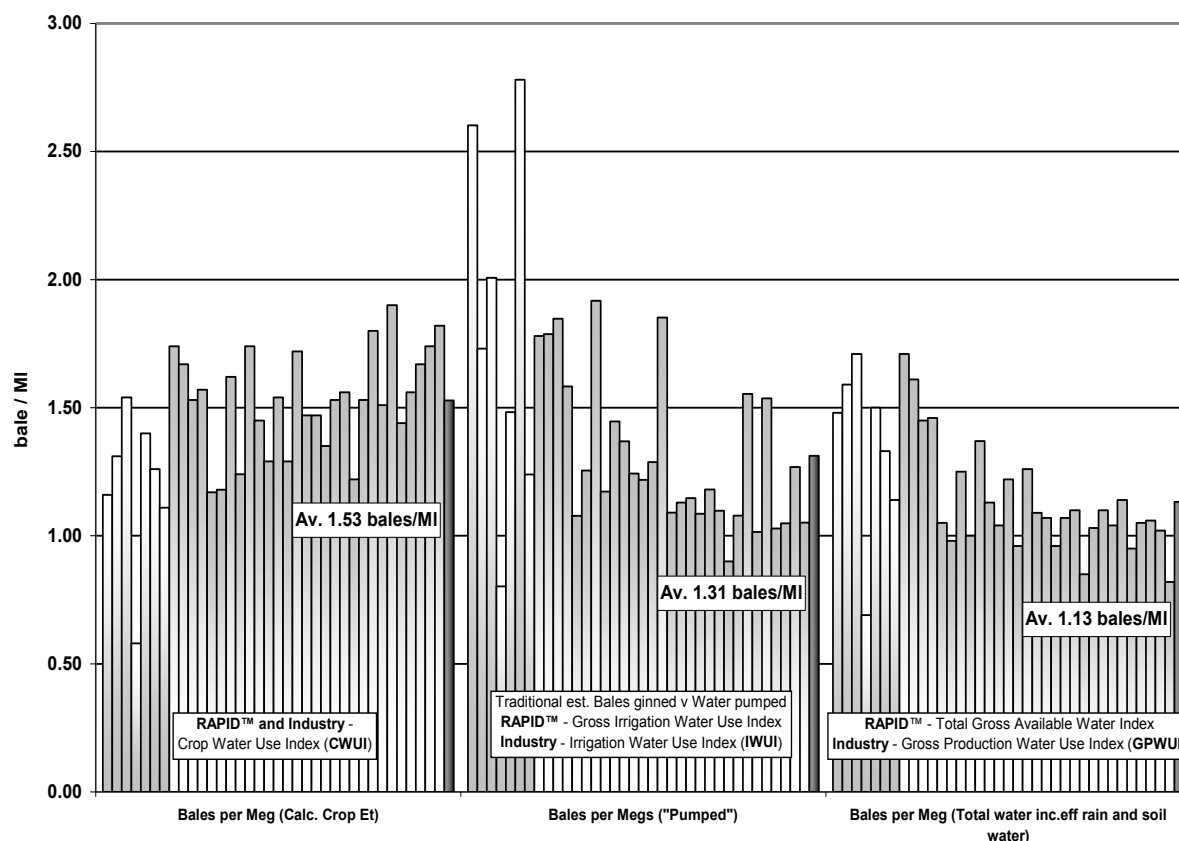
- Create awareness of the benefits of WUE benchmarking
- Create awareness of the industry approved indices for monitoring and recording water use efficiency
- Collect good quality water use efficiency data to assist industry monitor productivity improvements over time
- Promote decision support tools and online WUE benchmarking tools in general, and
- To satisfy the requirements of the CCCRC Namoi CMA sub-contract. (Baseline data required for use in evaluating water use efficiency improvements in the Namoi valley).

4.5.1 WaterTrack™ Rapid

In an effort to stimulate adoption of current industry standards for recording water use efficiency, project staff conducted personal interviews on 42 farms from Emerald in central Queensland to Hillston in southern NSW to establish current WUE benchmarks for the cotton industry.

Water use figures for the 2006/2007 cotton season were collected using Aquatech Consulting's online calculator WATERTRACK RAPID™. This water balance model provides a simple approach to rigorous calculation of essential irrigation performance indicators. This water use benchmarking tool generates a report allowing an individual to compare their performance against the regional or industry average. Irrigators can compare their yields, total water used, irrigation water used and total farm water losses.

Figure 13: WUE Benchmarks for the Cotton Industry (2006-07)



These results are consistent with a separate literature review also conducted by this project. Based on the findings of previous surveys, both literary and anecdotal evidence suggest that in 2006-07 80% of Namoi cotton growers had a water use efficiency around 1bale/ML of applied water, while the top 20% of growers produced 1.5 bales/ML.

The WaterTrack Rapid™ benchmarking study received an overwhelming endorsement from not only the growers who participated, but from the irrigation industry as a whole.

Grower Comment - “This is exciting information. In the future I think it will be important to quantify and justify our water use and use a standard method of calculating water use numbers across the industry”.

Irrigation Industry Comment – ‘This is the best set of water use efficiency data the cotton industry has seen in years’. (Guy Roth – Program Manager, National Program for Sustainable Irrigation)

The results from the study were presented in the Australian Cottongrower Magazine and at the 2008 Australian Cotton Conference.

Recommendation – **To document the continual water use efficiency and productivity improvements within the cotton industry it is of the highest importance that a similar benchmarking study be conducted with the same growers in the original 2006-07 study, and expanded to include other growers to assess the relative water use efficiency of irrigated grains.**

4.5.2 Other Industry Benchmarking Initiatives

A survey of cotton consultants was conducted in late 2006 to establish baseline data for the type and abundance of irrigation services offered to growers. The snapshot of the consultancy base within the cotton industry revealed:

- 95% of consultants interviewed offered a form of *Irrigation Scheduling Service* to their clients, and 83% of total clients accessed this service.

- 63% of consultants provided a benchmarking service with varying degrees of confidence due to the limited amount of actual measured in-field water use available on farm, and only 17 % of total clients accessed this service when offered.
- 27% of consultants provided in field irrigation evaluation service, and in total 19% of clients accessed this service.

The original aim was to conduct a similar survey every 2/3 years to establish the effectiveness of extension strategies in generating increased adoption of new technologies and a greater number and diversity of irrigation services.

Recommendation – It would be beneficial for future extension projects to consider resurveying consultants to establish changes in the quantity and types of irrigation services available to growers.

Objective 8 – Enhance Waterpak and BMP guidelines for furrow irrigation

Unfortunately the revision of furrow irrigation BMP guidelines did not take place due to time pressures and the lack of a furrow irrigation performance evaluation database. A comprehensive dataset is required with a variety of performance measures on differing soil types and crops to enable the development of representative guidelines. Delays in the National Centre for Engineering in Agriculture (NCEA) establishing a database were attributed to the delay in acquiring industry funds to support the initiative.

A new NSW DPI extension project funded by the CRDC, GRDC, and National Program for Sustainable Irrigation (NPSI) is currently being negotiated. Within this project a full upgrade of Waterpak incorporating other irrigated industries will be scoped. CRDC agreed that the process of upgrading the entire content of Waterpak is a considerable task. To facilitate the upgrade a new project will need to be developed and funding sourced to potentially employ a project officer. The timing of the full upgrade is yet to be determined. It is envisaged that the furrow irrigation guidelines will be upgraded as part of this exercise.

This project has cooperated with the National Centre for Engineering in Agriculture (NCEA) by providing Irrimate™ surface irrigation performance data to assist in the development of the Irrimate Surface Irrigation Database (ISID). It is expected that this database will allow industry to accumulate high quality water use efficiency data and enable growers to benchmark their field application efficiencies to both growers in the cotton industry and to those in irrigated grains.

Similarly, pressurised irrigation performance evaluation data has been provided to the NCEA to test the Irrigation Performance Audit Reporting Tool (IPART). This database will allow relative efficiencies of pressurised systems to be compared within and across industries.

4.6 Economic and Cost Benefit Analyses

Objective 9 - Improve growers' awareness of costs for practices and systems that improve water use efficiency

In an effort to increase both growers' and industry's awareness and knowledge of the financial benefits of investing in technology adoption and practice change, 2 economic case studies were produced with the assistance of a NSW DPI economist. Articles were posted on the Irrigated Cotton and Grains website and published as simply worded articles in the Australian Cottongrower magazine. Materials were also distributed at irrigation training workshops and at farm walks and field days.

4.6.1 Irrimate™ - Surface Irrigation Performance Evaluation Cost Benefit

The cases studies are summarised below.

In 2001 Oakville Pastoral Company, Narrabri made a decision to further improve the irrigation performance of their farm by undertaking irrigation efficiency analyses using Irrimate™ equipment.

In summary significant improvements in application efficiency were identified by halving the field length. While the cost of redeveloping the field was approximately \$358/Ha, the economic benefits in terms of water savings and yield improvement were in the order of \$564/Ha.

Based on this analysis it is evident that this type of investment paid for itself in the first year. Furthermore it was shown that increased surface irrigation application efficiency could potentially add up to \$280,000 to the overall farm budget in 10 years.

4.6.2 Pump Efficiency – Cost Benefit of Redevelopment

To save money it is important to have pumps working at maximum efficiency. If the installation is incorrect, it may also affect pumping capacity and the performance of the entire irrigation system, reducing irrigation efficiency and productivity.

Auscott at Moree started investigating why a particular pump was delivering 40% less water volume compared to its theoretical optimal capacity. It was discovered that the pump had been installed incorrectly and it was decided that a full overhaul of the pump, power plant and pump installation was essential to increase pumping capacity, reduce operating costs, and deliver water to the fields in a timely manner.

A detailed cost benefit analysis was conducted by the NSW DPI CottonCRC Water Team and the results disseminated to industry by inclusion in the Australian Cottongrower magazine and by uploading of the case study to the *Irrigated Cotton and Grains* website.

In summary, investment in more efficient infrastructure lead to an increased pumping capacity from 60ML/day to 90ML/day, and diesel consumption decreased from 45 litres/hr to 35 litres/hr. In addition the redevelopment of the pump site enabled 350 hectares to be irrigated in approximately 5 days instead of 12 days. Redevelopment costs totalled \$49,650.

The actual returns from savings in labour and diesel costs amounted to \$65,565 (excluding yield benefits) and hence the investment was recouped within 1 year. Furthermore it was estimated that the net present value after 10 years would be around \$615,000.

Anecdotal evidence suggests that the dissemination of this information to industry has stimulated greater interest in pumping efficiency, and a growing number of irrigators seeking expert advice with the aim of reducing farm operating costs.

Documented Evidence of Practice Change

Irrigation Training - Greater awareness of the economics of pumping was also generated at a number of pumping workshops held in Mungindi, Walgett, and Mullaley. At each workshop the co-operator's pump was assessed to ascertain its efficiency and typical operating costs. At the Walgett workshop it was discovered that a river pump was only operating at around 42% efficiency. It was subsequently demonstrated that with fine tuning and a reduction in suction head, pump efficiency could be increased resulting in a \$38,000 saving in annual pumping costs.

A similar story occurred at the Mungindi workshop. The irrigator whose pump site was used for example data had recently purchased a new engine to improve pump performance. Pump efficiency calculations found that the pump was only performing at 69% efficiency, well below what its theoretical optimal efficiency of 85%. The irrigator said he would repeat water flow and fuel consumption measurements then repeat calculations he had learnt during the workshop to confirm pump efficiency before speaking to his engine supplier.

It was also noted at the workshop that none of the participants had ever carried out pump efficiency calculations. Only 1 participant had measured fuel consumption and flow rate in ML/hr from his pump. A number of participants had electric power units at their pump site but none of them had ever measured their electricity usage.

As a result of attending the training:

- One participant indicated that as a result of this course, that he would go home and measure his electricity usage.
- All participants agreed that it was important to check their pumps/engines performance.
- 5 participants at the Walgett workshop indicated that they would endeavour to assess their pump performance as a matter of priority.

Grower Comment: “Showed me how its important to assess pump efficiency, and the fuel savings can be significant if the pump is not running above 65% efficiency.”

4.7 Soil Monitoring in the Macquarie Valley

Objective 11 - Quantify in-field production impacts from previous low irrigation uniformity and efficiency

‘The risk of salinity having a major impact on cotton production in NSW has generally been considered to be low. However, given the above scenario and recent electromagnetic induction (EMI) surveys conducted in the Namoi, Gwydir and Border Rivers by the Cotton CRC have highlighted the increase in the incidence of localised salinity. This increase in localised salinity has been associated with excessive drainage from irrigation channels and storages. There is no evidence; however of broad scale increase in salinity, but recent research conducted by the Australian Cotton CRC, NSW DPI, NSW DIPNR and Macquarie 2100 in the Macquarie Valley has highlighted this region as a potential high-risk area for salinity.’ (Extract from *Whole Farm Salinity Management Strategies for Cotton Production in the Macquarie Valley*, CRDC Final Report 2004)

In 2003 the *Whole Farm Salinity Management Strategies for Cotton Production in the Macquarie Valley*, CRDC Project Number: CRC 51C established five long term monitoring sites in the Lower Macquarie Valley. These sites are allowing the long term monitoring of deep drainage and changes to the salt store in the major irrigated cotton growing soils.

The Advancing Water Management Project provided funds to enable monitoring to continue in 2006 and 2007. Detected changes in key soil chemical properties can be used to assess the long term effect of irrigation water quality, crop and water management on the productivity and sustainability of irrigated cotton farming systems in the Lower Macquarie Valley.

Results

A brief examination of the 2007 soil and water analyses suggest that sodium and chloride concentrations increase during the irrigation season but decrease during the winter (non-irrigation season). Presumably this is due to leaching of the salts out of the crop root zone with winter rainfall. In time, it is likely that they will move into groundwater reserves. However, there is considerable variation among locations due to variation in soils (texture, ESP etc.) and cropping systems.

Nilantha Hulugalle (soils researcher based at the Australian Cotton Research Institute, Narrabri) will conduct a more detailed analysis of the results including estimation of deep drainage with a chloride mass balance model in early 2009. The results will be presented at technical and industry conferences and workshops such as the ACGRA Cotton Conference and published in technical journals.

5. Conclusions and Recommendations

There is documented evidence that the training resulted in growers having a greater knowledge and understanding of irrigation best practice, and has lead to genuine practice change. Increased adoption of technology, better water management techniques, and investment in new infrastructure facilitates improvement in whole farm water use efficiencies.

Workshop participation also led to many growers applying for water use efficiency incentives available from Catchment Management Authorities. In the Namoi valley alone, this translated to approximately 5111Ha coming under best practice water management.

A third outcome from the irrigation training was an increase in awareness of the Cotton BMP program. Growers were encouraged to consider the advantages of obtaining formal recognition of their best practice. Between October 2006 and July 2008 Cotton Australia conducted a total of 35 and 20 Land and Water Pre-Certification Audits in the Namoi and Gwydir Valleys respectively. Based on these PCA numbers, in the Namoi the *Advancing Water Management* project contributed to an additional 13,614 ha being managed and irrigated according to best practice.

Irrimate™ hardware and WaterTrack™ Optimiser software demonstrations were initiated to showcase how decision support tools could assist growers to manage and measure water more efficiently. Knowledge and awareness of surface irrigation performance evaluation particularly has increased and practice change is now being documented within the cotton industry. Many growers have begun to reconfigure fields to minimise losses, and shorten irrigation times to optimise field application efficiencies. The demonstration of the WaterTrack™ software and storage seepage/evaporation meters also increased awareness of the magnitude of storage losses currently being experienced on irrigation farms. A growing number of growers are now either raising storage bank heights or consolidating water storage to minimise evaporative losses.

Adoption of current industry standards for recording water use efficiency is gaining momentum. As outlined in the section 4.4.1 many growers who participated in the training workshops indicated that they intended to change how they measured water use efficiency. Growers have also gained a greater appreciation of the benefits of benchmarking. The 42 growers who participated in the WaterTrack™ Rapid benchmarking survey overwhelmingly endorsed the initiative, and a majority stated the exercise was highly beneficial for their farm business.

At a higher industry level, the compilation of high quality cotton water use efficiency data will enable industry representatives (e.g. Cotton Australia) and government policy makers to make sound policy decisions based on facts and not estimates. Establishing water use efficiency benchmarks (1.31 bales/ML -water pumped or 1.13bales/ML – including stored soil moisture and effective rainfall), will enable industry to monitor and determine the magnitude of cotton industry water use efficiency gains in coming years. The results also showed that cotton growers should be aiming for at least 1.5bales/ML (furrow irrigated) as an industry target.

Summary of Key Recommendations and Future Research Priorities

1. Reduced farm incomes, coupled with chronic labour shortages have reduced the cotton industry's ability to embrace the benefits of furrow irrigation performance evaluation. Research and development needs to focus on technologies that will allow the automation of furrow irrigation systems to reduce labour costs.
2. Those developing water management software and decision support tools need to consider the following:
 - Minimise the purchase cost or licence fee. If access to the tool is expensive then it has to be demonstrated that the potential benefits from improved water management exceed the annual cost.
 - Reduce the operational complexity so 'average' irrigators or consultants have the confidence and ability to operate the software.
 - Reduce the labour input where possible. Adaptation of existing remote sensing technologies is desperately required to gather the necessary input data to minimise labour input by the grower or consultant.
 - Growers and consultants need to be included more in the development phase. It's important to know what the industry needs and in what format or skill level.
 - Too often decision support tools require input data that is not easily accessible by the average grower. Typical examples include soil moisture, which is usually expressed as a deficit (mm) or Plant Available Water (mm). Unless a soil

characterisation has been conducted in the field in question then it usually comes down to an educated guess by the grower or consultant. Growers often see decision support tools as too hard. If adoption is to succeed then the input data needs to be both easily collected and low cost. Further research and development of technology is urgently required to allow these types of parameters to be determined more easily.

3. Future extension programs should target on-farm storage management and infrastructure improvement to generate significant improvements in cotton industry water use efficiency.
4. Future extension projects and initiatives should use the irrigation training resource package, developed by the Knowledge Management in Irrigated Cotton and Grains project, as a platform for increasing grower knowledge and skills in the use of technology and management practices that generate greater water use efficiency.
5. Promotion of the training needs to be undertaken in partnership with industry and not left solely to government agencies. As suggested by the *Knowledge Management Final Report*, an annual calendar of training events should be considered (to complement the on-demand model). The use of consultants as trainers should also be fostered.
6. To document the continual water use efficiency and productivity improvements within the cotton industry it is of the highest importance that a similar benchmarking study be conducted with the same growers in the original 2006-07 WaterTrack™ Rapid study, and expanded to include other growers to assess the relative water use efficiency of irrigated grains.
7. It would be beneficial for future extension projects to consider resurveying consultants to establish changes in the quantity and types of irrigation services available to growers.

6. Publications

Conference Papers and Presentations

- Parr, E.J., Smith P., Montgomery, J., Jackson, R.** (2008). Water use efficiency in the NSW cotton industry – an industry approach. Irrigation Australia Conference, Melbourne, 20th-23rd May 2008.
- Jackson, R.** (2008). Adaptation to Climate Change - Irrigation and water use efficiency extension by NSW DPI/CottonCRC water team. Cotton Catchment Communities Cotton Links Forum, Dubbo 29th May 2008.
- Jackson, R.** (2007). Advancing water management in NSW. Cotton Catchment Communities CRC Science Forum, 8-9th August 2007.
- Wigginton, D. and **Smith, P.** (2008). Building capacity for delivery of commercial irrigation services: A case study in the cotton and grains industries. Irrigation Australia Conference, Melbourne, 20th-23rd May 2008.
- Williams, D. and Montgomery, J.** (2008). Bales per Megalitre – An Industry Wide Evaluation of the 2006/2007 season. Australian Cotton Conference, Gold Coast, Queensland, 12-15th August 2008.

Magazine Articles

- Brotherton, E., Harris, G., **Smith, P.** and Wigginton, D. (2008). Deep drainage myth-busters. *The Australian Cotton Grower*, Volume 29, No. 4, August – Sept. 2008, pp. 38-42.
- Jackson, R.** (2008). Economic benefits of performance evaluation. *The Australian Cotton Grower*, Volume 29, No. 3, June– July 2008, pp. 26-28.
- Jackson, R.** (2007). Undertaking a whole farm water balance. *The Australian Cotton Grower*, Volume 28, No. 7, Dec 2007 – January 2008.
- Ferguson, N. and Montgomery, J.** (2007). Water trial measures efficiency” *Cotton Outlook*
- Montgomery, J.** and **O’Halloran, J.** (2008) A comparison of water use between solid planted and on-in-one-out skip, *The Australian Cotton Grower*, Volume 29, No. 3, Jun- Jul 2008, pp.21-25.
- Montgomery J.** and Brotherton, E. (2007) EM survey for probe placement. *The Australian Cotton Grower*, Volume 28, No. 6, Oct- Nov 2007.
- Montgomery, J.** (2007). Water: Measure and Manage. CRDC Spotlight, Winter 2007
- Montgomery J.** and Wigginton, D. (2007). Evaluating Furrow Irrigation Performance’, *The Australian Cotton Grower*, Volume 28, No. 7, Dec 2007 – December 2007.
- Montgomery J.** (2007) Water: Measure and Manage. *Spotlight*. CRDC Publication, Winter 2007, pp18-19.
- Montgomery, J.** and O’Halloran, J (2007) A comparison of water use between solid planted cotton and on-in-one-out skip planted cotton, *Gwydir Valley Cotton Season & Trial Book 2006/07*. NSW DPI and Cotton Catchment Communities CRC Publication.
- Reynolds, M., **Jackson, R., Montgomery, J. & Bray, S.** (2008) Improving pump installation for efficiency. *The Australian Cotton Grower*, Volume 29, No. 3, Jun- Jul 2008, pp. 29-31.
- Smith P.** (2008) ‘How to evaluate the performance of CP&LM systems’, *The Australian Cotton Grower*, Volume 29, No. 1, February-March 2008, pp. 14-16.
- Smith P.** (2008) ‘Why should you evaluate your CP&LM systems? – A case study of test results’, *The Australian Cotton Grower*, Volume 29, No. 1, February-March 2008, pp.17-18.
- Smith, P.** (2007) ‘Seepage – what can you do about it?’ *The Australian Cotton Grower*, Volume 28, No. 6, Oct- Nov 2007, pp. 38-39.
- Wigginton, D. (2008) ‘Evaluating surface irrigation performance’, *The Australian Cotton Grower*, Volume 29, No. 1, February-March 2008, pp. 18-21.
- Wigginton, D. and **Smith P.** (2008). The value of storage surveys – Could you live with a 22% error? *The Australian Cotton Grower*, Volume 29, No. 2, April-May 2008, pp. 38-40.
- Williams, D. and **Montgomery, J.** (2008). Calculating and comparing bales per megalitre. *The Australian Cotton Grower*, Volume 29, No. 4, August - Sept. 2008, pp. 43-44.

Journal Articles

- Smith, P.** 2008, ‘How to make sense of pump curves’, *Irrigation Australia Journal*, Vol 24, Autumn 2008, pp. 16-17.

Newspaper Articles

- Bray, S.** (2007) Irrimate Trial, Quirindi Advocate 19/11/07.
- Bray, S.** (2008), 'Cotton Grains Irrigation Workshop Series - Scheduling', Northwest Magazine, 11/02/08.
- Bray, S.** (2008), 'Cotton Grains Irrigation Workshop Series', Advertorial circulated into various newspapers in the Gwydir, Namoi and Macquarie Valleys
- Jackson, R.** (2008), 'Any means necessary', Agriculture Today, Department of Primary Industries Publication, The Land Newspaper, February 2008.
- Montgomery, J.** (2008), 'New Website launched to improve accessibility of irrigation information', Countries Eye with DPI, Border News Newspaper, 04/03/08
- Montgomery, J.** (2008), 'Optimising Irrigation Performance', Countries Eye with DPI, Border News Newspaper, 21/01/08
- Montgomery, J.** (2007) Improve water use efficiency by measuring, Agriculture Today, June 2007, NSW Department of Primary Industries.
- Montgomery, J. and Smith P.** (2007) Taking care of dry storages, Agriculture Today, September 2007, NSW Department of Primary Industries.
- Montgomery, J.** Brotherton E, Wigginton, D. (2007) Correctly placing moisture probes, Agriculture Today, November 2007, NSW Department of Primary Industries.
- Smith, P., Atkins, D. and Montgomery, J.** (2008), 'Moree Farmers learn about effective water management', Border News Newspaper, 11/03/08

Newsletters

- Jackson, R.** (2008). Watertrack™. Determining farm water losses. Lower Namoi Valley Cotton Association Newsletter, 17/1/08.
- Jackson, R.** (2008) Calibration of capacitance probes. Lower Namoi Valley Cotton Association Newsletter, 08/11/07.

Cotton Tales

- Montgomery, J.** (2007). CPLM course promotion. Cotton Tales 19/12/07.
- Montgomery, J.** (2007). C-probes, do probes need to be calibrated in the field. Cotton Tales 1/11/07.
- Montgomery, J.** (2007). Border Rivers Gwydir CMA Incentives. Cotton Tales 10/10/07.
- Montgomery, J.** (2007). CPLM Course and Border Rivers Gwydir CMA Incentives. Cotton Tales 28/08/07.
- Montgomery, J.** (2007). Dry Storage Management. Cotton Tales 23/07/07.

Electronic Publications

- Jackson, R.** (2007), 'Undertaking a whole farm water balance', Cotton and Grains Irrigation Website. <http://www.cottonandgrains.irrigationfutures.org.au/news.asp?catid=3>
- Montgomery J** and Brotherton, E. (2007) 'EM survey for probe placement', Cotton and Grains Irrigation Website. <http://www.cottonandgrains.irrigationfutures.org.au/news.asp?id=132&catid=60>
- Montgomery J,** Wigginton, D. (2007), 'Evaluating Furrow Irrigation Performance' Cotton and Grains Irrigation Website. <http://www.cottonandgrains.irrigationfutures.org.au/news.asp?catid=3>
- Montgomery, J. and Smith P.** (2007) 'Dry storage management', Cotton and Grains Irrigation Website, <http://www.cottonandgrains.irrigationfutures.org.au/news.asp?catID=16>
- Reynolds M. and **Jackson, R.** (2008), 'Economic Benefits of Performance Evaluation, A case study', Cotton and Grains Irrigation Website. <http://www.cottonandgrains.irrigationfutures.org.au/news.asp?id=133&catid=46>
- Reynolds, M., **Jackson, R., Montgomery, J. & Bray, S.** (2008) Improving pump installation for efficiency, Cotton and Grains Irrigation Website
- Smith, P.** (2007) 'How to minimise losses?' Cotton and Grains Irrigation Website <http://www.cottonandgrains.irrigationfutures.org.au/news.asp?id=130&catid=59>
- Smith, P.** (2007) 'Seepage – what can you do about it?' Cotton and Grains Irrigation Website. <http://www.cottonandgrains.irrigationfutures.org.au/news.asp?id=128&catid=59>

7. References

Coutts, J&R. (2008) Knowledge Management in Irrigated Cotton and Grains (Phase 2). External Evaluation Report.

Mitchell, D. (2004) Whole Farm Salinity Management Strategies for Cotton Production in the Macquarie Valley. CRDC Final Report.

Smith, P. and Wigginton, D. (2008) Knowledge Management in Irrigated Cotton and Grains – Stage II Final Report. National Program for Sustainable Irrigation, Canberra

Tennakoon, S.B. and Milroy, S.P. 2003. Crop water use and water use efficiency on irrigated cotton farms in Australia, *Agricultural water management*, vol. 61, pages 179-94.

Wigginton, D. and Smith, P. (2008) Knowledge Management in Irrigated Cotton and Grains – Stage II Report of Findings, NSW DPI, Orange