

Water use efficiency in NSW the cotton industry - an industry approach

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Abstract

NSW DPI is working with the NSW Cotton industry (growers, ACGRA, CRDC, Cotton Catchment and Communities CRC, Catchment Management Authorities, Cotton Australia, Cotton Consultant Association, etc) to lift industry water use efficiency through a coordinated industry approach to advisory and education/training services in water use efficiency (WUE) incorporating 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. This project is contributing to a 15% increase in whole farm water use efficiency over the next five years by irrigation in the Namoi Valley and other valleys. The project is also including development and delivery of economic information on irrigation systems and management to assist cotton grower adoption of improved systems and management.

Results of the use of evaluation technology are indicating that irrigated cotton and grains growers are achieving high levels of efficiency however a more active approach to irrigation management will take their in-field efficiency into the high 80 – low 90% range. For those who have opted for technology upgrades to lateral move/centre pivot irrigation systems these need to be evaluated as soon as they are installed as some recent results have indicated that designs are not translating into high range DUs the systems are capable of.

At the same time, the use of whole farm water balance models are indicating that inefficiency in the water storage system far outweighed any improvements in in-field efficiency. As a matter of priority farmers should therefore evaluate the use and management of their on-farm water storage systems best use to determine the best use of them to minimise evaporative and seepage losses. Actions that farmers may take include dividing larger storages into smaller cells with ancillary pumping capacity and the installation of additional bores to minimise the amount of time water is in storage.

Introduction

NSW DPI is working with the NSW Cotton industry (growers, ACGRA, CRDC, Cotton Catchment and Communities CRC, Catchment Management Authorities and Cotton Australia) to lift industry water use efficiency through a coordinated industry approach to advisory and education/training services in water use efficiency (WUE). The project involves demonstrations and trials of new and existing technologies to improve water use efficiency on-farm and the delivery of the Cotton and Grains Irrigation Workshop Series that incorporates Cotton industry's BMP guidelines and assists Catchment Management Authorities to achieve Catchment Action Plans and Investment Plan targets relevant to the cotton industry.

With Irrigation Officers located in each of the cotton irrigation valleys, there is support available to assist irrigators in their region to improve on farm water management and water use efficiency. They provide information to increase grower knowledge of new

technologies, provide on-farm demonstrations of water management and monitoring systems and delivering training workshops for professional development of consultants and farm managers. This project is contributing to a Cotton catchment and Communities CRC target of 15% increase in whole farm water use efficiency over the life of the CRC.

Summary

Benchmarking irrigation is crucial if an irrigation enterprise is going to improve their water use efficiency. Knowing how you are performing compared to your region or industry enables continuous improvement in management and water use. Unfortunately irrigation benchmarking data has in the past not been recorded well. The performance indicators measured are generally not well defined and calculations have not been standard across the industry. We talk about water use efficiency and all the other terms but what do we mean? The cotton industry has been developing an on-going process to capture water use information from growers and consultants. There is currently web based tools available to collect this information, including the Water Benchmarking Tool (Cotton Community Catchments CRC and CRDC 2007) and the commercially available Watertrack™ Rapid. The significance of these tools is that calculations of water use indices are standardised and are defined.

Recently NSW DPI collected water use data from almost 30 cotton irrigation farms for inputs to Watertrack™ Rapid. This is the first time that this type of data has been collected by the one person in a standard fashion. It took no more than two hours to collect the information from any individual and while all data remains anonymous, the software generates a report that allows an individual to compare their performance against the average for growers where data was collected within their region or they can compare their performance to the industry average. Irrigators can compare their yields, total water used (water diverted from river and/or bores, water harvested on farm, effective rainfall and soil moisture), irrigation water used and total farm water losses (seepage and evaporation from storages + distribution system + fields). A number of irrigation performance indicators are calculated including Gross Production Water Use Index (GPWUI), Irrigation Water Use Index (IWUI) and Crop Water Use Index. This data not only provides benchmarking data to the individual, but continued collection of this data over time enables the cotton (irrigation) industry to show how it is improving and the rate of improvement in water use efficiency.

Preliminary data from 26 farms shows a wide range in irrigation performance across the industry. Water losses on farm range from virtually nil to just over 4ML/green Ha, with an average loss of around 2ML/green Ha. This was around 23 percent of the total water inflows (water diverted from river and/or bores, water harvested on farm and effective rainfall). The average GPWUI was 1.2bales/ML, ranging between 0.8 and 1.9bales/ML. The cotton irrigators that provided information were very interested and there was much discussion about the figures calculated in the Watertrack™ Rapid reports. Some were keen to know *“where this data was going?”* *“Why was it being collected?”* *“This data could be dangerous”*. These comments show that the industry is still cautious about providing this data. However there was also good discussion about the amount of water lost on farm, where the losses were occurring and the why the differences in water use indices. *“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”*

Determining where water is used and lost across a whole farm can be a challenging exercise however, identifying where losses are occurring is fundamental to achieving

greater farm water use efficiency. Whilst it is possible to perform some basic calculations at the whole farm level, it can be quite difficult to partition water use and loss to different components of the irrigation system.

Watertrack™ Optimiser is a software package that allows irrigation managers to monitor water movements around the farm and identify how much water is available on a daily basis. The program is able to predict crop water use and calculate evaporation and seepage losses in different components of the irrigation system.

Members of the Cotton Communities Catchment CRC Water Team undertook two demonstration trials using Watertrack™ Optimiser in the Namoi and Macintyre Valleys (Jackson, 2008). For both farms almost 60 per cent of the water was used during crop evapotranspiration. The remaining 35 – 40 per cent was lost from the system. Storage losses accounted for 22 per cent in the Macintyre and 12 per cent in the Namoi. Minor losses occurred from supply channels, tail drains and fields. These growers can look at the results for their farm and see where they should be focusing their efforts for improved water management or perhaps elements of their irrigation system that need further investigation. *“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.*

It is well documented that losses from storages, especially evaporation losses are the largest within the irrigation system. Results from whole farm water balance models are also indicating that inefficiency in the water storage system far outweighed any improvements in in-field efficiency. As a matter of priority farmers should therefore evaluate the use and management of their on-farm water storage systems to determine the best use of them to minimise evaporative and seepage losses.

Seepage and Evaporation Meters are being used within the industry. Quantifying storage losses allows irrigators to conduct a cost/benefit analysis to determine if remedial actions are justified. Further research is required to reduce evaporation losses from large (>10Ha) storages. Chemical monolayers are the only economic option at present, but their performance is reduced with windy conditions, UV radiation and algae (NCEA [Evaporation Control](#)). Research is currently being funded through the Cotton Communities Catchment CRC, Irrigation Futures CRC and Polymers CRC to fast track the chemistry of monolayers and monitoring their application and ‘stayfastness/stickability’ to improve their performance in reducing evaporation.

Many irrigators have already or plan to increase the wall height of their storages and/or divide larger storages into smaller cells to allow for active storage management to reduce overall evaporation and seepage losses. The Border Rivers Gwydir Catchment Management Authority received several applications for their water use efficiency incentives for on-ground works that involved reconfiguration of on-farm storages to reduce water losses.

Although the largest water losses are from storages, there are opportunities to increase water use efficiency at the field level. Over the 06/07 season, 47 furrow irrigation performance evaluations were conducted across 9 farms in the Gwydir and Namoi Valleys (Montgomery & Wigginton, 2007). Individual irrigation events were evaluated using Irrimate™ based on the grower’s usual management practices.

The results show there is still considerable room for improving irrigation performance of furrow irrigation systems. About 35 per cent of irrigations had an application efficiency of less than 80%. An application efficiency of 80% should be considered as a standard for minimum performance. Over half of the measured events had a requirement efficiency

of less than 100 per cent, indicating that deficit irrigation was occurring. This does not need to be of concern, as deficit irrigation usually results in reduced deep drainage potential and increased capacity to capture rainfall, although the irrigation interval must be shortened and management must be precise. Interestingly, for the events measured application efficiency was most often high when deficit irrigation was occurring. In contrast a high requirement efficiency often resulted in lower application efficiency. Distribution uniformity was high with 64 per cent of the events having a distribution uniformity greater than 90 per cent. However, a high uniformity does not guarantee an efficient irrigation and often more water was applied than necessary to achieve such uniform applications.

Importantly, the evaluations also show that high application efficiencies are achievable under furrow irrigation; in fact 45 per cent of events evaluated had an application efficiency of over 90 per cent. Undertaking a performance evaluation of these efficient fields is just as critical as a poorly performing field. As many growers seek to change their irrigation practices it is imperative to ensure that any change is actually worth undertaking. A change in practice without first measuring current performance can lead to a decrease in efficiency.

It was found from the evaluations that improvements at the field level were achieved with changes in simple management practices, in particular the flow rate, whether it be increasing flow rate by doubling siphons or increasing the height of water in the head ditch, and/or reducing the time of the irrigation by pulling siphons earlier. Maintaining a constant flow rate, making sure siphons are discharging below the water level in the rottobuck, along with rottobuck placement is also important for improving irrigation performance.

Modifying an irrigation event to improve application efficiency also led to savings in the amount of water applied. The amount of water applied was reduced by up to 0.41 ML/ha/irrigation, with the average reduction 0.18 ML/ha per irrigation event. (This compares well with the average 0.2ML/ha achieved by Aquatech for their evaluations.) These savings were achieved simply by changing flow rate and cutoff time. Although 0.18ML/ha/irrigation may not sound a lot, over 500 ha and seven irrigations, this would amount to a total saving of 630 ML. This could grow an extra 80 ha cotton or provide enough water for one irrigation cycle on this farm. Alternatively this water could be traded if the farm is land constrained.

“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 1

“The most challenging aspect was 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”. Grower 2

“With the aim to produce more bales of cotton for every ML we use, the irrigation evaluations carried out this season enabled us to gain an important insight into what was actually happening at a field level” Consultant

Delivery of training remains an integral step in improving water use efficiency within the industry. The Cotton and Grains Irrigation Workshop Series was developed following consultation with industry through the first phase of the Cotton and Grains Irrigation Knowledge Management Project. A key recommendation of this phase was the

development of concise, detailed, practical irrigation training, targeted at a level suitable for consultants and managers. The Cotton and Grains Irrigation Workshop Series contains 7 modules: Irrigation Benchmarking and Water Budgeting; Scheduling I; Scheduling II; Pumps; Surface Irrigation Performance Evaluation; Storage and Distribution Systems and Metering. The workshop series is mapped to National Training Competencies and aligned to the Cotton BMP Land and Water Module and build on the Cotton industry's WATERpak publication. To date 21 workshops have been delivered across all cotton valleys with a total of 185 participants. Significant outcomes have been recorded from the workshops:

75 per cent of course participants at a Benchmarking and water budgeting workshop at Walgett said as that they will use benchmarking and water budgeting in their future farm planning.

At a Surface Irrigation Performance Evaluation Workshop at Wee Waa – 75 per cent of growers moved from a medium understanding to a high understanding of surface evaluation. On rating the importance of evaluation 80 per cent of participants agreed that it was important. 50 percent indicated that they have had fields assessed using Irrimate, while the remaining 50 per cent said they would do Irrimate efficiency assessments on select fields if there were funds available.

“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 ”

“It (Scheduling I workshop) 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”

“The pumps course showed me how it's important to assess pump efficiency, and the fuel savings can be significant if the pump is not running above 65% efficiency.”

“My lift pump on my tail water return runs for twice the time as my river pumps, if it isn't performing it will be costing me. I need to set aside 2 days in winter and go around and test all my pumps on farm”

There is considerable interest in overhead irrigation systems. The Centre Pivot and Lateral Move Irrigation Systems, National Training Course, developed by the CRC for Irrigation Futures has been delivered by NSW DPI Irrigation Officers. Four training courses have been delivered across the cotton valleys with 85 participants. Participants include irrigators that already have an overhead system as well as irrigators deciding whether or not to purchase one.

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

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

“We are looking at putting in a CP and found the course most valuable in helping us decided weather or not to go ahead with it.”

Working with consultants has played an important part in improving water use efficiency within the cotton industry. Through consultants, information, technologies and practice

change can be delivered to their growers – more than extension staff could achieve one-on-one.

“The work you did last season on one of my clients farm was not only beneficial to them 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 irrigation measurements you made reinforced other research and our ideas and so I was able to relay that to growers with more confidence after working with you last season. Also, once I had let other growers know what you were doing and why, they would often ask me for the results or discuss the results that were relevant to their farms and what they should be doing in the future when it comes to monitoring irrigations”.

The Cotton and Grains Irrigation Knowledge Management Project set up the Consultant Mentoring Program which aimed to increase the irrigation skills and services available for consultants. The program engaged 14 consultants requiring support in a variety of irrigation areas including: surface irrigation evaluation, storage management (storage survey), lateral move performance evaluation and pump efficiency. Modules from the Cotton and Grains Irrigation Workshop Series have been run with consultants and consultants and their clients. A lateral move system audit training day was successfully held in the Gwydir Valley and Darling Downs.

One consultant involved in the program was keen to get a better understanding of how to manage irrigation under a lateral move machine and, in particular, to be able to check the machine performance and make appropriate recommendations. The consultant liaised with NSW DPI staff and a special event was organised to undertake a Lateral Move Evaluation as a demonstration and learning exercise. 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.

Following this event, the consultant 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”

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

The Consultant Mentoring Program was most successful in the Darling Downs where the project was boosted by funding through Condamine Alliance, Cotton Australia and the Cotton Catchment Communities CRC. This funding enabled a part time coordinator be appointed to the project along with incentive funds for growers wanting to use the services of an irrigation consultant. The extra staff and incentive funding was a key driver to the success of the mentoring program in this region.

The Cotton Knowledge Management Survey Evaluation, conducted by Coutts (2008), provided details on the way in which growers and consultants would like to receive irrigation information. Survey participants nominated e-mail alerts and newsletters

(including Cotton Grower, Cotton Tales) as the best ways to receive on-going irrigation information.

A new website has been developed to improve the accessibility of irrigation information to the cotton and grains industries. The website www.cottonandgrains.irrigationfutures.org.au was developed in March 2007 as part of the Cotton Catchment Communities CRC (Cotton CRC) 'Cotton and Grains Irrigation Knowledge Management' project. The new site contains a wealth of information, including irrigation resources, on-farm trial updates and easy to use web-based production tools. The record of visit shows an increasing trend of use, with an average daily hit rate of 100 by April 2008 (Coutts 2008).

Communications, including newspaper and magazine articles, cotton tales, newsletters and posting of material on relevant websites (Cotton and Grains Irrigation Website and Cotton Catchment Communities CRC Website) provide current information and case studies relating to water use efficiency. Recent survey results from the Knowledge Management Evaluation Report (Coutts 2008) found a high level of awareness and appreciation of these across the industry. Almost a quarter of survey respondents commented that information gained had contributed to a change in their on-farm practices or heightened awareness of water use efficiency and irrigation issues (Coutts 2008). Coutts (2008) said that case studies were highly valued and further value would be added by including strong economic analysis. This is being fulfilled with the development is economic information on irrigation systems and management.

Irrigators interested in making change want to know what the change is going to cost them, the return on their investment and the payback period. Two case studies that have been developed are "Economic Benefits of Performance Evaluation" (Reynolds & Jackson 2008), "Improving pump installation for Efficiency" (Reynolds *et.al.* 2008).

The costs associated with some technologies, and particularly on-farm water use efficiency projects that include earthworks are extremely high. Interest from irrigators in the industry to improve water use efficiency is good, but the means is not necessarily there. Irrigators in all valleys have experienced low water allocations for a number of years and ground water allocations are being reduced. The time when these larger earthworks can take place is during a dry year which obviously coincides with lower income. The Border River Gwydir Catchment Management Authority was inundated with applications for their Water Use Efficiency Incentives. Many of the applications were for works in excess of one millions dollars and the CMA was providing a maximum payment of only \$60,000. Despite the large grower in-kind contribution there were still many applications for reconfiguring storages, increasing wall height of storages, piping bore water, field shortening and changes to the tail water return system to improve water circulation.

Conclusion

Although the Australian cotton industry is recognised as an industry in which innovation is more likely to be accepted and move across the industry, it is caught in a cost price squeeze between low commodity prices and rising farm inputs, coupled with low water allocation and a skills flight to other industries. Consequently new technologies and on-farm works are not always able to be adopted.

The challenge remains to engage cotton growers, at there point of need, to complement other adoption drivers, to improve water use efficiency.

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Janelle Montgomery: Janelle is the NSW DPI Water Use Efficiency Officer at Moree. She has worked in a number of capacities within the Border Rivers and Gwydir Catchments delivering NRM outcomes at the farm level. She worked as a Research Fellow with UNE investigating water quality and bird habitat on broad acre irrigation farms in Northern NSW. Janelle completed her PhD in 2003, which measured components of the soil water balance under irrigated cotton.