Cotton Catchment Communities CRC

FINAL REPORT

Part 1 - Summary Details

Cotton CRC Project Number: 5.01.33

Project Title:RWUE4: Responding to Climate in the CQ Irrigation Sector

Project Commencement Date: 1/1/2010 **Project Completion Date:** 30/6/2012

Cotton CRC Program: 5.1 Knowledge Transfer

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Part 3 – Final Report Guide (due at 31st May 2012)

Background

The RWUE4 project was preceded by three Rural Water Use Efficiency programs across Queensland. The projects funded for the cotton and grain industry have been:

- Rural Water Use Efficiency Initiative - Improving on farm irrigation water use efficiency in the Queensland cotton and grain industries – 1999-00 to 2002-03
- RWUE2 - Extension & Adoption Program Best Water Management Practices for Cotton and Grain Farming Systems – 2004-05 and 2005-06
- RWUE3 - Improved water use efficiency in irrigated cotton and grains – 2006-07 to 2008-09

These projects contributed to a dramatic improvement in irrigator awareness of and access to new irrigation technologies. Enhanced irrigation management skills have enabled increased crop production and significantly improved water use efficiency within the cotton and grains industries in Queensland.

These projects enabled the development of a productive relationship with the irrigation community. This relationship enabled a collaborative approach to identifying, developing and delivering training and information to irrigators.

The theme "measure to manage" was consistently promoted across all RWUE projects. Extension efforts, from assistance in the initial development of suitable methodology, to its subsequent on-farm implementation, have resulted in widespread industry acceptance of the value of furrow optimisation evaluations.

Benchmarking has been consistently promoted by successive RWUE projects. Considerable effort was devoted to increasing industry usage of key performance indicators. Gross production water use index (GPWUI), irrigation water use index (IWUI) and crop water use index (CWUI) is now terminology used throughout the cotton industry.

Promotion by RWUE projects has resulted in a significant increase in the use of soil moisture probes throughout the irrigation sector. These instruments, in conjunction with improved understanding of the detrimental effects of waterlogging, have enabled considerable improvements in irrigation scheduling and as a consequence enhanced yields and water use efficiencies. Similarly, the promotion of both storage and flow meters has resulted in grower appreciation of their value in relation to implementation of irrigation system improvement.

Workshops delivered, including the Cotton and Grains Series specifically developed by the RWUE projects, provided excellent opportunities to enhance the knowledge base of irrigators. In association with demonstration sites these workshops also facilitated discussion regarding what irrigators required to assist in achieving improved performance.

All RWUE projects have played an active role in the promotion of best management practise. Expertise accumulated by RWUE officers has contributed extensively to the development of myBMP and other industry publications such as WATERpak.

RWUE4: Objectives

Objective 1: Meeting with Advisory Committee at regular intervals.

The Central Highlands Cotton Grower & Irrigators Association (CHCGIA) Advisory Committee agreed to act as an advisory committee for the RWUE4 project. This committee consisted of five cotton irrigators (Cam Geddes, Craig Barsby, Greg Barnett, Ross Burnett , Hamish Millar and Emma McCullagh), and a local agronomist (Graham Spackman).

In April 2010 the RWUE4 principal researcher met with the committee and provided an overview of the project. It was agreed that a progress report be presented in six months time. At this subsequent meeting (18th November 2010) a presentation outlined the progress made and the anticipated future activities of the project. A written response provided by the committee expressed their satisfaction with the progress of the project and provided a number of suggestions regarding activities that could contribute to the projects ongoing success. Of note amongst these was the comment that the ability to benchmark water use efficiency required an improved understanding of the various efficiency indices amongst irrigators throughout the Central Highlands.

In March 2011 in the wake of extensive floods in the region it was suggested by a spokesperson of the advisory committee that progress reports presented regularly at general CHCGIA grower meetings and supplemented by on-going contact throughout project activities with a number of those on the Advisory Committee, was a more appropriate means of exchanging information regarding the projects progress. Presentation of a final report regarding the projects achievements is intended at the next opportunity following the recent unanticipated termination of the RWUE4 project.

Objective 2: Readily available WUE Information and Decision Products – 4 case studies published.

Case studies

1. *Efficiency check for Karamarra centre pivot* **(published More Profit per Drop Blog 6 Sept 2010)** *http://moreprofitperdrop.wordpress.com/2010/09/06/efficiency-check-for-karamarra-centre-pivot/#more-468*

A centre pivot efficiency evaluation conducted on a large machine operating on an irrigated cotton property in Central Queensland emphasised the value of conducting these evaluations. The performance of this machine was compromised by a number of problems that limited its ability to apply sufficient irrigation uniformly. The grower has since been able to modify his cropping strategy by moving to a lower planting density on wider spaced rows. In addition identification of modifications required to improve the machines performance has facilitated a cost benefit analysis to be completed.

Unfortunately a recent succession of floods and associated infrastructure damage on the property has delayed any actions to implement modifications on this machine.

2. *CPLM efficiency evaluations - "Pivot Point".* **Article published in Spotlight (Summer 2011/12) included a synopsis of results provided by evaluations conducted.**

This case study reported conclusions drawn from a number of centre pivot efficiency evaluations conducted in the Central Queensland region. Approximately 70% of identified problems with machines have been attributed to the emitter package installed, an interesting situation given that these components only account for approximately seven percent of the initial machine purchase price. As discussed in this case study incorrect pressures were also identified as a common cause of sub-standard performance.

3. *"Using crop water use indices to benchmark crop water use efficiency"* **Article co authored with Jenelle Montgomery and published in The Australian Cottongrower, October – November 2011 (see Attached)**

Developed in conjunction with Janelle Montgomery (NSW DPI), this case study presented Australian cotton industry benchmark data that enabled growers to compare their performance from season to season and with other growers. Results were based on the results of two industry wide surveys that used the web-based benchmarking program, Watertrack Rapid. The use of gross production water use index (GPWUI) and irrigation water use index (IWUI) have gained acceptance across the industry in recent years in the quest to continually improve production efficiencies.

4. **Pump efficiency evaluations -** *"$$ How efficient are your pumps $$"* **Article presenting 3 case studies to be published in The Australian Cottongrower, June 2012 (see Attached)**

Three pump system efficiency evaluation case studies were combined in this article. Results reported highlight the value of conducting a close examination of pump system performance as identification of inefficiencies can enable system changes that provide significant operational cost savings. As reported, the verification of performance should not be confined to older pumping systems as new installations can also suffer from problems. These may be related to inappropriate selection for the required task or installation problems.

<u>Information & decision products</u>

1. **On-going rewrite of WATERpak underway.**

The project has been involved in the current revision of the WATERpak manual by accepting responsibility for rewriting the three sections covering pumping, metering, and irrigation management tools. This resource, accessible online, is closely linked to the myBMP project so as to assist growers achieve implementation of best management practises.

2. **Contribution to the restructure of more profit per drop website.**

The RWUE4 project has continued to support the development of the 'More Profit per Drop' website and has contributed to its major revision of content and structure. This site

provides a readily accessible and comprehensive information resource that has proven to be widely supported by irrigators (as evidenced by the record of hits).

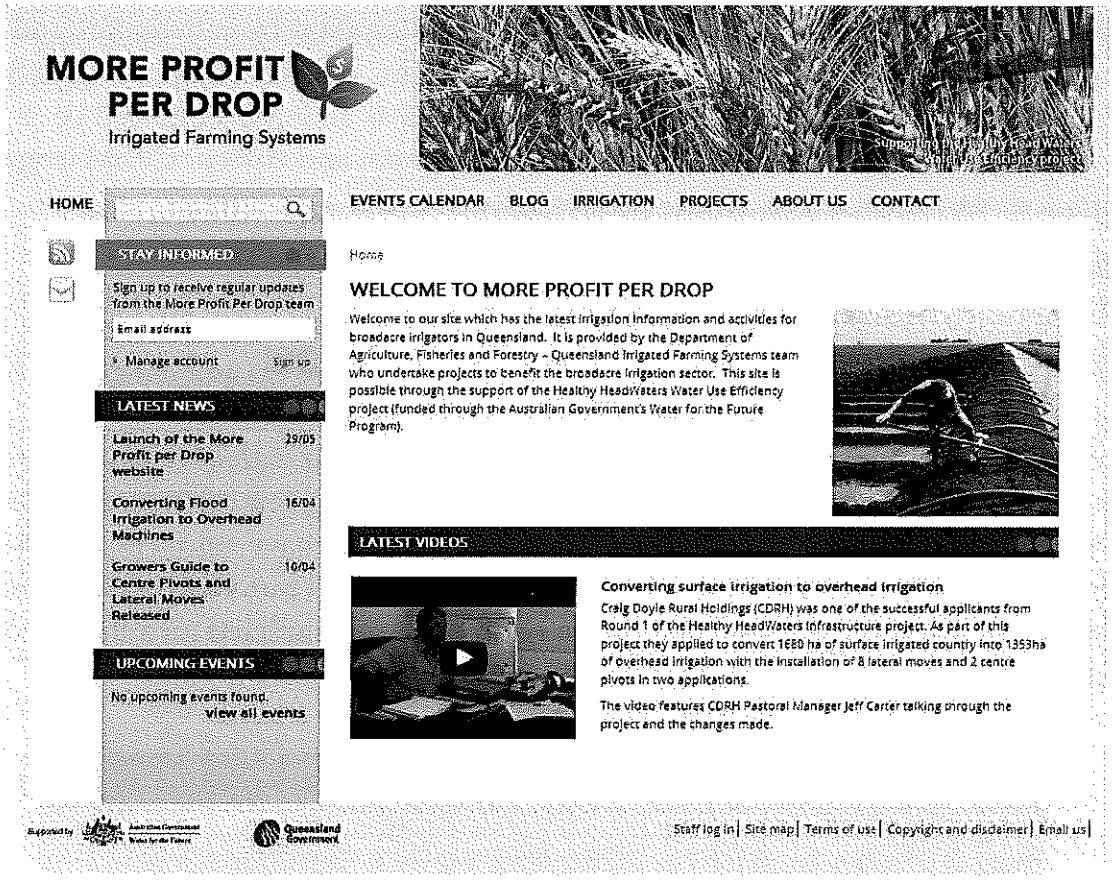

Fig1 :The More Profit per Drop website provides readily accessible and up to date information across a broad range of irrigation topics

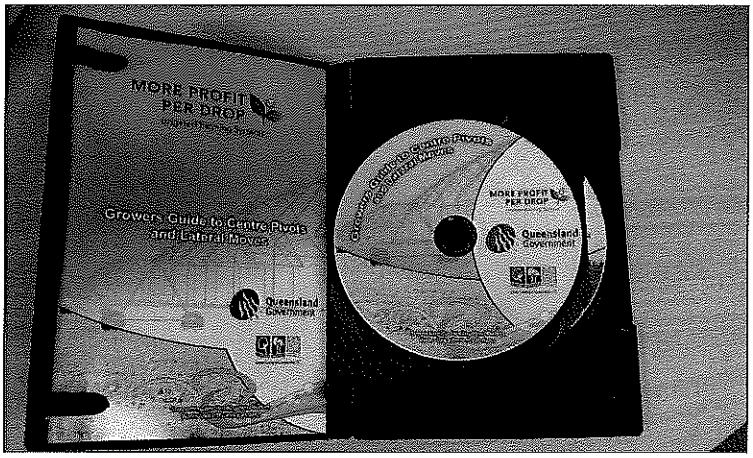

Fig2 : The recently released DVD "Growers Guide to Centre Pivots and Lateral Moves" provides a comprehensive information resource for those already operating or considering the purchase of their first machine.

3. "Growers Guide to Centre Pivots and Lateral Moves" DVD

The recent release of the DVD "Growers Guide to Centre Pivots and Lateral Moves" was the culmination of considerable efforts by the RWUE4 project working in conjunction with the Healthy HeadWaters Water Use Efficiency Project. Response from irrigators and industry has been very positive to this product. Comments received support the belief that the DVD will efficiently address what was identified as an important need i.e. a readily available, comprehensive resource base for potential and current CPLM irrigators.

Objective 3: Skills development of irrigators, their consultants and irrigation equipment suppliers - 2 workshop/field days.

Workshops/field days delivered (2 workshops/field days)

1. A CPLM workshop (19 August 2010) was attended by 4 growers and 6 industry reps. The invited speaker, Pat Daly (Dalys Water Service Pty Ltd) provided a comprehensive overview of overhead irrigation based on his extensive experience. Although recent rains made the planned field visit inappropriate attendees expressed their satisfaction with the day's proceedings. Two growers have since employed Dalys Water Service as a consultant to assist with the selection and purchase of new centre pivots. Two pivot efficiency evaluations have since been completed on a third grower's property.

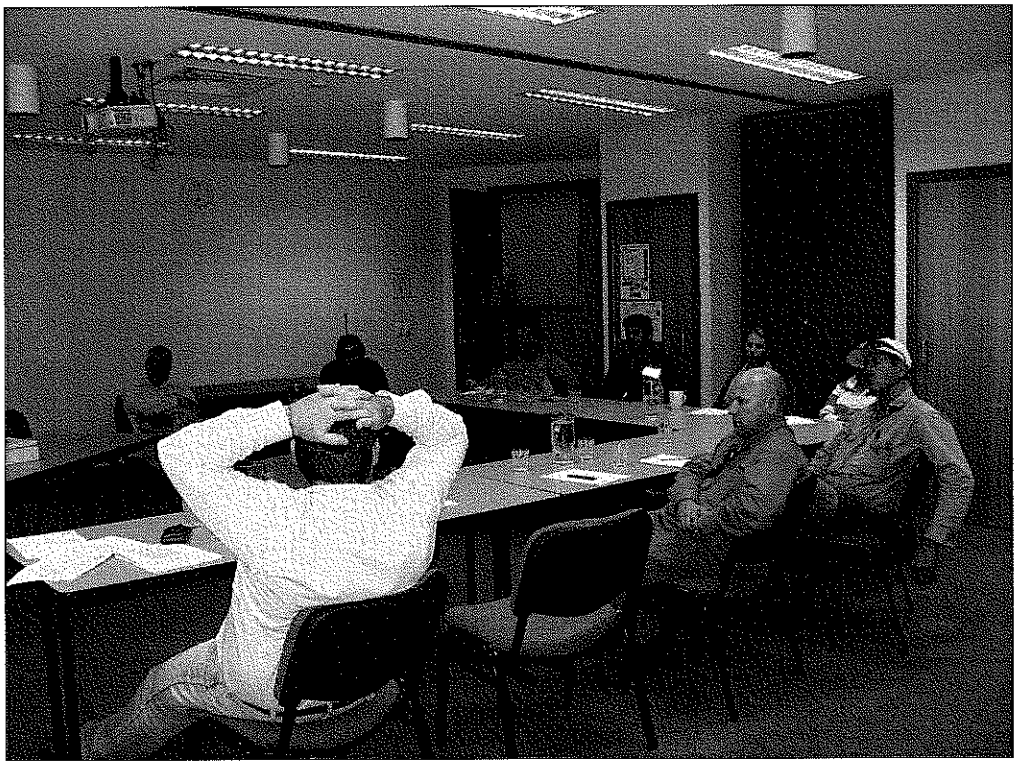

Fig3 : Attentive audience discussing the merits of overhead irrigation technology at the CPLM workshop

2. A Benchmarking workshop (22 October 2010) from the Cotton & Grains Irrigation Workshop series was attended by 6 growers and 3 industry representatives. This workshop was specifically aimed at those who had recently purchased soil moisture probes. A follow-up meeting was held with four growers who where unable to attend the workshop due to on-farm commitments at the time.
3. A "Pumps" workshop (08 December 2010) from the Cotton & Grains Irrigation Workshop series was delivered to Emerald growers

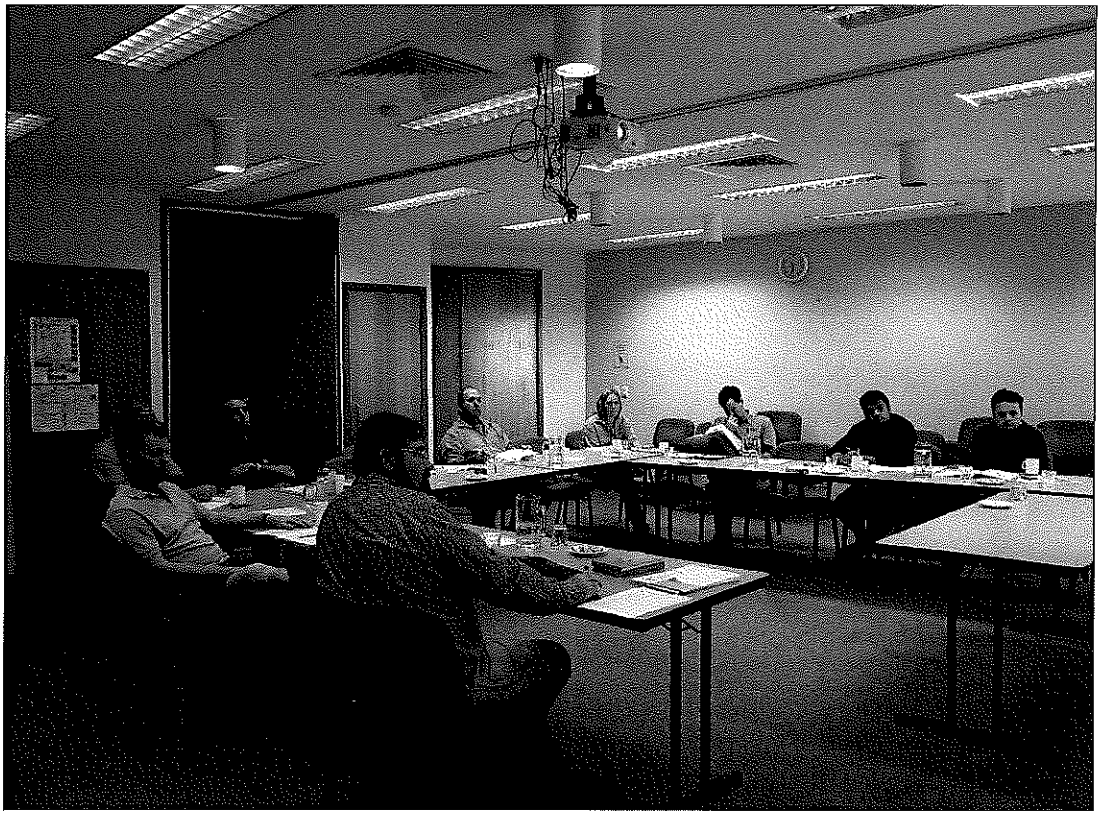

Fig4 : Six local irrigators and two industry representatives absorb some of the experiences of the guest speaker Pat Daly at a "Pumps" workshop delivered in Emerald.

4. In June 2011 a Water Use Efficiency workshop was conducted at Theodore. This workshop, attended by 24 irrigators, 1 consultant & 2 industry representatives, all from the Dawson / Callide region, was specifically designed to assist those interested in completing the myBMP "Water Management Module". The Fitzroy Basin Authority provided funds to invite an industry representative (Pat Menkens - Menkins Irrigation Services) to discuss the use of soil moisture probes. Local context was provided by the Theodore based agronomist, Damien Erbacher. This workshop was very successful as all attending growers have subsequently successfully completed the Water Management Module. In addition, several irrigators have since purchased moisture probes for the first time.

Fig5 :Attendees at theRWUE4 water use efficiency workshop held in Theodore prepare for successful completion of the myBMP Water Management module.

5. A pivot evaluation workshop / field site visit, attended by 13 growers & 1 consultant, was held at Theodore in February 2012. The field component consisted of an inspection of a pivot that had been modified to address problems identified by an earlier efficiency evaluation (conducted by the RWUE4 project). A dynamic discussion ensured between a number of those attendees who have experience operating CPLM irrigators, and several who were considering investment in their first machine. This venue was also the "premier release" of the growers guide DVD. A highlight of the day for the project was observing growers promoting the merits of pivot evaluations to those operators who operated machines that had not been evaluated.

6. A "Water use efficiency" presentation was delivered to members of the Fitzroy Basin Authority Technical (21 June 2011). The presentation was designed to increase the panels awareness of the issues involved in increasing irrigation efficiencies so that members were better informed when considering funding applications. The RWUE4 project has assisted FBA field officers and the FBA in general on a number of occasions by providing advice on water related matters. In turn these officers have disseminated information to their clients regarding the activities of the RWUE4 project.

Fig6 :On-site discussion of CPLM technology including common problems often identified by machine efficiency evaluations.

Objective 4: Assessment of Existing Irrigation Systems – reports prepared for participants and entered into databases.

1. System efficiency evaluations were successfully conducted on 17 centre pivot machines with technical reports recorded in IPART, and provided to and discussed with participating growers (see Attachments – IPART report).
2. System efficiency evaluations were conducted on eight pumping installations with 5 technical reports recorded in IPERT database. Again, as with the CPLM evaluations, reports were provided to the irrigator along with post evaluation discussion of any problems identified and possible remedial strategies.

Details of these evaluations are discussed further in the following *"Methods"* section.

Objective 5: Support provided to irrigators – advice provided in a timely fashion.

Regular attendance at CHCG & I Association and DVCG Association meetings provided an efficient forum for updates of the programs activities. The social aspect of these events was conducive for a wide range of discussions that often resulted in requests for information and advice from growers. Although the regular newsletter ("Cotton Tales") was successful in encouraging utilisation of the projects resources some irrigators remain much more receptive to face to face interaction (as opposed to electronic communication). While the project deliberately scheduled particular activities to be delivered in a timely manner, e.g. avoiding workshops during planting and peak irrigation times, irrigator feedback at grower forums often identified when particular assistance was appropriate.

Typically workshops resulted in subsequent requests for specific information. In several cases, presumably after reflecting on the content of a workshop previously attended,

prospective purchasers of CPLM machines requested assistance to employ a suitable consultant. Without exception water use efficiency workshops prompted subsequent inquiries regarding potential suppliers of soil moisture probes.

The project has assisted specific growers address leaky storage issues. As promoted by the project a first step towards remediation works is the conduct of an EM survey. The successful conduct of a number of storage EM surveys in the CQ region has resulted from acting as liaison between the suppliers of this service and growers.

A range of funding opportunities was available to irrigators following the extensive infrastructure damage caused by successive floods in the CQ region in recent years. The RWUE4 project provided extensive assistance to irrigators in the formation of their applications, and to the Fitzroy Basin Authority technical review panel in its evaluation of submissions (see Appendix 1 "Three examples...").

Production of the CPLM DVD, developed in conjunction with the Healthy HeadWaters team, has been completed and is being distributed to growers, suppliers and industry representatives. The DVD will fill a resource knowledge gap that became increasingly obvious with the recent upsurge in grower interest in overhead irrigation investment. Very positive feedback regarding this product has verified the assumptions that prompted its development. It has already become a valuable "first stop shop" for those fielding inquiries regarding CPLM.

Media releases (listed in KPI 5 under Publications) include 1 peer reviewed article (PhD), 6 non peer reviewed articles, 3 publications submitted and accepted, 1 conference presentation and acceptance to present at the forthcoming Irrigation Australia and the Cotton conferences.

As detailed previously (Objective 3) six workshops were delivered throughout the Central Queensland region throughout the course of the project.

Objective 6: Reporting – Centric milestone to Cotton CRC 31st May 2012

Centric milestone reports to the Cotton CRC were delivered as required.

Methods

This extension project delivered to the irrigation sector in the Central Highlands and Dawson-Callide Valleys of Central Queensland.

The project focused on:

1. The irrigation and energy performance of irrigation systems in Central Queensland were assessed via CPLM and pumping systems assessments. The current project was able to capitalise on groundwork achieved by the preceding project (RWUE3) which had made valuable inroads towards promoting an awareness of the value of CPLM system efficiency evaluations. At the conclusion of the current project there has been a noticeable shift in grower attitude, with ambivalence replaced by enthusiasm. Typically growers had been sceptical as to whether the cost charged by consultants for a comprehensive system evaluation (c. $2,000) was warranted. At the beginning of RWUE4 candidates for machine evaluations were often "obligingly cooperating" whereas now there is a backlog of requests from growers keen to have their systems checked as soon as circumstances permit. Activities devoted to this area were designed to demonstrate their value and thereby create a demand that could be addressed by commercial suppliers e.g. consultants. The project has achieved this to some extent but further efforts are still required.

   Many suppliers / installers of machines have demonstrated some reticence to accept the validity CPLM efficiency audits dismissing conclusions that have identified problems as not based on accurate data. For this reason all evaluations conducted by the project, have rigorously adhered to the methodology standards. It is expected that pressure from growers who have achieved improved performance from changes initiated by evaluations will assist in a more positive attitude from installers.

   The value of pumping system efficiency evaluations is not widely appreciated by many irrigators. This project has produced a number of case studies that will assist future efforts to change this situation. In many ways there is a parallel with the process discussed above in relation to CPLM evaluations. Until there is increased awareness of the potential savings that can be achieved growers will remain reluctant to commit resources. Further dissemination of case studies that document cost savings achieved via improved energy efficiencies is required. This area was to be a principle focus of the project "Optimizing energy use in the CQ Irrigation Sector".

2. developing information products on improving irrigation and energy performance of irrigation systems. Release of the "Growers Guide to Centre Pivots and Lateral Moves" DVD, produced in association with the Healthy HeadWaters project, is regarded as a major achievement of this project. Its production involved extensive data collection and editing and directly involved many individual irrigators. There

has already been a very positive response from growers to this product suggesting that it achieves its intended goals.

3. providing targeted training to encourage the assessment of irrigation system performance. Although circumstances related to the post floods rebuilding process did make it difficult to conduct workshops those that were conducted throughout the project were important venues for providing training targeted at improving water and energy use efficiencies.

Outcomes

KPI 1: 80% of irrigators in Central Highlands and Dawson-Callide aware of RWUE4 program

Presentations at grower associations, area wide meetings and other venues, and a range of publications including a regular newsletter enabled the successful achievement of an awareness of the RWUE4 project amongst 80% of irrigators in Central Highlands and Dawson-Callide.

The RWUE4 project extension officer regularly attended CHCGIA, and the DVCGA meetings, and occasionally their social functions. Area Wide Meetings, usually organized by the RWUE4 and the cotton extension officers, were also regularly utilized. These venues provided an excellent opportunity to promote awareness of the RWUE4 project and typically facilitated presentation of a project progress report, discussion of / invitations to participate in upcoming RWUE4 activities, and dissemination of general information.

Specific articles concerning forthcoming activities and specific water / energy use issues were included in the regular Cotton Tales newsletter. This newsletter, co-authored with the local Cotton extension officer, has a distribution list of 60 individuals across the irrigation sector. In addition articles published in industry publications (e.g. Irrigation Australia, The Australian Cotton grower, & Spotlight) and presentations at Conferences (e.g. Irrigation Australia 2011) contributed to awareness amongst the general irrigation community.

KPI 2: 30% of Central Highlands and Dawson-Callide irrigators have had their system performance assessed

System efficiency evaluations which focused on 17 centre pivot machines and 8 pumping installations were conducted on 16 separate irrigation enterprises over the period of the RWUE4 project. This constituted system performance assessments on 28 % of the estimated total 57 irrigation enterprises.

KPI 3: 30% of Central Highlands and Dawson-Callide irrigators have achieved 10% improvement in WUE

Pivot efficiency evaluations involve assessment of a range of parameters that contribute to their efficient operation. A key indici provided is the coefficient of uniformity (CU) as this relates to a machines ability to deliver irrigations uniformly across the crop and thus avoid exposure to over / under watering areas and the associated loss of production. Evaluations conducted in the period of this project reflect conclusions reported in the preceding RWUE3 project (see "Centre Pivots not up to scratch" Irrigation Australia Journal Vol 24 No 2) i.e. that typically systems are operating below their design specifications. In most cases the CU of evaluations reported herein was below the benchmark of 90 % (see Appendix 2*"Brief summary of CPLM evaluations conducted"*). Improvement in CU directly translates to improved yields per unit of water applied throughout the system. It is estimated that increasing CU from 80 % to the benchmark 90

% provides at a minimum a 20 % improvement in water use efficiencies (both GPWUI and IWIU). Where problems were identified and reported (with attached suggested remedial strategies) growers have expressed their intention to implement required changes.

Recommended changes have already been undertaken in some cases and feedback from growers has suggested that improvement in system performance has been significant. Definitive quantification of their improvement in WUE however necessitates a follow-up system evaluation. The priority has been to first increase awareness of the problem amongst as many operators as possible to heighten awareness of potential gains required. This focus has been at the expense of conducting follow-up evaluations. It is recognized that publicity on efficiency gains achieved via system improvements implemented on the basis of an evaluation is a powerful tool. Follow-up evaluations have been scheduled with a number of growers who have already implemented changes and will be conducted before the next cotton planting.

In summary improvements in the performance of pivots and pumping systems evaluated on 28 % of the estimated total of 57 irrigation enterprises in the CQ region has resulted in clearly identified strategies that will result in greater than 10 % improvement in WUE. It is recognized that these gains have not necessarily been achieved at this point but that the delay is largely a result of the requirement to modify activities in response to the ongoing rehabilitation of flood damaged infrastructure. Capacity to deliver these targets has been included in the activities of the final year (2012-13) of this projects funding.

KPI 4: 30% of Central Highlands and Dawson-Callide irrigators have achieved 20% reduction in irrigation energy use

Increased energy use efficiency is typically associated with any improvement in WUE as greater yields per volume of irrigation water supplied equates to reduced pumping per unit yield. Improvements in WUE, as outlined in the preceding section, would be expected to be reflected in a reduction in energy use by a similar magnitude. In addition, improvements to pumping systems achieved as a result of system efficiency evaluations further enhances energy use efficiency as expressed by cost per unit of water pumped.

Ironically the flooding events that damaged so many pumping facilities reduced the opportunity to conduct pump system evaluations. An immediate problem facing many irrigators was the loss of ability to deliver irrigations to their remaining crops. Efficiency was not of paramount importance given the risk of total crop loss if water could not be delivered. This dilemma was compounded by the widespread damage to storage and delivery / tailwater recovery infrastructure. The latter has remained the primary focus of recovery investment. Many of the recently harvested 2011-12 cotton crops were produced on fields that could only be prepared to a very basic standard of gradient uniformity in time for planting. This was reflected in their reduced performance and growers will be devoting considerable efforts towards laser levelling fields before next season.

The priority of the RWUE4 project has been to ensure that sufficient information is available to increase consideration of pumping efficiency as a key factor when investing in

required pump repairs or replacement. The pump system evaluations conducted were specifically targeted to maximise this goal with three of the 8 evaluations deliberately conducted for growers with reputations as peer leaders. This focus however was at the expense of conducting the "post- modification" re-evaluations that provide the concise quantification of efficiency improvement.

KPI 5: 30% of Central Highlands and Dawson-Callide irrigators exceeding best practice energy efficiency of 5 kWh/ML/m head

The project was unable to achieve the target of 30% of Central Highlands and Dawson-Callide irrigators exceeding best practice energy efficiency of 5 kWh/ML/m head. A range of factors contributed to this.

As previously discussed, circumstances created a situation wherein growers had to prioritise their activities to basic infrastructure rehabilitation at the expense of achieving incremental increases in efficiencies. Achieving benchmark energy use efficiencies remains an aspirational goal.

Importantly, project activities did contribute significantly towards developing an increased awareness of the 5 kWh/ML/m head energy use benchmark which is a critical foundation for the success of future efforts. This benchmark figure may not necessarily be totally appropriate in all circumstances but its use directly assists in promoting efforts to improve efficiencies. Irrigators certainly appreciate knowing the operational costs of a particular pumping system. The value of this information is enhanced when it is compared to what is considered possible (i.e. measured efficiency vs. potential efficiency as represented by the benchmark).

The most potent driver for practise change is the ability to identify potential cost benefits. In one basic pump evaluation conducted comparing performance against the benchmark it was readily determined that reducing pump revs by a mere 100rpm (from 1800 to 1700 rpm) improved the efficiency of both pump and diesel drive motor. Although the change in revs was negligible this new operational regime reduced kWh/ML/m head from 6.0 down to 5.4 resulting in 9.5 % reduction in fuel use per ML pumped. A more comprehensive efficiency evaluation that enabled the comparison of two systems at the one site clearly identified a large difference in energy efficiency between the two (see Attachment, Publications and presentations - *"$$ How efficient are your pumps$$? –Three case studies"*). The electric motor driven pump was significantly more efficient than its neighbouring diesel pump (4.5 vs. 5.6 kWh/ML/m). This information resulted in an immediate practise change.

It was anticipated that further energy efficiency evaluations would be completed throughout the 12 months of the "Optimizing energy use in the CQ Irrigation Sector" project however this project will now not be conducted due to cessation of future RWUE funding.

Conclusion

As a result of RWUE4 activities acceptance of the value of CPLM efficiency evaluations has reached a critical mass in the CQ irrigation sector. Good news permeates throughout the irrigation community. Word on the value of evaluations is now passing between growers such that the project is now receiving "bookings" rather than devoting resources towards creating interest. The take home message circulating is that (i) typically something in all overhead systems can be improved, and (ii) information provided by evaluations greatly assists in getting problem machines sorted out.

Many of the problems identified with existing machines could be traced back to the initial purchasing decisions having been made in the absence of a sufficient knowledge base. The RWUE4 project has successfully increased operator's knowledge of their machines and how to maximise their production efficiencies. In addition, information is now more readily available to those considering for the first time investment in CPLM technology.

The continual promotion throughout the RWUE4 project of the value of soil moisture probes for efficient irrigation scheduling has resulted in increased uptake by irrigators. This will have an ongoing beneficial effect on efforts to continually improve water use efficiencies throughout the industry.

Although perception of the value of attention by irrigators towards improving their energy use efficiencies is still limited the RWUE4 project has made a valuable contribution in this area. Given the anticipated increases in energy costs, and the demonstrated potential savings that can be achieved, this is an aspect of production that merits a concerted effort.

The adage "measure to manage" remains as the key take home message. Improved efficiencies in both water and energy use rely on verifying the performance of current practises so that potential improvements can be instigated where the need is identified.

Extension Opportunities

A principle focus of the project has been to promote the value of assessing the performance of overhead irrigation machines (see Attachments – "IPART report"). At the projects inception there was limited willingness amongst CPLM operators to commit funds for evaluations. Results of work completed have successfully demonstrated the potential for gains in both energy and water use efficiencies system. In the more extreme cases sub-standard performance may be obvious however this is not always the case. In many instances growers who had assumed that their machines were achieving their full potential were surprised when CPLM system efficiency evaluations identified where improvements could result in significant yield /efficiency gains. It is envisaged that now their value has been demonstrated the industry is much more prepared to employ private sector providers to undertake system efficiency evaluations.

Participation with the Healthy HeadWaters extension team in the successful production of the DVD "Growers Guide to Centre Pivots & Lateral Moves" has been a major project achievement. Industry response to this produce has been very positive. It is important

that this product is made available for active promotion / distribution by other parties after the conclusion of both this project and the current Healthy HeadWaters project.

The project was able to build on the groundwork established by the preceding RWUE projects in relation to increased perception of the "need to measure to manage". There is now widespread industry acceptance of the two water use efficiency indicies, Gross production water use index (GPWUI) and Irrigation water use index (IWUI), and their use for comparison of performance against a benchmark. Benchmarking energy efficiencies is however a comparatively new concept to the industry.

It is important that future extension work builds upon this project's efforts to promote the value of evaluating on-farm energy efficiencies. The "Optimizing energy use in the CQ Irrigation Sector" project was to contribute towards this goal by directly assisting in the refinement of tools developed by NCEA, the development and trialling of an energy use efficiency workshop, and a continuation of pumping system efficiency evaluations.

It is of concern that recent developments (i.e. withdrawal of funds to RWUE projects) will result in the failure to capitalise on gains made. Response to the current challenging economic climate appears to have prompted a downgrading of the role of extension as a vital component in the successful implementation of advances in production capabilities.

Publications

Peer reviewed articles / books

Pendergast, L. (2012), "Benefits of aeration of subsurface drip irrigation water – field evidence on CQ highlands vertosols", PhD Thesis

Non-peered reviewed articles

Pendergast, L. (2010), "Efficiency check for Karamarra centre pivot" http://moreprofitperdrop.wordpress.com/?s=Pendergast

Montgomery, J and Pendergast, L. (2011) "Using water use indices to benchmark crop water use efficiency", The Australian Cottongrower October 2011, Vol 32, No 6.

Pendergast, L. "Pivot points", Spotlight Summer 2011/12

Pendergast, L. (2011), Ch 10 "Crop Water Use", Australian Cotton Production Manual.

Pendergast, L. (2011), Ch 11 "Alternative Irrigation Systems" Australian Cotton Production Manual.

Pendergast, L. (2012), Cotton Growers Can Save Up to 30% On Pump Power Bills In a Matter of Minutes, Spotlight May 2012

Submitted:

Pendergast, L. (2012), "$$ How efficient are your pumps $$? -Three case studies", submitted (22/05/2012) to Australian Cottongrower

Pendergast,L & Bhattarai, S. (2012), "Optimising delivery and benefits of aerated irrigation water for subsurface drip irrigated cotton industry", Australian Cotton Water Story. . To be released at the 2012 Cotton Conference.

Pendergast, L. (2012), "Optimising Alternative Irrigation Systems ", Australian Cotton Water Story. To be released at the 2012 Cotton Conference.

Presentations (conference, field days, workshops etc)

Bhattarai, S. David J. Midmore, D, Pendergast, L and Ronnfeldt, A (2011), "Oxygation: using aerated water for cotton irrigation with sub-surface drip: Opportunities for gains in yield and water use efficiency, IAL Launceston, 2011

Payero, J. Hare, J. Pendergast, L. Harris, G & Robinson, G. "Is it feasible to schedule irrigations using the ETgage?", to be presented at 16th ASA Conference, October, Armidale

Invitation to submit poster, "Irrigation systems energy benchmarking", at IAL Conference 2012.

Pendergast, L. (2012), "Irrigation systems energy benchmarking", to be Keynote presentation at Australian Cotton Conference 2012

Workshops delivered

- "Benchmarking" (22/10/10) Emerald
- "Centre Pivot Lateral Moves" (9/18/11) Emerald
- "Pumps" (08/12/10) Emerald
- "myBMP Water Management Module" (14/06/11), Theodore
- "Water Use Efficiency" presentation to Fitzroy Basin Authority Technical panel.
- "Water Use Efficiency" (02/03/12) Theodore
- "Centre Pivot & Lateral Moves"

Online resources and website address

- MoreProfitPerDrop http://www.moreprofitperdrop.com.au
- DVD "Growers Guide to Centre Pivots & Lateral Moves" at http://www.moreprofitperdrop.com.au

Part 4 – Final Report Executive Summary

The RWUE4 "Responding to Climate in the CQ Irrigation Sector" project successfully extended upon the groundwork established by the preceding RWUE projects. In addition exceptional circumstances resulting from the record flood events experienced by Central Queensland irrigators required a prompt response from the project. A redirection of activities was implemented to assist growers redress the extensive flood damage to infrastructure.

Fig7 : During a site inspection of proposed repair works Dawn and Peter French (Theodore) reflect on the height of the 2010/11 devastating flood across their cotton fields and the severe infrastructure damage they caused.

The RWUE4 project provided 28 technical assessments of applications for flood relief funding under review by the Fitzroy Basin Authority. In many cases site visits were made to assist the grower plan restoration works and to ensure that the energy and water use efficiencies of options were taken into full consideration.

The project continued efforts towards increasing perception amongst irrigators of the need to "measure to manage". As a result of this concerted focus there is now enhanced industry acceptance of the two water use efficiency indicies, gross production water use index (GPWUI) and irrigation water use index (IWUI). Promotion of the use of these indici has enabled an increase in benchmarking of irrigation efficiencies (see Attachment Publications and presentations - "Using water use indices to benchmark crop water use efficiency") As a result irrigators are now better positioned to identify and implement changes that provide improved production-system water use efficiencies.

Benchmarking of energy efficiencies is however a comparatively new concept to the industry. As a means of promoting the value of energy use efficiency evaluations the RWUE4 project conducted efficiency examinations on a range of pump systems. These directly assisted involved irrigators assess their system energy efficiencies. Importantly, case studies produced provided examples for the promotion of the value of this exercise amongst the wider irrigation community (see Attachment, Publications and presentations

- "$$ How efficient are your pumps $$? -Three case studies"). It is critical that future extension work builds upon this and other projects efforts to further promote the value of on-farm energy efficiency evaluations.

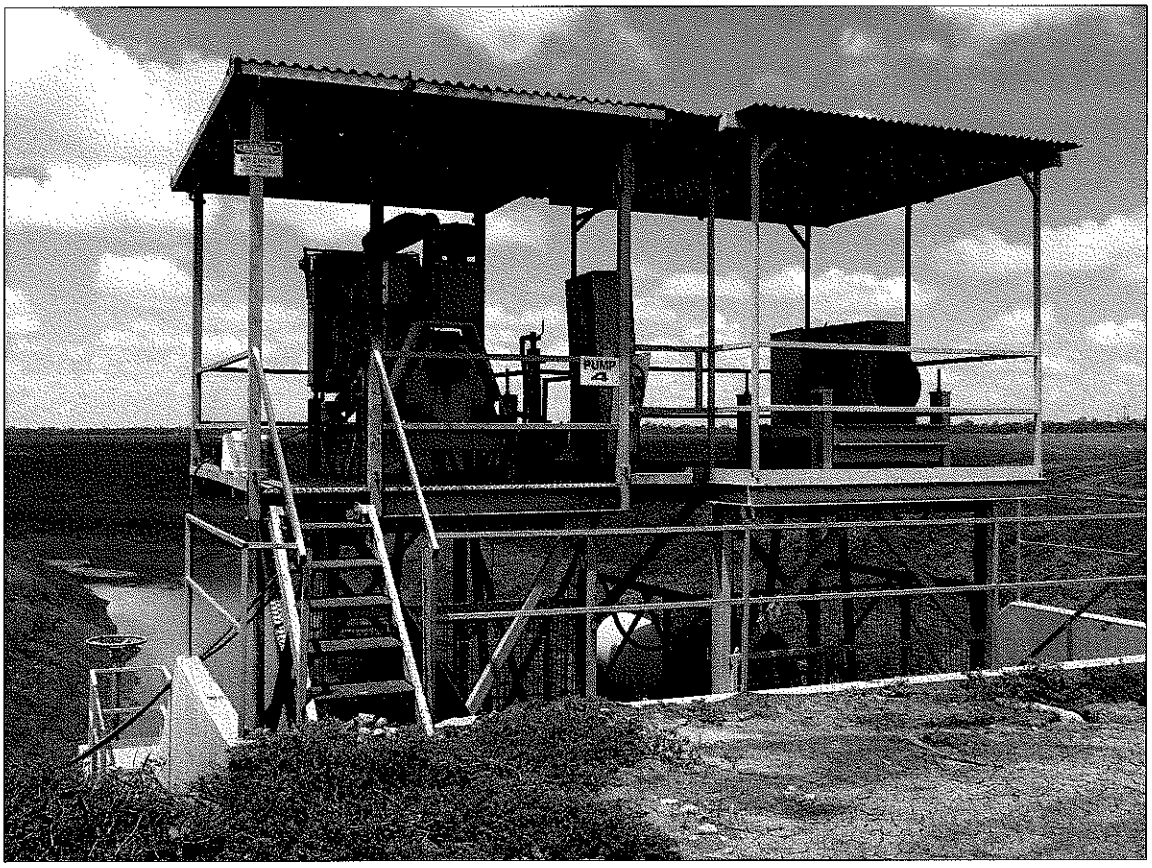

Fig8 : A comparison of performance following pump system efficiency evaluations on two pumps located side by side resulted in the operator implementing a strategy that will significantly reduce energy costs

A principal focus of the project was the promotion of overhead irrigation machine performance assessments. At the projects inception there was limited willingness amongst centre pivot / lateral move (CPLM) operators to commit funds for evaluations. Results of work completed have successfully demonstrated the potential for gains in both energy and water use efficiencies system. In the more extreme cases sub-standard machine performance may be obvious however this is not always the case. In many instances growers who had assumed that their machines were achieving their full potential were surprised when a CPLM system efficiency evaluation identified where improvements could result in significant yield /efficiency gains.

It is envisaged that as evidence of their value is demonstrated irrigators will be more prepared to employ private sector providers to undertake system efficiency evaluations. Acceptance of the value of CPLM efficiency evaluations has reached a critical mass in the CQ irrigation sector. Good news permeates throughout the irrigation community. Word on the value of evaluations has passed between growers such that, at its conclusion, the

project was receiving "bookings" rather than devoting resources towards creating interest. The take home message now circulating is that (i) typically something in all overhead systems can be improved, and (ii) information provided by evaluations greatly assists in getting problem machines sorted out.

The project was successful in increasing operator's knowledge of their machines and how to maximise their production efficiencies. In addition information is now more readily available to those considering purchasing their first CPLM.

Fig9 : Results of the centre pivot evaluation conducted on "Karramarra" enabled manager George Sypher (on right) to determine the most appropriate cotton planting strategy.

Many identified problems of machines could be traced back to the initial purchasing decisions often being made in the absence of a sufficient knowledge base. The Growers Guide to Central Pivots and Lateral Moves DVD, produced by the RWUE4 project in collaboration with the Healthy HeadWaters project, was specifically designed to redress this issue. It is expected that this product will prove to be a valuable resource for both new investors and current operators.

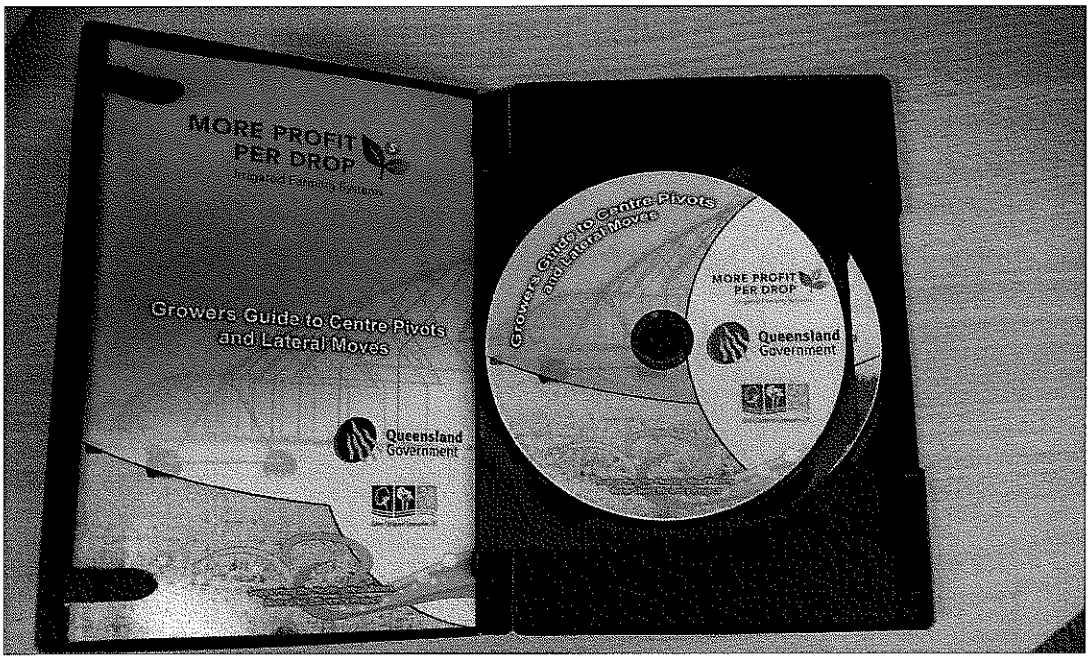

Fig10 : The recently released DVD "Growers Guide to Centre Pivots and Lateral Moves" provides a comprehensive information resource for those already operating or considering the purchase of their first machine.

The RWUE4 project increased the ability of irrigators to face the challenges ahead. Improvements in water use and energy use efficiencies, and the additional information resources generated by the project will contribute towards an enhanced industry production-system performance.

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Appendices

Appendix 1: *Three Examples of Technical notes provided by RWUE4 to FBA for consideration of application for flood assistance funding*

Property A Technical notes

XXX are located on the South western outskirts of Moura on the Dawson River. Flood water from the damaged Sunwater Off Stream Moura Storage resulted in an increased inundation of water that extensively disturbed the soil under the XXX pivots. The XXXX pivot was inundated by Dawson River flooding.

The ground surface under both pivots has suffered from both the redistribution of existing soil and from deposition of material transport from elsewhere. Although centre pivots are capable of operating over undulating terrain their performance is significantly enhanced when the surface is uniformly graded. This minimises the potential for waterlogging of crops, deep drainage, erosion and surface run off. When operating over laser levelled fields centre pivots provide the capacity to deliver precise, uniform and timely application of irrigation, tailored to match the specific requirements of a crop as it develops. This capacity facilitates achievement of excellent water use efficiencies. Surveying and laser levelling is required to return the pivots to a condition that will enable their optimum performance.

Repair to the associated infrastructure is also required. Efficient farm reticulation systems are essential for containment of all tailwater on farm and minimisation stormwater run-off into rivers and creeks.

Global positioning steering systems have become extensively used in agricultural production systems. They are a vital component in precision agricultural activities as they directly benefit soil health by confining machinery movement to defined pathways and thereby reduce exposure to the detrimental effects of soil compaction. In addition GPS facilitates the precise positioning required to optimise nutrient, herbicide and pesticide application efficiencies. Increased efficiencies directly translate to a reduction in usage.

Prior to the floods, Lance Pendergast, undertook pivot evaluations on the large pivot at XXX, and had identified that it was operating at 90%. It is recommended that this application be viewed favourably as each of the components listed will contribute to returning the improved function of the irrigation enterprise.

Completion of each of the proposed activities will provide a direct environmental benefit as they will enable improved water use efficiencies and a significant reduction in off-farm movement of soil and water borne contaminants. These outcomes will contribute directly to better water quality flowing to the GBR lagoon.

Property B Technical notes

XXXX is on the Dawson River, near Baralaba and has been a long term participant in BMP. While flooding was considered in farm design at 'Harcourt', the unprecedented flooding of 2010/11 breached levies and caused extensive flooding across XXXX.

Repairs to the tailwater and stormwater system were required across the property, reform earthen tailwater return drains, and rebuild head ditches to repair the farm's reticulation system.

Through the myBMP process XXXX have identified the previous head ditch design, was prone to erosion. During flood repairs they have identified the opportunity to improve on the system and reduce erosion, by implementing a second head ditch, pipe and bubbler infrastructure which slows the water before delivery into the field, thereby reducing erosion.

It is a legal requirement to contain contaminated tail water on-farm, (that is water generated from an irrigation event that is not used by the crop, and typically runs off the field). The amount of tailwater is minimized by efficient application techniques and appropriately designed fields. Stormwater resulting from rainfall is considered separately and the first flush of stormwater potentially holds the highest concentration of contaminants and capture of this is part of the general requirement. It is therefore important that the first 15 mm of run-off is retained on-farm. It is particularly important to capture run-off from fields that have been recently treated, as they will contribute the highest levels of pesticide. Repairs to the levy to return it to its previous state will also help to reduce the risk of future flooding of the farm.

Laser levelling is required to restore the system to efficient operation. The principle of surface irrigation revolves around the intake or infiltration rate of the soil. Water is provided to the field so that wetting of the root zone is satisfied by infiltration through the surface. Once the root zone at the top of the field is refilled, the water should advance down the field to continue refilling the root zone without wastage by continued high infiltration at the top. This process requires heavy clay or clay loam soils and reasonable field slopes to complete an irrigation in a reasonable time and to prevent the top end of the field from overtopping.

Furrows should be designed to run down the slope, with minimal crossfall. Excessive crossfalls can result in furrow overtopping, leading to erosion across the furrows. Nearly all fields are now graded using laser controlled equipment. Lasers make construction easier and provide very uniform grades which greatly facilitate irrigation and drainage. Computer programs are available to calculate grading schedules. Fields are broken into sub-areas to minimise earthworks, and different combinations of run length, down slope and cross slope are modelled.

Property C Technical notes

Total inundation of the XXXX pivots in successive floods (2010 and 2011) could be expected to have had a large influence on both the structure and chemistry (nutrients) of the soil under these machines. The depressed performance of the recently harvested crops suggested that this is indeed the case. It is essential that appropriate action is taken to return this area to its former productive capacity.

Following in season site visit, Susan Maas has recommended to this grower that soil monitoring, especially at depth be conducted, as multiple cotton crops have shown unusual symptoms, and it was important to rule out sub soil constraints and better understand the full profile of nutrition. A good understanding of these variable fields, would enable more targeted and efficient use of nutrition, especially nitrogen, in turn reducing risk of excess nitrogen runoff into nearby river system. If there are sub soil constraints a long term plan will be able to be developed to ensure the continued sustainability of the soil for farming.

After discussion with the grower it is understood that that the intention is to utilise a Veris machine (supplied by a local consultant) to conduct a comprehensive EC analysis under the pivots. This machine provides electromagnetic (EM) data that can then be related to soil electroconductivity (EC). It is a rigorous methodology that enables informed decisions regarding soil characteristics. In addition the intended targeted deep soil testing will provide valuable information regarding nutrient status. The combined effect will be an enhanced ability to optimise any remedial action that is required. Typically this information enables the grower to optimise his fertiliser requirements, with crops grown more efficiently and with a minimum of inputs. In many cases fertilizer applications can be effectively applied as required onto precise management zones using the variable rate technology now available.

Irrigation scheduling based on previous practises may no longer be appropriate given the flood induced changes to the soil. It is very important that the irrigator has access to as much information as possible regarding soil moisture status over the coming seasons. Soil moisture probes under pivot machines are a necessity. "Measure to manage" is the principle underlying mantra in the quest to improve water use efficiencies of irrigation operations. Soil moisture probes and water meters play a pivotal role in irrigation management decision making as they provide data that optimises water use efficiencies which includes the minimisation of exposure to deep drainage and off-site movement of herbicides and pesticides. Considerable efforts by an extensive number of agencies, including neighbourhood catchment authorities, have been devoted in the past to increasing the uptake of both soil moisture probes and flow meters. The high levels of water use efficiencies obtainable from center pivot irrigation relies on concise measurement of soil moisture status

Appendix 2: *A brief summary of CPLM efficiency evaluation results.*

id	Application amount (mm)	Flow rate	Uniformity CU (%)	Rating	Comment
1	overreading	above designed	88	excellent	amongst the best performers
2		needs to be doubled	89.5	excellent	50% below panel
3	9mm	o.k.	85	Fair/good	Difficulty meeting high demand, fixed plate sprinklers
4	12mm	na	na	na	Compromised audit
5		o.k.	81.6	average/fair	Pronounced leaks Bogging
6		below design	86	Reasonable	18% below panel, Extra span added
7		Slightly below design	86	Good/excellent	Problem with blockages (filter) Well caliberated
8	10mm	drop off a concern	87	Good	Delivery 12% below panel
9		12% below designed	85	Good/excellent	Delivery 12% below panel Uniformity/End gun
10		17% above design	83	fair,	fixed plate sprinklers
11	12mm	below design	75	Poor	fixed plate Blocked emitters, old regs
12	10 mm	correct	90.7	excellent	Follow upunexplained pressore variance.
13		n.a	80.5	Fair	New emitter package planned
14	31	correct	87	Good	boombacks need attention
15	25	not measured	83	Fair	Change emitters on last span
16	45	ok	87	Good	excellent boombacks. 7% appl variance to panel
17	25		84	Fair	emitters fitted not ideal for "sodic" soil
18	13.6	10% below spec	83	Fair	Discrepancy: panel / actual delivery
19	18.5	ok	90.5	Excellent	Excellent machine