Australian Government
Cotton Research and Development Corporation

FINAL REPORT 2013

Part 1 - Summary Details

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

CRDC Project Number: **DAQ 1303**

Project Title: Optimizing water and energy use in the CQ Irrigation Sector

Project Commencement Date: 1/07/2012 **Project Completion Date:** 30/06/2013

CRDC Program: Farming Systems

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Part 3 – Final Report

1. Background

Since 1999-2000 the Queensland Government has funded four Rural Water Use Efficiency programs across Queensland. These projects, primarily focussed on improving water use efficiency within the Cotton and Grains industries of Queensland, resulted in significant improvements in the efficiency of irrigation within these industries. The most recent project (RWUE4) focused specifically on the assessment of the performance of centre pivot and lateral move machines in Central Queensland, and the development of the Growers Guide to Centre Pivots and Lateral Move DVDs.

Water remains a major limiting factor in the Australian cotton production system. Pumping costs typically constitute a major component of irrigation system energy use. Due to rapidly escalating cost of energy pumping now represent a major cost in most cotton production systems. Consequently, in this context of rising energy costs and concerns over greenhouse gas emissions, attainment of improvements in on-farm energy efficiency has becoming increasingly important.

This project has built on those previous projects listed above. The principal focus (40%) has been the examination of potential methodology for automation of furrow irrigation. Furrow automation would assist growers adapt to the increasing difficulty in sourcing labour. The potential for increased flexibility associated with automation in irrigation application would enable irrigators to adopt more precise scheduling methodology than currently possible.
In addition, this project continued providing assistance to growers seeking to improve both water and energy use efficiencies via overhead machine and pumping system efficiency evaluations. These activities were conducted in conjunction with general resource development and promotion of best practise amongst irrigators. The project has also played an important role in providing information where requested by governmental agencies and the community in general in relation to the cotton industries concerted commitment to improve energy and water use efficiencies

2. Objectives

OBJECTIVE 1: Advisory Committee in operation
At an initial meeting (July 18th 2012) the draft research proposal was presented to the CHCG & I Assoc Research and Tech panel for discussion. At the request of the R & T panel, as most members of the CHCG & I Assoc Research and Tech panel are regularly in attendance at association general meetings, all subsequent updates of the projects progress were submitted and discussed at the general CHCG & I Assoc members meetings.

OBJECTIVE 2: Develop techniques to automate furrow irrigation – 2.1 *Conduct field trialling, 2.2 a farm walk and 2.3 publish results.*
The objective of providing data validating the role of AutoSISCO and developing techniques to automate furrow irrigation was successfully achieved in CQ by project completion. Results of the evaluations have been integrated into the database developed by the NCEA furrow automation project. No field walk was conducted as there was very little to see. It was considered inappropriate to invite growers to an event where the single feature was a number of stainless steel rods (Advance /depth meters) nestled amongst the cotton.
Trialling in the Central Queensland context was conducted in collaboration with work undertaken by the NCEA CRDC project. The trials were specifically designed to augment the data set pertaining to furrow automation and thereby enhance the validity of any conclusions reached by trials conducted in southern regions. While many of the issues faced by Central Queensland cotton production systems are common industry wide there are

aspects unique to this region. The CQ climate is one of the most variable in the world. This constitutes an additional challenge for growers in their efforts to improve yields and is the driver behind a range of research activities, including this project.

At the inception of this project the AutoSISCO software programme had been evaluated across a range of southern cotton production regions but this work had primarily been conducted in the context of bay irrigation. There is considerable interest amongst growers regarding the prospect of furrow automation and the researcher had to explain on a number of occasions why a field visit was of limited value. When automation at the head-ditch is installed in forthcoming trials it is expected that a large bbq plate will be required when the first field walk is conducted.

Results of the evaluations have been integrated into the database developed by the NCEA furrow automation project. A co-authored publication discussing the outcomes of trialling across the various regions is currently under review for publication (Principal author Prof Rod Smith)

OBJECTIVE 3: Ascertain & promote pumping system energy benchmarks – *3.1 Completion of 7 Pumping system energy performance evaluations, 3.2 a farm-walk, 3.3 availability of benchmark report, and 3.4 data entry into IPERT*
This objective fell 1 short of the milestone target of 7 evaluations
A project milestone was to conduct pump system evaluations to assist growers improve their production efficiencies and provide data to facilitate benchmarking of energy use in the Central Queensland Irrigation sector. As pumping constitutes a major energy cost in most irrigation systems the project focused on achieving a target of 7 pumping system evaluations. In addition to the 2 evaluations previously reported in the November Progress Report a further 4 evaluations were conducted by the conclusion of the project. Results of all evaluations were compared to the benchmark of 5 kWhr/ML/meter head and discussed with the operator. These evaluations have formed the basis for a range of presentations discussing their value for assisting in efforts to reduce energy costs in cotton production systems.

OBJECTIVE 4: Evaluate the performance of overhead irrigation systems and publish results - *4.1 system efficiency evaluations conducted (8), 4.2 case study published, 4.3 data recorded into IPART*
Six overhead irrigation systems, all centre pivots, were evaluated. This fell two short of the milestone target of 8. Due to the various cropping regimes in place the window of opportunity to conduct these evaluations at the beginning of the 2012/13 planting was unusually restrictive. Quick crop turnover (e.g. wheat) to cotton was common in CQ that season. Evaluations cannot take place before the first cotton in-crop irrigation but must be conducted before the crop attains a height that will impede collection-cup interception of sprinkler emission.

OBJECTIVE 5: Provide support to Fitzroy Basin Association - *5.1 assist with myBMP uptake, 5.2 provide technical advice*
This objective was satisfactorily achieved. Assistance with FBA funded roll-out of myBMP (Bluedog Consultant) and technical advice were provided as required.

OBJECTIVE 6: Provide advice to irrigators concerning water use and energy efficiency – *6.1 promote existing energy and water use efficiency tools*
This objective was achieved throughout the conduct of the project.

OBJECTIVE 7: Interaction with local irrigators group (CHCG&I) - *7.1 attend meetings and provide update reports*
The researcher has attended and provided an update on activities and events at most grower meetings. Exceptions were when travelling.

OBJECTIVE 8: Provide technical advice to the Cotton D & D team – *8.1 update the water management module of my BMP, 8.2 review and update the Crop water use chapter in Australian Cotton Production Manual 2013, 8.3 4 articles to D&D E newsletter and 2 Spotlight articles, 8.4 provide technical support to D&D regional development officers, 8.5 attend 2 D&D team meetings.*
In conjunction with Janelle Montgomery, in the shared role as the Cotton D & D team Water technical specialist, all commitments required were addressed successfully by the project (e.g. provision of technical support, development of articles for delivery team, completion of myBMP rewrite, and attendance at D & D team meetings)

3. Methods

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

1. *Conduct on-farm trialling of furrow automation techniques to compliment CRDC funded NCEA/Rubicon project,* "Sensor technology to enable full automation of irrigation".

After discussion with NCEA to determine the appropriate priorities for automation trials to be conducted in CQ the trialling was specifically designed to

- Verify if the successful performance of AutoSISCO in bay irrigation would translate to a furrow irrigation context
- Determine the most appropriate position downfield of the advance / depth sensors providing required input to AutoSISCO for calculation of optimum in-flow cut-off time
- Investigate if there was any benefit in the use of multiple advance / depth sensors placed incrementally downfield in comparison to placement at a single location.
- Validate AutoSISCO across the range of furrow irrigated field types in CQ and thereby extend the diversity of data sets, and consequently, the validity of any conclusions made.

The data sets from 7 individual automation trialling irrigation events have been integrated into the existing NCEA data set for inclusion in analysis.

2. *Complete irrigation efficiency evaluations on a least 7 Central Queensland overhead irrigation systems and enter into IPART data base*
The methodology underpinning the Centre Pivot / Lateral Move (CPLM) system evaluation process is based on a sound statistical foundation (as verified by the American Society of Agricultural Engineers and the Australian Standards Association). Evaluations involve an extensive examination of machine pressure and flow characteristics, and of general component performance. This enables a comparison of actual performance to the machines quoted design specifications. Observations made throughout the conduct of the evaluation assist in determining the suitability of the machine in relation to the specific field, particularly the soil characteristics. Results of the evaluations have consistently provided valuable assistance in identifying the source of any problem and therefore equip the grower with information that can be used to rectify issues of poor performance. In the past machine manufacturers and contracted installers were often quite vocal in dismissing results from the evaluation process (particularly when unfavourable) however, in recent years, this response has fortunately become more subdued. There is now increasing acceptance of the validity of

the process employed and of the value provided to the industry in general by both providers and growers. This may be related to increased maturity of the industry as reflected by the observed general improvement in the product provided to growers. The methodology has been regarded by some critics as being to labour intensive / expensive however this researcher disputes this. There are now many documented examples where the attention to detail and accuracy of the data collected has resulted in significant improvement in machine performance and /or operational techniques.

3. *Evaluate and benchmark energy efficiency of a least 8 Central Queensland pumping systems and enter into IPERT data base.*
The methodology employed to evaluate performance of pumping systems is rigorous and sound. The process is conducted in a manner similar in many ways to that used to evaluate CPLM machines. Measurement of a suite of variables, including pressure and flow, operating head, and energy consumption, enable comparison of measured performance to the theoretical best operating point, as identified on relevant efficiency curve graphs. Use of this data enables comparison of performance against a benchmark (e.g. 5 kWhr/ML/m head). Where a pump system is identified as performing outside its optimum range operators are better equipped to make cost benefit analysis of options for improvement.
One of the challenges when conducting evaluations is that every pump system has its idiosyncrasies, no two are identical. This often necessitates the use of "novel" techniques to gather the required data. Achieving access to a suitable length of pipe for installation of an ultrasound flow meter is the most common challenge.
Considerable effort has been committed to finding a more efficient and expedient method of evaluating pumps system performance than the methodology used throughout this project. This researcher has no first hand experience of the PIMS system that has been developed by NCEA but there has been suggestion that this system may provide a means to evaluate pump performance in an efficient manner once its development is complete.

4. *Communicate benefits of assessing energy and irrigation performance of irrigation systems*
Actions throughout the 12 month project to promote efficient irrigation water and energy use, and to advance both the concept and subsequent application by growers of benchmarking encompassed a range of activities. These included regular presentations at local irrigator association meetings, presentations at national conferences, representation on special interest groups, and assistance with revision of both myBMP and WATERpak.

Project activities that contributed to promotion of energy and irrigation performance included

- Attend Northern Rivers Forum presentation and assist with formation of local growers group. On-going liaison with manager of trial irrigation at "Silver Hills, Richmond providing technical advice re irrigation, pumping and storage management.

- Presentation to the "Teach the Teachers" (15 March) field day outlining the role of research and extension (funded by CRDC) in achieving improved production efficiencies and environmental sustainability.

- Presentation (reported by ABC radio and TV) at release of "The Risks and Impacts of Coal Mining Subsidence" release (6 May)

- Presentation "Current and future Research focus in CQ" at Research & Tech CQ Research Forum (16 April)

- Presentation and display stand, conducted on behalf of cotton industry, to 15 groups of school students (180 students / 15 teachers in total) at Natural Resource Management Expo

- Contribution as member to two IAL Special Interest Groups, Surface Irrigation, and Centre Pivot Lateral Moves. This Involved provision of information for development and delivery of online learning system and editing of various resource materials.

- Provided assistance (Stuart Bray) in compilation of general footage and interviews with CQ growers for development of video clips (U tube and digitalfarmtv) relating to CPLM and pump efficiency evaluations, furrow automation research, oxygated SDI and water and energy use efficiency in general.

- Assist in revision of WATERpak. Subsequent to the conclusion of this project the WATERpak revision has been completed (released on-line August 2013).

- Continuation of the Water module rewrite (conducted in collaboration with Janelle Montgomery, NSW DPI) as part of the overall myBMP revision. This principally involved restructuring the Key areas and practises, revising Levels (from the previous 4 back to 3) and associated check list items, and updating all resource links, including those to the revised WATERpak

- Contribute Chapter 8 "Irrigation Efficiency" to Australian Cotton Production Manual 2013

- Development of role (shared with Janelle Montgomery, NSW DPI) as Water Technical Specialist on D & D Team.

- Submit FRP to CRDC for Optimising water and energy use in the CQ Irrigation sector 2013/16. Project approved 9 March 2013.

5. *Provide assistance as requested to the Fitzroy Basin Association (FBA), particularly with roll-out of myBMP and technical advice regarding funding applications.*
This objective was successfully provided throughout the conduct of the project.

6. *Continue interaction with local irrigator group (CHCG&I Assoc) and individual irrigators for promotion of techniques and resources that assist achievement of improved water use and energy efficiencies.*
With the exception of when travelling to attend other activities precluded the possibility, all local irrigator group (CHCG&I Assoc) meetings have been attended. This venue has always provided an important opportunity to catch up with growers that the researcher may not have interacted with in the course of field activities. In addition, the invitation to present an overview of project progress is a standing item on the CHCG&I Assoc meeting agenda. Although there are a number of growers that are not "meeting attenders" the association meetings are one of the most valuable venues for disseminating information, requesting assistance, and generally staying in growers view.

4. Results

OBJECTIVE ONE.

Advisory Committee in operation

At an initial meeting (July 18th 2012) the draft research proposal was presented to the CHCG & I Assoc Research and Tech panel for discussion. A presentation and discussion regarding the proposal was also delivered that evening to the grower association general meeting. In detailed feedback provided several weeks later (8th Aug) a representative from the Research & Tech panel expressed their satisfaction with the intended focus of the project.

The panel also suggested that it would be timely if possible to "revisit" a number of activities promoted by earlier water use efficiency projects. Water use efficiency benchmark terminology requires continual promotion as there are still growers who are not conversant with it. The panel inquired as to the availability of the furrow optimisation evaluation process (i.e. Infilt / Sirmod) that had been conducted in times past as it was felt that this process could promote CQ irrigation methodology improvements. It is a requirement that soil infiltration and advance characteristics etc are available for all sites that depth meters and CISCO are to be trialled as part of the furrow automation research component of this project. Although trialling will utilise field data sourced from a number of sites where furrow optimisation trials were previously conducted it will be necessary as part of the project to conduct these evaluations on a number of additional sites. Fortunately the required equipment (Flow, flume & advance meters) has been retained.

The progress of and rational behind Objectives of the project were again presented to growers at East and West side area wide meetings held 31st October.

This Final Report will be submitted and discussed at a general CHCG & I Assoc members meeting.

OBJECTIVE TWO**.**

Develop techniques to automate furrow irrigation – 2.1 *Conduct field trialling, 2.2 a farm walk, and 2.3 publish results***.**

The completed trialling provided information regarding optimum downfield placement of the advance / depth sensor(s) that enables progression with evaluation trialling to be conducted in the CRDC funded project now underway. Interim analysis has provided encouraging results suggesting a strong correlation between AutoSISCO predicted cut-off time and their associated outcomes in relation to irrigation efficiencies. A number of practical issues were identified and addressed relating to placement of probes in the furrows and long standing issues with the operation of siphon meters and downfield flumes continue to cause issues. In consultation with NCEA it is expected that future trials will overcome these disruptive issues.

The trials conducted by this project were undertaken on two different fields. Future work (already underway) conducted on different properties (i.e. different field conditions) will further extend the diversity of sites involved in the evaluation and development process. Again, the focus of the future field trials has been determined via consultation with NCEA as to the most appropriate questions that require examination via work in the CQ context.

OBJECTIVE THREE.

Ascertain & promote pumping system energy benchmarks

Results of each pump system efficiency evaluation were communicated with the individual grower and imported into the IPERT data base.

For examples see Appendix 1 & 2.

OBJECTIVE FOUR.

Evaluate the performance of overhead irrigation systems and publish results

Results of the evaluations have been integrated into the IPART database and were presented at the IAL conference as part of the Modernising surface irrigation presentation and forum.

It was readily obvious when evaluated that three of the evaluated machines were suffering from a common problem i.e. operating below their design pressure. A fourth system was actually operating in excess of its designed pressure, a situation that directly impacts on energy use efficiency. Pressure should be approximately 5 psi above pressure regulators where fitted. System pressure at the outer end of this machine was noted at varying pump rpm in order to ascertain the appropriate operating strategy. This process alone should result in improved energy efficiency and consequently a reduction in operating costs.
The remaining three machine evaluations were indicative of the positive trend that has been observed recently i.e. they were well designed to meet the specific conditions, and importantly, were installed correctly. As a consequence their performance was rated as excellent.

For examples of Pivot evaluation Reports see Appendix 3, 4 & 5.

OBJECTIVE FIVE.
Provide support to Fitzroy Basin Association - *5.1 assist with myBMP uptake, 5.2 provide technical advice*
A total of 34 Technical reports evaluating applications for FBA administered funding (predominately for repairs to flood damaged infrastructure) were provided over the course of the project. In addition, technical advice was provided to FBA / Bluedog Consultancy in promoting the uptake of myBMP by assisting growers at "Big Bend" and Theodore successfully work through water module workshops. Attendance at the annual two day FBA "Muster" provided the opportunity to establish links with new Landcare extension officers and renew acquaintances with other FBA personnel.

For examples of Technical reports provided to FBA see Appendix 6, 7 & 8

OBJECTIVE SIX.
Provide advice to irrigators concerning water use and energy efficiency – *6.1 promote existing energy and water use efficiency tools*

OBJECTIVE SEVEN.
Interaction with local irrigators group (CHCG&I)
Local irrigator association meetings were regularly attended and presentation of project update reports were a standing agenda item.

OBJECTIVE EIGHT.
Provide technical advice to the Cotton D & D team – *8.1 update the water management module of my BMP, 8.2 review and update the Crop water use chapter in Australian Cotton Production Manual 2013, 8.3 4 articles to D&D E newsletter and 2 Spotlight articles, 8.4 provide technical support to D&D regional development officers, 8.5 attend 2 D&D team meetings.*

5. Outcomes

Describe how the project's outputs will contribute to the planned outcomes identified in the project application. Describe the planned outcomes achieved to date.

Design and conduct of this 12 month project was based on three principal overarching objectives (listed below).

1. To retain momentum of the main activities previously provided under RWUE funding (prematurely terminated following the last QLD state elections) in the CQ region.

2. Provide a platform for development of a more substantial project designed to enhance validity of research results achieved predominately in more southern environs by conducting parallel trialling in the CQ region.

3. Initiate research conducted in collaboration with the CRDC funded "*Sensor technology to enable full automation of irrigation*" project and its focused on evaluating potential and achieving methodology for automated furrow irrigation. .

Performance evaluations conducted by the project of both overhead system and pumping system performance have expanded the resource base critical to the development and promotion of water and energy use efficiency benchmarking industry wide. Inclusion of these results provided additional data sets to those already recorded in the NCEA IPART & IPERT databases. These two repositories constitute a valuable resource as they provide the cotton industry with a readily accessible overview of performance characteristics across a broad range of applications.

Discussion with growers subsequent to each evaluation provided the individual operators with additional information to assist in efforts directed towards achieving improved water & energy use efficiencies. Gains in both aspects typically translate to enhanced profitability of their enterprise. Outcomes have been utilised to promote the benefit and uptake of these efficiency evaluations, both within the CQ irrigation community, and to the broader cotton industry.

Trialling of furrow automation methodology specifically examining the validity of AUTOCISCO performance, and the most effective down-field location of associated sensoring devices, was successfully conducted. The results have been integrated into the data set already established by the collaborative partner at NCEA.

When the collaborative basis underlying the furrow automation development trialling was proposed it was intended that the project would be acting as a pilot for subsequent cooperative activities. Often research conclusions based on evaluations conducted "elsewhere" are met with varying degrees of scepticism. The validity of this response may well often be unfounded but nonetheless it can negatively impact on potential uptake. The addition of data collected throughout the project from fields in CQ increased the range of conditions under which aspects of furrow automation have been trialled and thereby enhanced the scope for uptake of any conclusions that may arise.

The collaborative approach with NCEA has been very successful. On several occasions the researcher attended NCEA in Toowoomba for discussions regarding the most appropriate focus for automation trialling in CQ. Advice regarding protocols employed, future direction, and the provision of required equipment has always been readily provided. The success of this collaboration for implementing research in the CQ context was evident early into the project and provided incentive to apply the same approach when formulating the PRP for the CRDC funded 3 year project currently underway.

There has been keen interest in the prospect of furrow automation amongst local growers. The initial investigation reported herein and work already underway as part of the current CRDC funded 3 year project is the subject of persistent inquiry from a range of irrigators. It was new experience for this researcher to be placed in the position of justifying why a field

visit was not appropriate given that there was so little to physically see (updates provided at meetings throughout the season were a more effective substitute).

The projects commitment to continuation of a range of activities previously provided by the RWUE4 project was achieved. Aside from the provision of specific activities (e.g. trialling, pump and CPLM evaluations) the project continued to fulfil the role as a general "go-to" contact in relation to water and energy use issues. This included providing advice within and beyond the CQ region including both state and, on a number of occasions, federal government agencies. The role as Water Specialist on the Cotton D & D team (shared with Janelle Montgomery), taken up as a variation to the initial project objectives, provided the opportunity to devote more attention to this demand. In this capacity the project contributed successfully towards the revision of both myBMP and WATERpak.

6. Please describe any:-

a) Technical advances achieved (e.g. commercially significant developments, patents applied for or granted licenses, etc.);

- No commercially significant developments, patents applied for or granted licenses

b) Other information developed from research (e.g. discoveries in methodology, equipment design, etc.);

- Automated furrow trialling conducted did identify a number of practical issues that have since been redressed. These were discussed earlier

c) Required changes to the Intellectual Property register.

- None required

7. Conclusion

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

The outcomes of this project provide additional case studies that facilitate the on-going impetus behind efforts to improve both water use and energy use efficiencies of cotton production systems throughout the industry. In times of escalating costs growers require definitive evidence of the cost benefit of every dollar committed. The additional examples provided by this project highlight the value for growers in comparing their performance against industry benchmarks as this enables identification of potential improvements that typically translate to production cost benefits. The contribution by this project assists in the uptake of efficiency evaluation

The ongoing investigation into methods that enable efficient automation of furrow irrigated fields has created considerable interest amongst growers. The field trialling conducted by this project has already initiated discussion amongst local growers and it is envisaged that future work will be under close scrutiny. The observed interest verifies conclusions reached from consultation with the local growers in the formulation of the projects i.e. that many growers regard this area of investigation as having direct relevance to their needs. These augers well for uptake once growers are provided with sufficient information on how furrow automation can be effectively implemented.

8. Extension Opportunities

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

(a) To further develop or to exploit the project technology.

The 3 year CRDC funded project "*Optimizing water and energy use in the CQ Irrigation Sector*" came into effect immediately following completion of the 12 month project reported herein. This subsequent project is principally focused on researching a number of areas, including a continuation of furrow automation field trialling. Two potential scheduling methodologies, Dynamic Deficits, and a derivative of Biotic (using thermal imagery of canopy temperature) will also be evaluated. Again, these will be conducted in the CQ context on a collaborative basis with NCEA and CSIRO in order to cost effectively expand the data sets underlying the three existing research activities.

The new project contains provision for the conduct of a number, albeit reduced, of both CPLM and pumping system efficiency evaluations and will continue to promote the use of benchmarking as a means of achieving the production cost savings typically associated with improved efficiencies.

(b) For the future presentation and dissemination of the project outcomes.

The ongoing role as Water Specialist on the Cotton D & D team (shared with Janelle Montgomery) provides additional opportunity beyond those already utilised within the CQ region for presentation and dissemination of the project outcomes.

(c) For future research.

As per CRDC Project DAQ1404, "*Optimizing water and energy use in the CQ Irrigation Sector*"

A. Presentations & Publications arising from the research

- Presentation "Energy Use Efficiency: The Need to Benchmark" at Cotton Conference (Broadbeach 2012) *see Appendix 9.*

- Presentation "Modernising surface irrigation: A researchers perspective" at Irrigation Australia Limited (IAL) Conference, Griffith (29-30 May) *see Appendix 10*.

- Publication: Payero J, Hare J, Pendergast L, Harris G, Robinson, G (2012) Is it feasible to schedule irrigations using the ETgague? In Proceedings of the 16th ASA Conference, 14-18 October 2012, Armidale, New South Wales. Web site www.agronomy.org.au

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

The project contributed to the revision of both myBMP and WATERpak online resources,

Part 4 – Final Report Executive Summary

Increased flexibility associated with automation of furrow irrigation (40% of the projects activities) has potential to play a critical role in enabling irrigators to adopt more precise scheduling methodology than currently possible with the predominate industry irrigation practise of manually set furrow syphons. In addition, automation could assist with the increasing difficulty faced by irrigators in sourcing labour.

The project provided valuable information regarding optimum downfield placement of the advance / depth sensor(s), and resolved a number of identified practical issues relating to placement and operation of sensors. This facilitates progression with evaluation trialling to be conducted in the current CRDC funded project. Interim analysis has provided encouraging results. suggesting a strong correlation between AutoSISCO predicted cut-off time (using a single advance point), and their associated outcomes in relation to irrigation efficiencies. As a result of the collaborative basis of the automation research (NCEA CRDC project) many of the problems that are often associated with initial trialling were avoided. This was of great value in providing cost effective outcomes and progressing future research in an efficient manner.

Pumping constitutes a major energy cost in most irrigation systems. Previous evaluations have indicated the potential for significant improvements in many systems. Pumping system efficiency evaluations conducted by the project enabled comparison of measured performance to the theoretical best operating point (as identified on relevant efficiency curve graphs), and comparison of performance against an industry benchmark (using 5 kWhr/ML/m head). Where systems were identified as performing outside their optimum range, or at variance to the benchmark, growers were better equipped to make cost benefit analysis of options for improvement.

Historically performance evaluations results have indicated that many overhead irrigation systems were falling short of their expected performance efficiencies. In many cases, once identified, factors impeding efficient operation have been redressed via relatively inexpensive modifications. Evaluations conducted by the project provided valuable assistance in identifying the source of any problem and thus equipped the grower with information that could be used to rectify issues of poor performance.

The project continued working closely with the local irrigators and the community in general providing resources pertaining to water use and energy use efficiency. This has facilitated an enhanced awareness of industry wide efforts and has equipped the local growers with the options to improve the viability of their operations.

The recently funded CRDC project, now underway, will sustain this projects impetus by continuing to assist local irrigators address the challenges inherent in maintaining sustainable cotton production in the face of a changing environment.