

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

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

Background

1. Outline the background to the project.

Despite the increased adoption of pressurised irrigation systems in recent years, furrow irrigation is and will remain to be the dominant application technique in the Australian cotton industry in the foreseeable future. Furrow irrigation involves relatively low capital investment making it ideally suited to the opportunistic nature of cotton production where the area planted varies from season to season depending on commodity prices and water availability.

The Australian Cotton industry can stake the claim of being one of the leaders in irrigation practice and innovation. Nowhere is this more apparent than for surface irrigation where the industry has made significant gains in water management leading to direct increases in productivity. One key driver of this change is the ability to monitor and model furrow irrigation provided through the use of the Irrimate™ in field evaluation system. Over the past decade, hundreds of evaluations have been performed in order to guide individual growers and inform researchers. The resulting data resides in the archives of each of the parent government institutions and consulting firms. The data recording and reporting processes are inconsistent between organisations and often also between individuals. Consequently it has been difficult to perform industry wide benchmarking of water use management.

In 2008 the NCEA was commissioned by the Cotton Catchment Communities CRC to develop a web interfaced database for furrow irrigation evaluations. The resulting tool, the Irrimate Surface Irrigation Database (ISID) was completed and consequently populated with a total of 110 separate irrigation events. This data, primarily comprised of NCEA experimental trials, is merely a subset of the total evaluations that have been conducted. The true full number of previous Irrimate™ trials is unknown, Raine et al. (2005) estimated that there had been in excess of 300 field evaluations conducted prior to and including the 2004-2005 season. Notwithstanding the drought conditions that the industry has experienced over recent years this number is expected to have grown significantly since this time. Individually these trials might appear trivial but combined they represent a legacy of the industry's genuine and continuing effort to measure and improve water use efficiency.

While individually the evaluations have been useful to growers, combined these results provide a valuable resource to the industry as a whole. The previous project failed to capture datasets across the industry due to (i) the limited amount of time available and (ii) the time required for manual data preparation and entry.

Objectives

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

The aim of this project was to rectify shortcomings of the ISID system and work to collate historical irrigation measurements from a wide range of sources. Modification of evaluation procedures and modelling software aims to streamline collection of benchmarking data into the future.

1. To scope industry requirements and implement changes to the existing ISID database

At the completion of the initial ISID project in 2008 the NCEA participated in a meeting of consultants, extension officers and selected farmers in Goondiwindi. After demonstrating the system feedback was sought on the data collection process, interface and benchmarking components of this database. These comments assisted in the early scoping of design requirements.

It was determined that it would be preferable to have a working version of the computer software to demonstrate the current status of the system before asking for detailed feedback. Later in the project the principle researcher met with a number of key users of the evaluation process to demonstrate SISCO and its integration with the ISID system. More detailed feedback on the reporting of results was also requested during this time. The individuals involved represented commercial consultants, research staff and extension staff.

ISID was also presented at the 2012 Annual Cotton CRC Science forum and comments were invited and subsequent changes have been made to the database since this time.

2. To collect, process and upload data into this database

A significant quantity of data has been collated and entered into ISID during the life of this project. At the completion of the previous project and commencement of this project the database contained 110 irrigation events. The first stage of the project involved a quality assurance of this existing data by repeating the analysis and simulation.

During this project data was collated from the following sources:

- a) Aquatech Consulting are the commercial instigators of the Irrimate service and are also custodians of the largest quantity of irrigation measurements. Aquatech Consulting provided the project with all historical data that was

reliable and readily accessible. While Aquatech is based in Narrabri they have also conducted much of the analysis for other smaller consultants across NSW and QLD and hence the data represents a broad cross section of the industry.

- b) Data was also provided by Olive Hood, representing the time she was operating as a consultant. This data is significant as it represents the St George irrigation area which is lacking from other sources. Less than 20% of the total data was uploaded due to grower concerns over how the data might be utilised. There may be potential to capture a larger proportion of this data (possibly over 100 additional events) in the future
- c) Jenelle Montgomery and Rod Jackson provided data collected over a number of seasons by the NSW DPI.
- d) Jack McHugh and David Wigginton supplied measurements for in excess of 100 irrigation events in QLD across 8 irrigation seasons. This data represents some but not all of the evaluations conducted under the RWE programs.
- e) FSA Consulting was contacted and initial impressions were positive, However project time limits meant that this data was not pursued.

A substantial part of this data was received in the final stages of the original project schedule. For this reason an extension was granted beyond the finalisation of the CCC CRC.

At the commencement of this project it was envisaged that the majority of irrigations would be fully documented. It was expected that the data would include complete field measurements, model input files, results of analysis and optimised irrigation strategies. While this was true in some instances, the majority of the data required full processing, calibration of soil properties, creation of model files and generation of simulation results. This required far more work than was anticipated. Furthermore, recalibration and repeat simulations were performed on all data with available model files and results in order to validate the accuracy of reported results.

During this project a total of 520 events have been processed, analysed and uploaded into the database resulting in a current total number of 630 irrigation events.

3. Use this database to provide benchmarks of water use efficiency, study historical trends and relationships with field characteristics.

For individual users ISID serves as a storage mechanism for surface irrigation measurements. At a higher level the overview user account type allows users to interrogate the entire database based on specific queries.

Sample results are included in the results section of this report.

The data collected enables users to benchmark key indicators such as application efficiency, deep drainage and applied depths according to:

- Season
- District
- Field length
- Flow rate

Many other characteristics such as soil type are collected by the database but results are not presented as many properties are missing such details.

The accuracy of all benchmarking results will increase into the future as further irrigation measurements are added.

4. To integrate the evaluation software with the database, thereby simplifying the data upload process

The original ISID system is based on a web page that permits users to enter data manually or upload selected parts of the information from model input files. This process is time consuming and tedious process. This was identified as a major issue with the existing ISID system.

New code has been written in order to allow the computer model SISCO to automatically connect to the Database. Data may be downloaded from ISID into the model and data may also be uploaded back to the server. Users can browse through all properties which they have entered and have permission to access. Once they have selected a field they can then view the evaluations at that particular field over the season of interest. After selecting an irrigation they can view the separate furrows that were monitored as part of the evaluation.

Once a furrow is selected the interface displays all characteristics, measurements and performance indicators for that furrow. At this point the user may choose to:

- a) Modify field measurements,
- b) repeat the soil calibration process (improve fit of model to reality),
- c) repeat the model simulation (to evaluate efficiency, uniformity etc.)

In essence the modifications to SISCO allow users to bypass the time consuming process of manual data entry into the web portal which was a major issue with the existing ISID database.

SISCO by design is fully compatible with Irrimate evaluation procedures and therefore has similar data requirements as previous software and field measurement procedures. Historical field measurements and evaluation results are stored within the input files of several separate pieces of software including SIRMOD, Infiltr and IPARM. Functionality has been added to SISCO in order to allow it to extract field characteristics and measurements from the data files of other computer software used during Irrimate evaluations

Previously, accessing field characteristics required the user to load data files using each separate piece of software and manually transfer values. SISCO, the replacement software for Irrimate evaluations is now capable of extracting the data from these files. From this point it is an easy task to repeat analysis where required before uploading to ISID.

5. To provide documentation training, and support to users.

A full instruction manual has been written for ISID covering the following aspects:

- Background of ISID
- User accounts and login procedures
- Description of all information stored within the database including compulsory and optional elements
- Procedure for creation of new fields and evaluations
- Use of the SISCO – ISID connection module

It was initially envisaged that formal training would be provided during the life of this project. Whilst this did not occur individual discussions and meetings were conducted with Irrimate consultants and potential users of the database both prior to and midway through the project.

Follow up workshops are being organised in NSW and QLD for early November (or later depending on availability of stakeholders). These workshops will have the dual purpose of (a) providing training in use of ISID and SISCO and (b) discussion of the benchmarking results.

The NCEA is committed to support of ISID and its users into the future. A user manual has been written detailing the web interface and use of the SISCO-ISID uploading features. It is envisaged that ISID training will be incorporated as a module within the Surface Irrigation training course offered by the NCEA. This will ensure that future users of the Irrimate services are familiar with the ISID system.

Methods

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

This work was not a typical “hypothesis–methods–results–conclusion” style project and hence no unique methodologies were developed.

The basic methodology has been discussed in the previous section in relation to each of the separate project aims.

Results

4. Detail and discuss the results for each objective including the statistical analysis of results.

Development of ISID

Initial feedback from industry indicated that adoption of the Database would require guarantees on data security and grower anonymity. As a result access to ISID is only available through use of a secure username and login system. The NCEA is well experienced in this area with development of several other web based applications such as IPART which also store sensitive information pertaining to farmers water management.

Access to ISID is via one of two levels or account types, a consultant/technician level and an overview level. The consultant is able to create and upload evaluations, but only view and edit those evaluations which they originally entered. The overview level user is able to interrogate the database at a more generic level to gain industry wide irrigation statistics but cannot access the details of individual evaluations or growers. In this way the privacy of growers is maintained at all times.

Data Processing and Upload

Field evaluation data was collected from a wide range of sources representing irrigation events over the past 11 years since the inception of the Irrimate service. Even though the majority of this data was collected using similar field equipment and analyses using standard software it soon became apparent that initial concerns over the archiving procedures of the various parties were well founded.

Irrigation events were only uploaded to the database where full field measurements were provided. This enabled full quality checking of all values uploaded to the database. SISCO calibrations were performed for every event uploaded to ensure that the soil infiltration parameters were true representations of field behaviour. SISCO utilises the full hydrodynamic model for this calibration procedure, as opposed to the simplistic volume balance technique used for all Irrimate evaluations (e.g. INFILT & IPARM). For this reason re-calibration within SISCO also identified a number of events where the assumptions in the more simplistic models were violated hence resulting in unrealistic soil parameters.

This exhaustive use of SISCO to analyse all historic datasets has also assisted in identification of several minor bugs or missing features for inclusion within SISCO. This will ultimately improve the accuracy of the evaluation process into the future.

Preliminary Benchmarking of Furrow Irrigation

As mentioned previously the principle researcher has recently received a large quantity of data that will ultimately improve the quality of any benchmarking analysis that is provided here. For this reason all results presented in this report are preliminary and subject to change as those additional irrigations are processed and uploaded.

Summary Results

Currently there are in excess of 630 individual irrigation events within ISID. All major cotton growing catchments are represented with data stretching from the 1998-1999 to 2011–2012 seasons. Table 1 represents a statistical summary of all irrigation events currently in the database. Many prefer the median (middle) value rather than the simple average value as the latter is susceptible to being skewed by outliers. The values of the 1st and 3rd quartiles represent the spread of the middle 50% of measurements.

The application efficiency is defined as the percentage of total water applied to the field that is added to the root zone storage and can be used by the crop. This value assumes that all water that leaves the end of the field is a loss to the system. A more meaningful value for the majority of growers is the application efficiency with tail water recycling which realises that the majority of runoff can be recaptured for future use.

Table 1 - Summary of performance of all data within ISID (631 events)

| | Average | 1st Quartile | Median | 3rd Quartile |
|---|----------------|------------------------------------|---------------|------------------------------------|
| Flow rate (L/s per 2 m width) | 4.4 | 2.8 | 3.8 | 5.6 |
| Run time (hours) | 12.5 | 8.4 | 11.5 | 14.6 |
| Moisture Deficit (mm) | 82 | 65 | 80 | 100 |
| Total Water applied (ML/Ha) | 1.303 | 0.902 | 1.169 | 1.535 |
| Application efficiency (%) | 64.6 | 52.9 | 64.8 | 76.9 |
| Application efficiency with tail water recycling* (%) | 76.1 | 64.3 | 79.0 | 89.8 |
| Requirement Efficiency (%) | 95.2 | 95.3 | 99.9 | 100.0 |
| Infiltration (mm) | 104.8 | 71.8 | 95.5 | 124.5 |
| Deep drainage (mm) | 27.4 | 3.9 | 16.5 | 39.9 |
| Runoff (mm) | 25.3 | 7.2 | 16.1 | 31.4 |

* assuming that 85% of the tail water is recovered

As shown in Tables 1 the average application efficiency is approximately 64.5 % with immediate 11.5% water saving through adoption of effective tail water recycling. The average application rate for the typical 2m alternate row irrigation is 4.4 L/s for an approximate 12 ½ hour duration resulting in a total application of 1.30 ML/Ha of which on average 19% exits the field as runoff. The estimated deep drainage and efficiency values are both dependent on the soil moisture deficit. While the deficit

was measured in some cases, for many others it has been estimated from weather data. Furthermore no deficit was supplied for many of the pre-season events, in these cases the deficit was inferred from the magnitude of the crack volume indicated on the cumulative infiltration curve.

It is important to note that the majority of the measurements were not collected under controlled experimental conditions but represent irrigation performance under normal grower management. Secondly it must be noted that these results include both in season and pre-watering events. Often the soil behaves differently for the initial irrigation of the season, meaning that soil moisture deficits are difficult to estimate and infiltration can be significantly higher leading to lower performance. For this reason the same results are presented in Table 2 this time with the pre-watering removed. While individual pre-irrigations are known to behave erratically, a comparison between Table 1 and Table 2 indicates that on average, differences in efficiency are minor.

Table 2 - Summary of performance of all in crop irrigations (606 events)

| | Average | 1 st Quartile | Median | 3 rd Quartile |
|---|----------------|-----------------------------|--------|-----------------------------|
| Flow rate (L/s per 2 m width) | 4.4 | 2.8 | 3.8 | 5.6 |
| Run time (hours) | 11.7 | 8.3 | 11.1 | 13.9 |
| Moisture Deficit (mm) | 78 | 65 | 76 | 90 |
| Total Water applied (ML/Ha) | 1.227 | 0.880 | 1.135 | 1.419 |
| Application efficiency (%) | 64.7 | 52.1 | 65.6 | 77.5 |
| Application efficiency with tail water recycling* (%) | 76.4 | 64.1 | 80.0 | 90.9 |
| Requirement Efficiency (%) | 94.8 | 94.9 | 99.8 | 100.0 |
| Infiltration (mm) | 98.5 | 70.2 | 91.3 | 115.9 |
| Deep drainage (mm) | 25.3 | 2.5 | 14.8 | 35.1 |
| Runoff (mm) | 24.1 | 6.8 | 15.5 | 30.6 |

* assuming that 85% of the tail water is recovered

For growers, the major purpose of field evaluation is identification of strategies to improve performance (e.g. inflow rate and run time). For the majority of events, ISID also contains this optimised flow rate and run time and the predicted efficiency of the same field under that strategy. Many of the evaluations conducted by private consultants were accompanied by this alternative flow rate and time. In most instances this optimisation involves an increase in flow rate coupled with a reduction in run time, or in other cases simply a reduction in run time. In many cases this will result in a reduction in the depth of infiltration and hence reduction in deep drainage loss but commonly causes an increase in the runoff volume. This is not an issue for most cotton growers who recycle tail water and will routinely run a certain volume of tail water to ensure adequate application at the bottom end of the field.

Potential Irrigation Performance

In those cases without a specified optimisation strategy the optimisation was performed during the data processing. While there were some exceptions the majority of these optimisations involved altering the time and flow rate in order to fulfil the deficit (maximise requirement efficiency) while maximising the application efficiency with tail water recycling.

While for most cases this optimisation will result in an increase in efficiency and decrease in applied depth there are a large number of events where the volume of water applied has to be increased in order to replenish the deficit or in some cases to ensure water reaches the end of the field.

Table 3 is a summary of the average improvement to irrigation performance achievable through adoption of recommended changes to inflow rates and cut off times. As shown the application efficiency can be improved by an average of 10% with a halving of both the volume of water lost to deep drainage and runoff. Assuming that 85% of tail water is recycled this approximately equates to a water saving of 0.155 ML/ha per event.

Table 3 – As measured and predicted performance under suggested management strategy (614 events)

| | Measured (Average) | Optimised (Average) |
|---|--------------------|---------------------|
| Flow rate (L/s per 2 m width) | 4.4 | 5.7 |
| Run time (hours) | 12.6 | 8.1 |
| Total Water applied (ML/ha) | 1.312 | 1.086 |
| Application efficiency (%) | 64.2 | 72.7 |
| Application efficiency with tail water recycling* (%) | 75.7 | 84.7 |
| Infiltration (mm) | 105.5 | 91.5 |
| Deep drainage (mm) | 27.9 | 13.9 |
| Runoff (mm) | 25.6 | 17.0 |
| Potential water saving based on total applied (mm) | | 22.6 |
| Potential water saving with tail water recycling (mm) | | 15.5 |

* assuming that 85% of the tail water is recovered

Table 4 shows the same data this time describing the spread of the results expressed as the 1st, 2nd and 3rd quartiles. These results show that the majority of irrigation events would benefit from the optimisation process. Whilst those with lower measured performance experience the largest increase in performance there is still potential to raise the efficiency of those irrigations in the highest quartile of measured performance.

Table 4 – Spread of measured compared to optimised results (614 events)

| Measured | | | Optimised | | |
|------------------------|--------|------------------------|------------------------|--------|------------------------|
| 1 st Quart. | Median | 3 rd Quart. | 1 st Quart. | Median | 3 rd Quart. |
| | | | | | |

| | | | | | | |
|---|-------|-------|-------|-------|-------|-------|
| Flow rate (L/s per 2 m width) | 2.8 | 3.9 | 5.6 | 4 | 5.7 | 7 |
| Run time (hours) | 8.4 | 11.5 | 14.7 | 5.3 | 7.5 | 10 |
| Total Water applied (ML/Ha) | 0.907 | 1.174 | 1.536 | 0.823 | 1.039 | 1.284 |
| Application efficiency (%) | 52.2 | 64.4 | 76.6 | 66.7 | 73.3 | 80.4 |
| Application efficiency with tail water recycling* (%) | 63.3 | 78.3 | 89.6 | 80.1 | 88.4 | 93.6 |
| Infiltration (mm) | 72.3 | 95.9 | 124.9 | 66.8 | 86.0 | 108.5 |
| Deep drainage (mm) | 4.2 | 17.1 | 40.6 | 1.1 | 7.1 | 18.9 |
| Runoff (mm) | 7.0 | 16.5 | 31.9 | 7.2 | 12.6 | 22.7 |
| Potential water saving based on total applied (mm) | | | | 0 | 13.6 | 35.4 |
| Potential water saving with tail water recycling (mm) | | | | 1.5 | 9.4 | 22.3 |

Spread of results across Catchments

This project aimed to provide irrigation benchmarking across the entire Australian Cotton industry and as such data was collated from a range of sources in attempt to encompass all significant catchments where cotton is grown. As shown in Figure 1, the data currently contained within the database represents the larger catchments of NSW and QLD. The authors of this report are aware of additional sources of data from QLD, particularly the St George-Dirranbandi and Darling Downs regions that were not captured in this study.

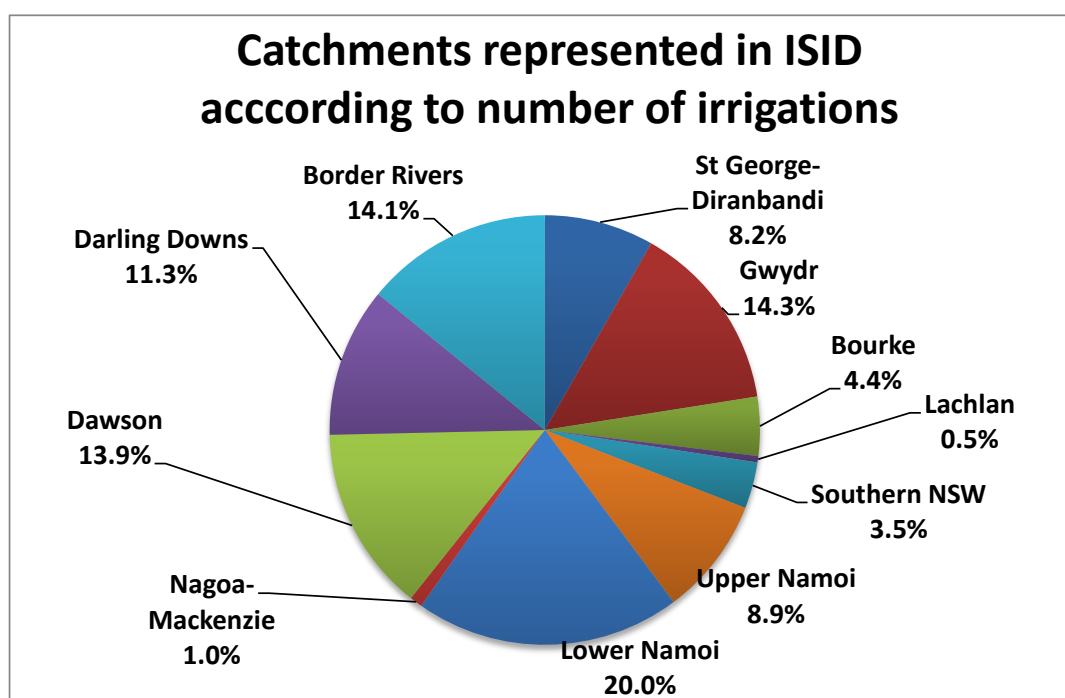


Figure 1 - Regional spread of irrigation measurements

Comparative analysis according to region is not presented here as the small number of irrigations for some catchments may skew the results.

Seasonal Trends

ISID also enables study of seasonal trends in irrigation management and irrigation efficiency. These values must be taken with caution with the reduced number of total evaluations within each year. Figure 2 shows the relative spread of the data

currently within the database, with an obvious concentration of measurements within the period 2004-2008.

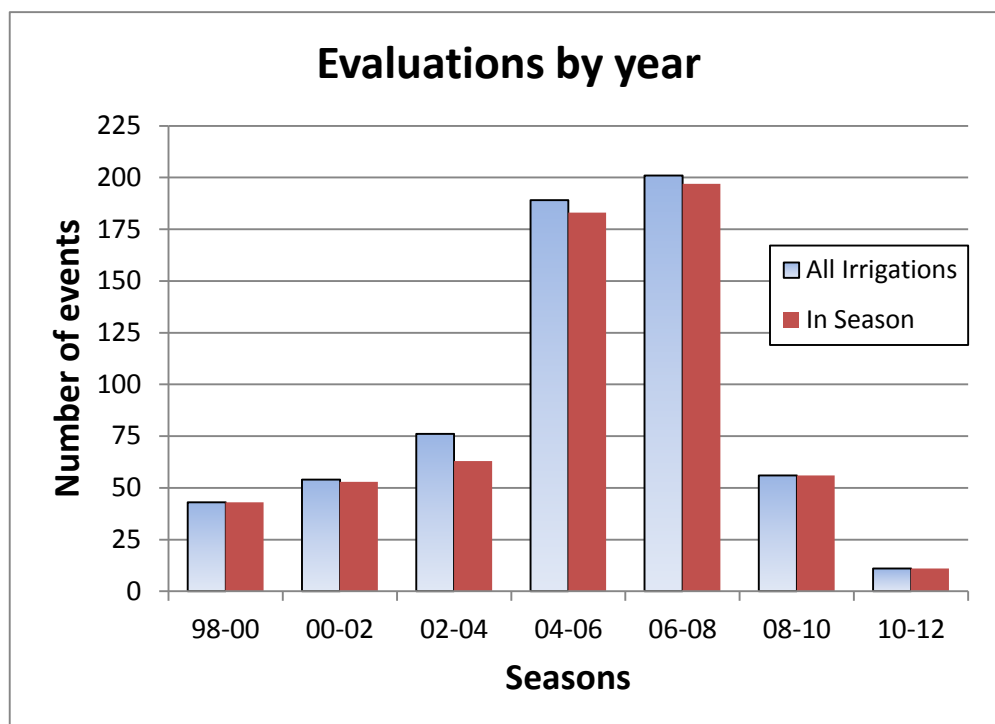


Figure 2 - Seasonal spread of irrigations

Figure 3 displays the seasonal trends of application efficiency (accounting for recycling) with irrigation season. Data from the last two years is not presented due to the limited number of evaluations. Here with the exception of 2000-2002 there appears to be a weak increasing trend in the efficiency. It was anticipated that this increasing trend should have been stronger.

There are several explanations for the results shown in Figure 3. Usually when a field is evaluated in a particular season the same field is not evaluated in subsequent seasons. This means that the implemented changes in irrigation management for each field is not captured in the data. Furthermore a similar impact can be concluded at the farm scale; often after a property has been evaluated it is common for that property to have no further evaluations in subsequent seasons. Finally it is often those fields that are most problematic that are identified by the growers for evaluation, potentially skewing the results.

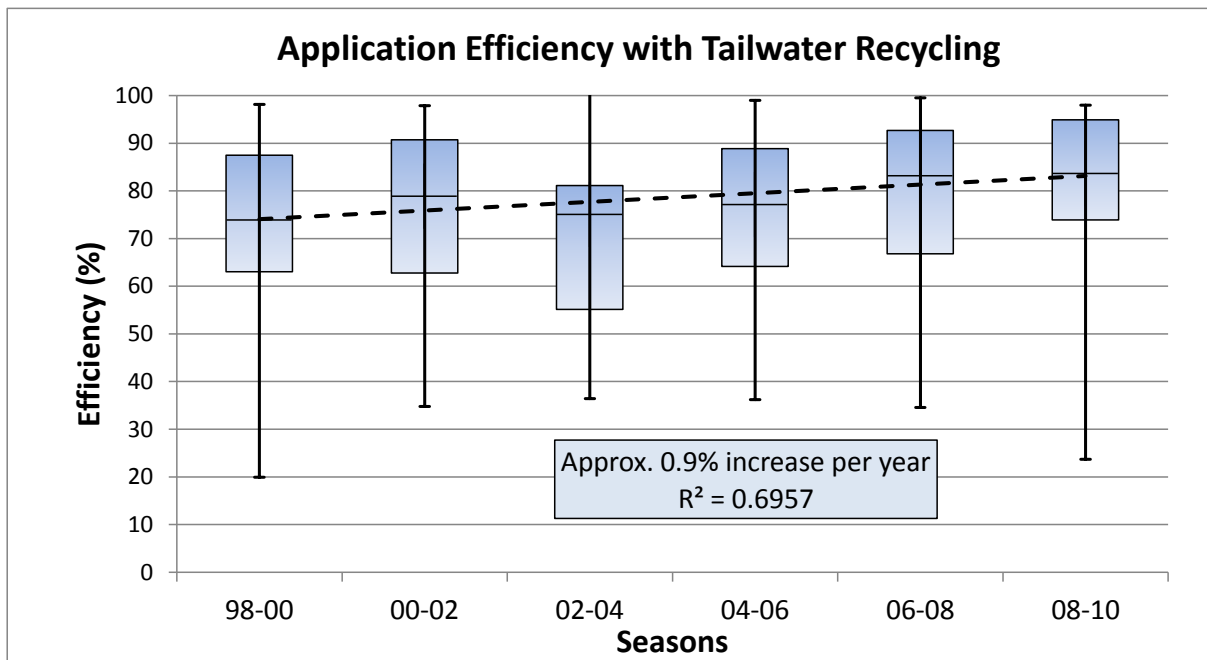


Figure 3 – Seasonal trend in application efficiency with tail water recycling

The database can also be used to study the performance of systems according to a range of field characteristics including field length, inflow rate, catchment and soil type. However soil type was not recorded for the majority of evaluations it is envisaged that soil type information can be added to the relevant datasets in the future.

Case Study – Influence of Field Length

The following results are a demonstration of how the database can be interrogated in order to study the impact of field characteristics. Despite the fact that longer furrows are often more convenient for farming operations it is a common conclusion that shorter furrows are preferred in all cases due to improvements in water use efficiency. The results presented in Figure 4 appear to debunk this generalisation.

The data currently in ISID represents fields with lengths ranging as follows:

- 250-500 m - 97 irrigations
- 500-750 m - 312 irrigations
- 750-1000m - 139 irrigations
- 1000-1250 m - 74 irrigations
- >1250 m - 9 irrigations

Although it is true that for any given field, shorter furrows will lead to increased uniformity and greater flexibility the results clearly show that under the correct circumstances that longer furrows can be operated efficiently. It can be assumed that those soil types that are most problematic for furrow irrigation, such as those with high infiltration rates are more likely to irrigated using shorter field lengths. Hence the field design has been influenced by the potential irrigation performance.

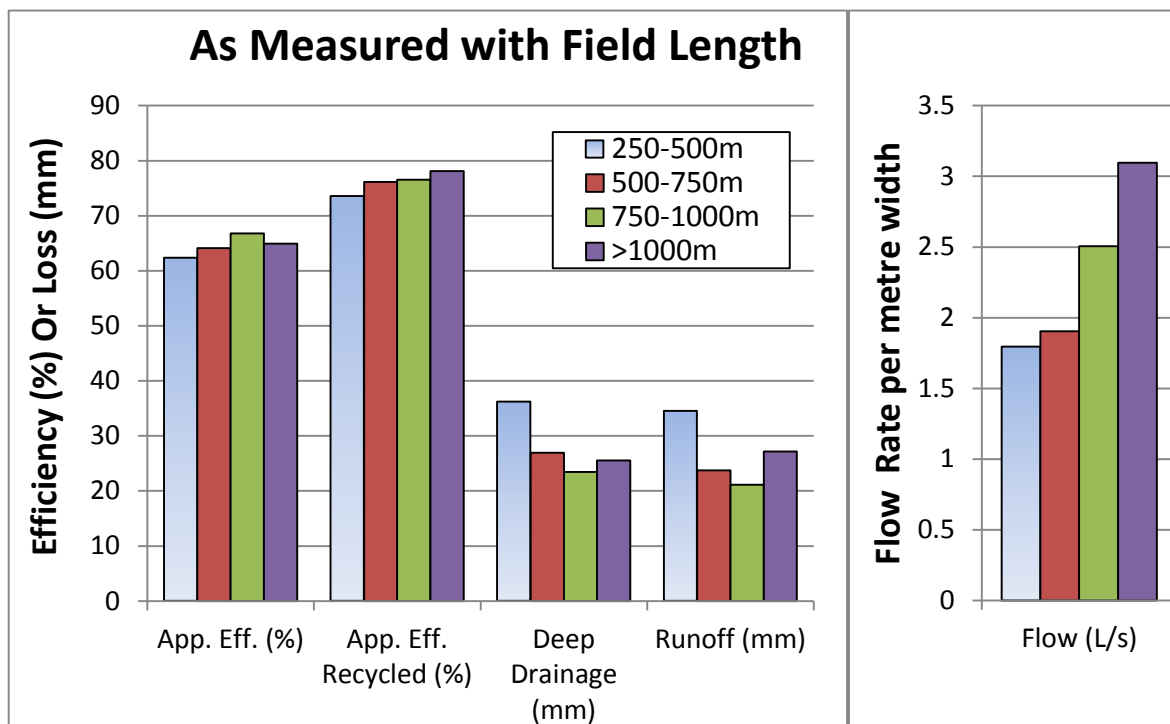


Figure 4 - Irrigation performance as measured with field length

In comparison, Figure 5 demonstrates the potential performance of the same group of irrigations under optimised flow rates and/or times. Here the average potential irrigation efficiency is approximately 80% regardless of the field length.

There appears to be a strong relationship between flow rate and field length, this relationship persists with the optimised flow rates. It is interesting to note that the optimised flows are typically higher than the measured flow for all field lengths.

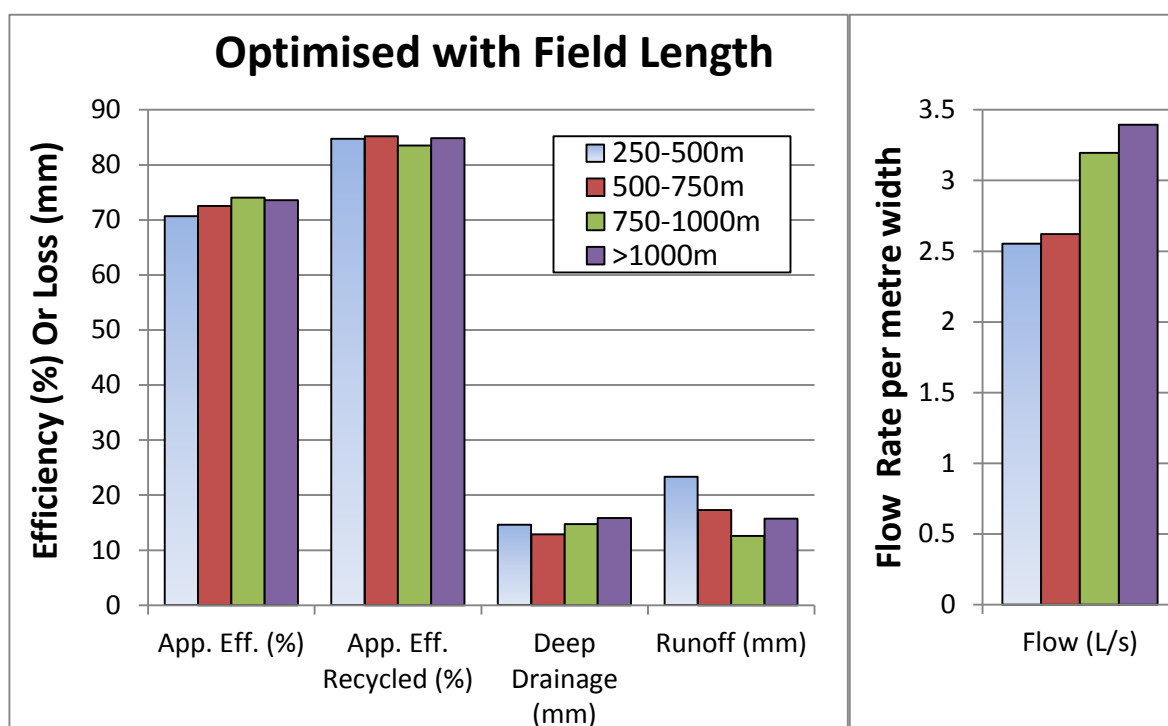


Figure 5 - Potential irrigation performance (optimised) with field length

The results presented here are merely an example of how the database can be interrogated to produce statistical analysis of irrigation management. The accuracy of results and conclusions will be improved as additional data is uploaded.

Outcomes

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

Output 1 – Surface irrigation database populated with historic data

Prior to this project irrigation data was spread across various organisations with little opportunity to benchmark the industry. This data was of varying quality and differed in the results reported depending on the purpose of each evaluation. The most significant output of this project has been the ability to collate historical data, standardise the reporting and store the resulting information for future use. To date over 630 individual events have been collected, reanalysed and uploaded into the database. There are other private consultants that have not provided data to the system; hopefully those organisations will become involved in use of the database after demonstration of the finished database.

Output 2 – Industry wide benchmarks of water use efficiency

As shown in the results above ISID can be used to provide industry benchmarks of water use efficiency including measures such as application efficiency, requirement efficiency, uniformity and estimates of drainage losses. The database is also able yield information of management variables such as inflow rates and run times. The information stored within the database is comprehensive and much of the information is not yet used in generation of these benchmarks. While this level of data capture allows users to archive the entire data set required for field evaluation it also provides additional data that may be used for analysis into the future.

Output 3 – Database can be used to identify improved management strategies

In addition to the values necessary for water use benchmarking such as efficiency the database also stores a significant number of field characteristics that can be queried. Some of these are already provided in the current web interface, results can be filtered on such characteristics as irrigation district, irrigation number, field length, flow rate and soil type. Examples of these results are provided above

Output 4 – Ensure that the database will be updated into the future

ISID has been integrated into the simulation model SISCO, the new software for Irrimate field evaluations. This greatly simplifies the process of data upload and does not impose

extra time costs on behalf of the user. The database functionality provides a convenient means for organisations to archive irrigation measurements, acting to encourage its use into the future.

Consultants and researchers also realise the value that this benchmarking can potentially provide to growers and are interested in incorporating these industry wide figures in any grower feedback they might provide in the future.

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

The major developments achieved by the project are as follows:

This project has involved further refinement of the ISID system which was originally developed under a previous CCC CRC project. While ISID has been incorporated under the KMSI group of irrigation tools the software IP remains the property of the CCC CRC.

This project also required development of a new module for the surface irrigation model SISCO. The software code and user interface allows users to connect to the ISID database and transfer measurements and results between the user's computer and the database. SISCO was developed with financial support from the Irrigation Futures CRC. The previously existing SISCO code including the hydraulic model remains property of the NCEA.

The data collected during this project still remains the property of the parent organisations who conducted the evaluations. This data is maintained by the NCEA who will ensure that the information of individuals will be securely stored and not used for any purpose that contravenes grower anonymity.

Conclusion

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

The take home message of this project is that the Australian cotton industry has made a significant investment over the past decade in measuring and improving the performance of furrow irrigation. The ISID database system provides the means to collate, store and benchmark this historical data.

Extension Opportunities

8. Detail a plan for the activities or other steps that may be taken:
 - (a) to further develop or to exploit the project technology.
 - (b) for the future presentation and dissemination of the project outcomes.
 - (c) for future research.

Adoption of ISID relies on its integration with the Irrimate surface irrigation evaluation process.

The completed database offers great potential for future studies in the performance or behaviour of furrow irrigation systems. For example one possible use in the near future is to assist in the understanding of optimal irrigation strategies across spatial and time scales important for implementation of real-time controlled furrow irrigation.

ISID will be promoted to all users of the Irrimate service and incorporated into any future training that the NCEA may conduct.

Publications

9. A. Publications relevant to this project.

Peer reviewed articles / books

Nil as yet,

Planned submission:

Gillies, MH (2013) *A decade of evaluating and optimising furrow irrigation in the Australian Cotton Industry*, (international journal such as Biosystems, Irrigation Science or Irrigation and Drainage).

Non-peered reviewed articles

Presentations (conference, field days, workshops etc)

Planned submission:

Gillies, MH (2013) *A decade of evaluating furrow irrigation in Australia what have we learned*, Next upcoming Irrigation Australia conference.

- B. All other publications by project team during this period.

Peer reviewed articles / books

Gillies, MH, Smith, RJ and Raine, SR (2011) *Evaluating whole field irrigation performance using statistical inference of inter-furrow infiltration variation*. Biosystems Engineering, 110: 134-143.

Non-peered reviewed articles

Morris, M. Hussain, A and Gillies, M, (2012) *Evaluating the performance of a real-time control and optimisation system for furrow irrigation*. ICID & Irrigation Australia Conference and Exhibition, Adelaide, 24-29 June 2012.

Koech, R. Smith, R and Gillies, M, (2012) *Can higher flow rate improve the performance of border check irrigation in the Murray region*. ICID & Irrigation Australia Conference and Exhibition, Adelaide, 24-29 June 2012.

Koech, R.K. Smith, R.J. and Gillies, M.H. (2011) *Trends in surface irrigation systems in the Australian irrigated agriculture*. Proceedings of the Biennial Conference of the Australian Society for Engineering in Agriculture (SEAg), 29-30 September 2011, Surfers Paradise, Queensland, Australia, 277-287.

Koech, R.K., Smith, R.J. and Gillies, M.H. (2011) *Design of an automatic furrow irrigation system using an adaptive real-time control*. Proceedings of the Biennial Conference of the Australian Society for Engineering in Agriculture (SEAg), 29-30 September 2011, Surfers Paradise, Queensland, Australia, 288-297.

Rojas-Ponce, S. Smith, R.J and Gillies, M.H. (2011) *Improved evaluation of bay (and furrow) irrigation*. In: Irrigation 2011: New Horizons, Fresh Ideas Regional Conference and Exhibition, 22-25 Aug 2011, Launceston, Australia.

(NB: Where possible, please provide a copy of any publication/s)

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

ISID website available at through the KMSI portal at: <https://kmsi.usq.edu.au/>

For username and password please contact the principle researcher.

Part 4 – Final Report Executive Summary

Provide a one page Summary of your research that is not commercial in confidence, and that can be published on the World Wide Web. Explain the main outcomes of the research and provide contact details for more information. It is important that the Executive Summary highlights concisely the key outputs from the project and, when they are adopted, what this will mean to the cotton industry.

Furrow irrigation is now and will continue to be the dominant application technique in the Cotton industry for the foreseeable future. Surface irrigation is ideally suited to the heavy cracking clays typical of districts in which cotton is grown and is readily adaptable to the erratic nature of water availability and commodity prices. Pressurised systems do offer benefits but also pose new issues such as increased energy costs.

The Australian Cotton industry can stake the claim of being one of the leaders in irrigation practice and innovation. Nowhere is this more apparent than for surface irrigation where the industry has made significant gains in water management leading to direct increases in productivity. One key driver of this change is the ability to monitor and model furrow irrigation provided through the use of the Irrimate™ in field evaluation system. Over the past decade, it is estimated that well over 700 evaluations have been performed in order to guide individual growers and inform researchers. Individually these trials might appear trivial but combined they represent a legacy of the industry's genuine and continuing effort to measure and improve water use efficiency.

Each organisation has adopted unique ways of analysing, and archiving field data, resulting in large quantities of data with limited hope being able to conduct industry wide studies. The Cotton Catchment Communities CRC and National Centre for Engineering in Agriculture (NCEA) have developed a web database, the Irrimate Surface Irrigation Database (ISID) with the following aims:

1. To allow the industry to benchmark the performance and potential performance of furrow irrigation
2. To provide added value to the process of irrigation evaluation where growers will be able to compare practices with others
3. To collate the large quantity of field measurements and evaluations that have been conducted over the past decade, a valuable source of information for future research in irrigation management.

Once completed, ISID was populated with data collected from all major catchments across NSW and QLD where cotton is grown with measurements stretching from the 1998-1999 to the 2011-2012 seasons. In excess of 630 separate irrigation events have been collated to date each with full field measurements, performance estimates and optimisation strategies.

The data capture and transfer process has been streamlined by integration of the database into the software model SISCO used during the evaluation process. This will ensure that the database is maintained and updated into the future. ISID also functions as a means to standardise and archive evaluations, a major shortcoming identified during collation of historical data.

Preliminary results from the database indicate that measured application efficiency across all seasons and districts is approximately 64.6% or 76.1% when accounting for tail water recycling. Optimisation of inflow rates and cut off times to improve

irrigation performance results in an average water saving of 0.155 ML/ha per event. The design of ISID also enables users to interrogate the database in order to summarise the results according to criteria such as catchment, season, soil type and field length adding further value to the benchmarking process.

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