Stretching water – Queensland’s water use efficiency cotton and grains adoption program

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Abstract The Cotton and Grains Adoption Program of the Queensland Rural Water Use Efficiency Initiative is targeting five major irrigation regions in the state with the objective to develop better irrigation water use efficiency (WUE) through the adoption of best management practices in irrigation. The major beneficiaries of the program will be industries, irrigators and local communities. The benefits will flow via two avenues: increased production and profit resulting from improved WUE and improved environmental health as a consequence of greatly reduced runoff of irrigation tailwater into rivers and streams. This in turn will reduce the risk of nutrient and pesticide contamination of waterways. As a side effect, the work is likely to contribute to an improved public image of the cotton and grain industries. In each of the five regions, WUE officers have established grower groups to assist in providing local input into the specific objectives of extension and demonstration activities. The groups also assist in developing growers’ perceptions of ownership of the work. Activities are based around four on-farm demonstration sites in each region where irrigation management techniques and hardware are showcased. A key theme of the program is monitoring water use. This is applied both to on-farm storage and distribution as well as to application methods and in-field management. This paper describes the project, its activities and successes.

Keywords Irrigation; scheduling; water use efficiency

Introduction

Only five percent of Australia’s surface water is harvested and of this, irrigated agriculture uses 70 to 80 percent. Cotton accounts for only 12 percent of this use (Commonwealth of Australia, 2002). Hearn (2000) reported that, in spite of popular belief, cotton uses less water per hectare than any other agricultural industry in Australia and produces more value per megalitre than any other, with the exception of horticulture. However, irrigation efficiency and water management can be improved. With growing concern for adequate water availability, and possible discharge of contaminated water from irrigation activities into river systems, the Queensland Government introduced, in 1999, a four-year program, the Rural Water Use Efficiency Initiative (RWUEI) (Bell, 2001). The program is also most appropriate at this time because of the emerging salinity threat to agricultural land. Triantafilis et al. (2002) reported that general improvements in salinity control can be made from maximising on-farm irrigation efficiency. Hood (2002) described water use efficiency (WUE), in irrigated agriculture, as maximising the returns and minimising the environmental impacts for every megalitre of water used for irrigation purposes.

QDPI’s Agency for Food and Fibre Sciences’ Farming Systems Institute, is undertaking the “Cotton and Grains Adoption Program” within the irrigated cotton and grains industries. The program is being conducted as part of the RWUEI in partnership with the Department of Natural Resources and Mines (DNR&M).

The objective of this adoption program is to help Queensland cotton and grains irrigators
measure, record and monitor their progress in WUE improvement, thus increasing by June 2003, irrigation efficiency by at least 10%, with 70% of growers adopting best management practice (BMP) guidelines for irrigation.

The program has industry ownership through Cotton Australia and AgForce and is administered through the Australian Cotton Cooperative Research Centre at Narrabri, New South Wales. It is being supervised by and takes direction from a consultative committee with grower leadership and has representatives from all stakeholders including: irrigators, consultants, agribusiness, research and industry organisations.

Similar programs are also being conducted in the sugar, fruit and vegetable, and dairy and lucerne industries.

**Methods**

Five major irrigation regions in the state are being targeted. These extend from St George in the West to the Eastern Darling Downs and from the Macintyre Valley at the New South Wales border to the Emerald Region of Central Queensland (Figure 1).

In each region, WUE officers have established grower groups to assist in providing local input into the specific objectives of extension and demonstration activities. The groups also assist in developing growers’ perceptions of ownership of the work. Activities are based around at least four on-farm demonstration sites in each region, where irrigation management techniques and hardware are showcased. A key theme of the program is monitoring water use. This is applied both to on-farm storage and distribution as well as to application methods and in-field management.

Thus the WUE officers are conducting an education program for growers which includes:

- Developing an awareness of water management issues.

![Figure 1](https://iwaponline.com/wst/article-pdf/48/7/191/423561/191.pdf)  
Figure 1 Shaded areas indicate the main irrigated cotton growing areas of Queensland
• Contributing information to and assisting with the development of an irrigation module for a BMP manual which will be applicable to both the cotton and grain industries.
• Developing, demonstrating and promoting the implementation of the water monitoring systems on farms using simple practical methods and devices.
• Establishing an annual award system which provides incentives and opportunities to improve WUE and which recognises individual achievements or initiatives that have led to improved WUE.
• Conducting benchmarking surveys at strategic times during the project to evaluate performance and outcomes.

To address some of the many issues confronting irrigators, 29 demonstration or trial (benchmarking) sites were established during 2001/2002. Crops involved were: cotton, peanuts, navy beans, barley, soybeans and maize. Irrigation systems included: furrow, centre pivot, subsurface drip, side-roll sprays, travelling gun and gated pipe delivery. In addition, trials were established to investigate the control of evaporation and seepage from farm storages, soil characterisation for water holding capacity, and the use of polyacrylamides in sediment control and water penetration. Similar activities were carried out by the Program team in previous years.

The implementation of the adoption of new irrigation technologies is being assisted by a financial incentives scheme that partly reimburses growers for their outlays.

**Progress and discussion**

Because of the Program, an increasing number of irrigators are now achieving irrigation efficiencies well in advance of the State benchmarks presented in a stocktake report (Goyne et al., 2000) which was compiled at the commencement of the program. These efficiency gains indicate that the 10% target increase in efficiency set for the program is being achieved and in many cases exceeded (Table 1).

The trial results are showing a gradual improvement in all indices across the state. The ranges indicate that improvements beyond the 10 percent objective can be achieved. The management practices that have resulted in these trends represent real and practical opportunities for growers to improve their WUE.

**Measurement is critical to irrigation management**

The greatest opportunity for water saving is with measurement. Through measurement, the trial site co-operators have investigated various management options and set targets for improvement. Irrigation scheduling tools are also now being well utilised to effectively

<table>
<thead>
<tr>
<th>Indices</th>
<th>1999/2000</th>
<th>2000/01</th>
<th>2001/02</th>
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<tbody>
<tr>
<td>Yield bales/ha</td>
<td>8.52 (8.5–9.0)</td>
<td>9.56 (8.1–10.7)</td>
<td></td>
</tr>
<tr>
<td><strong>Agronomic water use efficiency</strong></td>
<td></td>
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<td></td>
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<tr>
<td>Baales/ML (Et)</td>
<td>1.13 (1.07–1.19)</td>
<td>1.31 (1.28–1.36)</td>
<td></td>
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<tr>
<td><strong>Crop water use efficiency</strong></td>
<td></td>
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<tr>
<td>Baales/ML irrigation net (i.e. minus runoff)</td>
<td>1.58 (1.28–2.07)</td>
<td>1.77 (1.24–1.93)</td>
<td></td>
</tr>
<tr>
<td>Baales/ML irrigation net + effective rain</td>
<td>1.17 (Stocktake report)</td>
<td>1.12 (1.01–1.27)</td>
<td></td>
</tr>
</tbody>
</table>

| Engineering water use efficiency      |           |         |         |
| Application efficiency (%)            | 71 (64–82) | 77 (67–87) |
| Irrigation efficiency (%)             | 56 (Stocktake report) | 60 |

(Application efficiency = ratio of irrigation net to irrigation gross expressed as a percentage.
Irrigation efficiency = percentage of irrigation water actually used by the crop as evapotranspiration Et, relative to the total irrigation water inputs at the farm level available during the season)
time irrigations, but they are yet to be used to their full potential. If these tools are correctly calibrated they can be used to show the irrigator how much water needs to be applied in each irrigation. Monitoring of siphon flow rates has shown that currently irrigators are on average applying three times the amount required and that not all the excess is being recycled as tail water. The program team is endeavouring to rectify these issues.

The following case study highlights the importance of measurement. A cotton growing operation has been a benchmarking site for the Cotton and Grains Adoption Program for the past two seasons. The grower was able to use the information being generated from the meters and soil moisture monitoring devices that were installed in the irrigation inlets, outlets, siphons and furrows. This information was used to improve WUE on the property.

After pre-irrigation the meter results prompted a discussion about crop water-logging and how irrigations can be managed to minimise it. One day’s water-logging was found to be more damaging than one day of water stress. Water-logging from irrigation can be reduced by minimising the time that water is ponded in the furrows. Water should only be on the field long enough for the soil moisture profile to be replenished thus minimising water-logging or excessive drainage beyond the root zone. Matching siphon flows and shift duration with the required volume of water, run lengths and slope of the furrows will achieve this. It seemed that an optimum strategy would be to increase flow rates and reduce the shift times by about a quarter.

Capacitance probe soil moisture data indicated that after the initial irrigation, there was a period of three days when plants were not extracting water. It was explained to the grower that this was the result of water-logging. This prompted the grower to recall the discussion on how to minimise it. He commenced to implement the strategy so the period of water-logging was reduced by two-thirds in the subsequent irrigations. Over an entire season this crop was subject to only 13 days of post-irrigation water-logging via this management strategy, as opposed to 33 days if the original management system was maintained. Water was saved, runoff reduced and yield increased.

Evaporation and seepage mitigation

Dam evaporation and seepage losses have been identified as being high (up to 8 ML/ha and 13 ML/ha respectively) in some regions, so present opportunities for water savings.

Irrigators in the Emerald and St George regions have been attempting to use covers in order to reduce evaporation losses from farm dams. The Emerald trial results presented in Table 2 showed they were effective at mitigating evaporation, but the St George trial has shown that the commercial large scale installation of dam covers (4 ha in area) is difficult (Hood, 2002).

Strategies to reduce seepage losses are also under investigation in the Emerald region. Table 2 shows that both lining and bentonite are effective strategies to reduce water losses. A major outcome of the Emerald trial was that growers need to monitor both evaporation and seepage before a strategy for either is implemented (Hood, 2002).

Table 2  Expected losses from a 220 ML Dam (5.4 ha) at Emerald under a range of treatments based on a small scale trial adjacent to the dam

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Covered and lined</th>
<th>Covered only</th>
<th>Lined only</th>
<th>Bentonite</th>
<th>Untreated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Losses from a 220 ML dam (5.4 ha) for the season</td>
<td>3.2 ML</td>
<td>70.8 ML</td>
<td>45.1 ML</td>
<td>40.3 ML</td>
<td>115.9 ML</td>
</tr>
</tbody>
</table>

(Source: J. Okello-Okanya, 2002)
Some highlights to date

The program is achieving very significant outcomes towards the better management of irrigation water in both the cotton and grain industries. These include:

- Awareness and participation in the program exceeded 75% of growers (the target for 2001/2002) by August 2001 and is now estimated to be greater than 80% in some regions.
- A survey conducted in August 2001 indicated that 78% of cotton irrigators had become involved in BMPs.
- An increasing number of irrigators are now achieving irrigation efficiencies well in advance of the State benchmarks determined at the commencement of the program.
- Results indicate a gradual improvement in all water use indices across the state. The management practices that have resulted in these trends represent real and practical opportunities for growers to improve their WUE.
- Monitoring of siphon flow rates has shown that currently irrigators are applying up to three times the amount required and that not all the excess is being recycled as tail water. This leads to excessive runoff.
- Evaporation and seepage mitigation strategies present opportunities for water savings.

Program evaluation

The economic, environmental and social benefits of the program are being monitored. The impact of the program is to be evaluated in relation to its influence on improvement in WUE, irrigators’ movement to BMP, and their awareness of and participation in the program.

An independent evaluator carried out a mid-term evaluation of the program’s performance in September 2001 and a final evaluation will be made on completion of the program (Barraclough and Co., 2000).

The mid-term evaluation:

- reported outcomes against agreed measures and targets
- reviewed the effectiveness and rigour of the data collection processes
- reported on suitability of the measures used to evaluate performance
- recommended changes to the evaluation plans
- recommended any necessary changes to the adoption program
- highlighted areas where performance has been exceptional and indicated actions that could flow from these success areas
- identified poor performance areas and suggested actions to correct or cease these activities

At the final evaluation the evaluator will:

- report outcomes and outputs against agreed measures and targets
- report on accuracy of the data
- using the data accumulated, undertake a benefit/cost analysis of the program
- report on reasons for successes and failures
- provide recommendations for future actions to improve performance in WUE

Conclusions

Irrigators are now becoming increasingly conscious of the relationship between their industry’s economic sustainability and its impact on the environment. BMPs are being developed and applied. These are assisting in the elimination of runoff of any waters that may have high nutrient, chemical or turbidity levels.

The irrigated cotton industry relies mainly on furrow irrigation. There are a number of opportunities for efficiency gains with this system. The program team is encouraging irri-
igators to focus on the precision of their application of water. Many are now using scheduling tools to determine when and how much water to apply and so deliver to the root zone exactly what the crop requires. There is also now an increased use of water meters. These tools assist in minimising or eliminating runoff from the fields and drainage losses beyond the root zone, thus preventing the development of salinity.

Although the program has been in place only since 1999 the Cotton and Grains Adoption Program Team is making real progress in influencing irrigators to become more aware of their water use and assisting them in making those management changes which will enhance irrigation efficiency.

Irrigators in both the cotton and grains industries are now highly motivated to proceed with management changes that have been identified by the program, which will increase irrigation efficiency, but they need continued guidance and assistance to maintain this motivation and implement their new management goals. Funds are currently being sought to take the program beyond June 2003 so that irrigators can be assisted in their continued efforts to improve irrigation efficiency and water management.

References