FIVE seasons of benchmarking data relating to centre pivot and lateral move (CPLM) irrigation systems is now available and shows the year-to-year variability in water productivity, the importance of on-going benchmarking of your operation, and the significant improvement in water productivity in the cotton industry. From 2010–11 to 2014–15 the Queensland Healthy HeadWaters Program (funded from the Australian Government’s Sustainable Rural Water Use and Infrastructure Program) and the Queensland Department of Agriculture and Fisheries funded season-long benchmarking of 138 CPLM irrigation systems by WaterBiz in the Queensland Murray-Darling Basin (QMDB). Sixty-eight per cent were growing cotton (see Figure 1).
VALLEY® STANDS THE TEST OF TIME.

Great ground deserves great irrigation. That way, you get the most out of your investment. Hands down, Valley is the name successful growers depend on. Easy to use. And reliable as sun-up tomorrow. Get quality. Get service. Get ahead. You can count on that with Valley.
Figure 2 summarises the number of benchmarked CPLM systems growing cotton and their location in each season.

The benchmarking process examined both system performance (irrigation uniformity and system capacity), and seasonal water use. Water use was determined with a water balance approach using:
- Soil moisture measurement;
- Continuous pressure loggers (PIMS units); and,
- Estimates of effective rainfall.

There were seasonal fluctuations in cotton yields, generally in response to seasonal conditions. This can be seen in Figures 3 and 4.

For several years now the cotton industry has standardised the benchmark indices used to measure the water productivity of their industry. The key indices are:
- Irrigation Water Use Index (IWUI) – the production in bales per ML of applied irrigation water; and,
- Gross Production Water Use Index (GPWUI) – the production in bales per ML of total available water (applied irrigation, effective rainfall and soil moisture used).

Tables 1 and 2 summarise the average IWUI and GPWUI for cotton grown under the CPLMs benchmarked across the five seasons of this study.

### TABLE 1: Average IWUI (bales/ML applied irrigation) under CPLMs in the QMDB

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>St George</td>
<td>2.95</td>
<td>3.16</td>
<td>2.05</td>
<td>1.27</td>
<td>2.28</td>
</tr>
<tr>
<td>Goondiwindi</td>
<td>2.95</td>
<td>3.94</td>
<td>1.88</td>
<td>0.98</td>
<td>2.47</td>
</tr>
<tr>
<td>Dalby</td>
<td>9.32</td>
<td>4.93</td>
<td>4.10</td>
<td>1.25</td>
<td>4.20</td>
</tr>
<tr>
<td>Texas</td>
<td>3.26</td>
<td></td>
<td></td>
<td></td>
<td>0.95</td>
</tr>
</tbody>
</table>

### TABLE 2: Average GPWUI (bales/ML total available water) under CPLMs in the QMDB

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>St George</td>
<td>1.28</td>
<td>1.29</td>
<td>1.21</td>
<td>0.97</td>
<td>2.06</td>
</tr>
<tr>
<td>Goondiwindi</td>
<td>1.22</td>
<td>1.44</td>
<td>1.05</td>
<td>1.02</td>
<td>1.95</td>
</tr>
<tr>
<td>Dalby</td>
<td>1.12</td>
<td>1.56</td>
<td>1.21</td>
<td>0.97</td>
<td>3.05</td>
</tr>
<tr>
<td>Texas</td>
<td>1.44</td>
<td></td>
<td></td>
<td></td>
<td>0.70</td>
</tr>
</tbody>
</table>

The data in these tables demonstrate several important points:
- In locations with better rainfall, less irrigation water is required and a higher IWUI is achieved (see Table 1 data for Dalby compared to drier conditions at St George and Goondiwindi).
- In seasons with better rainfall, less irrigation water is required and a higher IWUI is achieved (see Table 1 data for 2010–11 compared with 2013–14).
- The GPWUI is a better indicator of water productivity – its value is more stable across seasons (see Table 2). But the drier the season, the lower the GPWUI in response to the increased irrigation demand (see the 2013–14 data in Table 2 compared with other years).

During the past three seasons, benchmarking of several surface irrigated cotton crops was also completed. EnergyCalc, produced by the National Centre for Engineering in Agriculture, was used to benchmark the energy use on a field basis for crops grown. Table 3 summarises the energy use associated with cotton production for the irrigation systems benchmarked in these seasons.

### TABLE 3: Average energy use (GJ/bale) and energy cost ($/bale) for benchmarked irrigation systems

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Centre pivot</td>
<td>0.47</td>
<td>$16.83</td>
<td>1.4</td>
</tr>
<tr>
<td>Lateral Move</td>
<td>0.48</td>
<td>$15.73</td>
<td>1.13</td>
</tr>
<tr>
<td>Siphon</td>
<td>0.36</td>
<td>$11.66</td>
<td>0.32</td>
</tr>
</tbody>
</table>

Not surprisingly there was greater energy use and energy cost per bale during the dry 2013–14 season, when more irrigation water had to be applied. Pressurised systems such as CPLMs generally have a greater energy use and cost compared to surface irrigated systems. This is to be expected where the greatest proportion of energy costs is related to irrigation applications. But there may also be energy savings with these systems with less tillage use compared with traditional surface irrigated systems.
It is interesting to note that in 2014–15 the energy use and cost for the surface system was very similar to that for the overhead systems. The results of benchmarking irrigation-system performance demonstrate:

- Year-to-year variability in these water productivity indices;
- Importance of on-going benchmarking of your operation; and,
- Care needed in comparing these indices between localities and farming systems.

It also demonstrates the significant improvement in water productivity in the cotton industry, where once the IWUI of one bale/ML was considered indicative of good management. The improvement is due to increasing crop yields resulting from varietal improvement and the better agronomic practices now used by the industry.
Irrigation feature…

IrriSAT update

By Janelle Montgomery

IrriSAT is a weather based irrigation water management and benchmarking technology that uses remote sensing to provide site specific crop water management information across large scales at relatively low cost.

The IrriSAT technology uses two sources of information:

- A local weather station for reliable estimates of reference evapotranspiration (ETo); and,
- Satellite imagery to determine crop coefficients (Kc) that are specific for individual irrigation fields which are then combined with ETo to calculate crop water use (ETc).

IrriSAT provides daily crop water use, along with a seven day forecast.

Developed initially in the CRC for Irrigation Futures, IrriSAT was first trialed in the Australian cotton industry in 2009–10. This was a small trial in the Gwydir Valley working with Nick Gillingham (Sundown Pastoral Co) and Rob Holmes (HMAg), who provided necessary feedback to adjust the technology to better suit cotton consultants who were working with multiple farms and potentially a large number of fields. Interest in IrriSAT rapidly expanded and in 2010–11, 10 consultants from across northern NSW were involved in the trial covering around 20,000 hectares. Then in 2011–12, the IrriSAT technology covered over 75,000 hectares.

These initial trials were essential to gauge interest in using the technology as well as adapting the technology to suit the requirements of cotton consultants.

The consultants all agreed that IrriSAT has enormous potential. Although it would not replace soil probes, they thought the technology has the potential to add value to irrigation scheduling decision making and provide a useful tool for benchmarking crop productivity.

Rob Holmes said that the greatest use he had for using IrriSAT is the ETc information which can be used to benchmark his client’s cotton crops.

“When I’m calculating the crop water use index I need a reliable estimate of ETc. The IrriSAT technology has provided me with this. It’s quick and easily obtained for my end of season benchmarks. Benchmarking crop water use allows me to look back over the season with my clients and compare crop productivity in terms of water use between fields and farms. We can discuss what might be occurring in field such as compaction and what areas are performing well – and try to improve over time.”

Figure 1 shows 2010–11 cotton yield (bales/ha) and seasonal water use calculated using the IrriSAT technology for individual fields. They vary in row configuration, irrigation system and irrigation deficit management strategies which can clearly be seen to affect yield and water use efficiency performance.

The other area where the IrriSAT technology offers benefits is looking at spatial variability across a field or multiple paddocks over a region, providing a basis for examining potential drivers of variation. The technology provides spatial data down to a 30x30 metre basis yet can cover entire irrigation regions.

Janelle Montgomery (NSW DPI) and John Hornbuckle (CSIRO) lead the current IrriSAT project. There have been significant advances in technology since 2011–12, including a massive increase in data availability and the ability for end users to harness the IrriSAT technology. This project will move the technology to a point where consultants have the ability to use the information sources themselves in their own applications. IrriSAT is not a stand-alone product, but rather a technique that people can apply and complement other irrigation scheduling tools.
More Cotton, Less Labour

Padman Stops are working with farmers to develop outstanding results in irrigation techniques for a smarter future in farming.

BANKLESS CHANNEL
We can provide Drop Boxes to suit any size layout. From 30-120 Mg/day.

THROUGH THE BANK
Pipe Ends come with downstream bubblers for optimum coverage.

MAXI-FLOW CULVERTS
Our Culverts unique design provides High Strength & Maximum Flow.

LABOUR SAVERS
We have a full range of portable and affordable automation.
This season will concentrate on the benchmarking aspects of IrriSAT and some intense field trials will be run to examine the drivers of in-field variability. Further development of an appropriate platform to deliver the IrriSAT output will also take place.

ET/IrriSAT workshops will be delivered over the next six months to improve consultant and irrigator skills in weather based scheduling methods, including the IrriSAT technology. The classes will provide a detailed explanation of how to download satellite imagery and apply the IrriSAT technology to produce crop productivity and seasonal crop water use maps.

For further information please contact Janelle Montgomery
e-mail: Janelle.montgomery@dpi.nsw.gov.au

TABLE 1: A rough guide to storage seepage rates

<table>
<thead>
<tr>
<th>Seepage rate</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above 3–4 mm per day</td>
<td>If you store water fairly regularly, it may be cost effective to undertake remediation works, provided the seepage is occurring in a confined area and the potential remedies provide effective seepage reduction. If this is not possible, at least having a precise measure of your seepage rate will be invaluable for water budgeting.</td>
</tr>
<tr>
<td>Above 6 mm per day</td>
<td>Numerous seepage remedies are likely to be cost effective, provided you can identify where the seepage is occurring and the applicable remedies are able to provide effective reduction in your circumstances.</td>
</tr>
<tr>
<td>Above 8 mm per day</td>
<td>You really need to take action. Most remedies will be cost effective. You will still need to be able to identify where the seepage is occurring and have conditions under which the mitigation solution will be effective. At these seepage rates it is probably advisable to use the storage as little as possible.</td>
</tr>
</tbody>
</table>

(Source: Waterpak 2012)
Jim Purcell, Managing Director/Principal Engineer of Aquatech Consulting, suggests that discovering storage leaks before they become large means an excavator can be used to repair the bank and save most of the stored water. Potentially, this could prevent the need for expensive repairs, costing many thousands of dollars.

Considerable water loss equates to a significant economic loss, especially if there are no more pumping opportunities or increases in allocation to take water. For example, if an irrigator’s storage fails and they lose 500 ML of water, the irrigator could theoretically lose $200–300 per ML of profit, or up to $150,000.

Storage seepage loss is an issue that many irrigators need to manage. Factors including soil types, storage design (shape and depth), location and, of course, unseasonal rain events influence these situations.

Jim said that irrigators whose storages fail need to realise that cutting corners when constructing the storage will often lead to expensive repairs in the longer term. The lesson to learn when constructing storages is not to cut on costs, compact well and roll the central core of the storage. Constructing a storage using these methods ensures that vegetation finds it difficult to penetrate the soil, and that it is less likely for any air voids to occur in the soil structure for water seepage.

Even when storages are operating at maximum efficiency, and evaporation and seepage loss is minimal, irrigators should still carry out regular maintenance including:

- Regularly maintaining storage walls, including visual inspection for cracks, leaks and seepage. Schedule dates in their diaries to drive around the crest and base of the storage.

- Maintain the crest, as it can decrease in height by approximately 25 mm per year due to erosion, but grading is also a contributing factor. Crest surveys every five years will determine the current shape and structure of the crest, and grader work will correct minor damage and level uneven surfaces as they appear. Diminishing crest levels reduce freeboard availability, resulting in decreased storage capacity. Banks that are constructed with dispersive soils are prone to erosion and regular cultivation will break down the early stages of tunnelling. Use harrows to ensure a smooth finish.

- Regularly measuring and monitoring storage losses will ensure early identification of problems that might need fixing. Soil imaging techniques (EM survey) are a cost-effective way of looking at the entire storage area. A seepage–evaporation meter can quantify seepage rates in order to identify if they are acceptable. A rough guide to seepage rates is provided in Table 1.

- No type of vegetation should be growing on storage banks, as their root system will disrupt soil compaction and provide a path for water seepage. Heavy vegetation cover also makes it difficult to detect holes, cracks, and erosion.

**If irrigators maintain storages as new throughout their life, the risk of deterioration, and storage failure, is greatly minimised.**

Through the Sustaining the Basin: Irrigated Farm Modernisation program (STBIFM), irrigators can assess their whole farm for water losses by completing an Irrigated Farm Water Use Efficiency Assessment (IFWUEA). The IFWUEA helps irrigators locate and quantify on-farm irrigation water losses (including storage seepage).

Locating and quantifying the losses helps irrigators make business decisions around irrigation infrastructure. That information can then be used to consider options to improve their on-farm efficiency.

Irrigators within the STBIFM program area (NSW Border Rivers, Gwydir, Namoi/Peel, Macquarie/Cudgegong and Barwon/Darling) can apply for up to $2000 towards the cost of preparing an IFWUEA.

The STBIFM program is funded by the Australian Government’s ‘Sustainable Rural Water Use and Infrastructure’ Program, as part of the implementation of the Murray–Darling Basin Plan in NSW.

For more information about the STBIFM program, please visit www.dpi.nsw.gov.au/info/sustainingthebasin or contact your local project officer.