NSW GOVERNMENT Department of Primary Industries

primefact

Benchmarking water productivity of Australian irrigated cotton

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Water Productivity Benchmarking Team

Summary

Improving **water use efficiency is a high priority** for Australian agriculture, especially given continuing dry conditions.

NSW DPI, in partnership with the Cotton Research and Development Corporation, have been **monitoring water productivity in irrigated cotton** over the last decade. The objective of this work has been to facilitate continuous improvement in water use efficiency and establish a benchmark that a grower can compare their performance against.

This work has identified **significant gains in water productivity and irrigation efficiency** by Australian cotton growers over recent years.

Overall, Australian cotton growers have significantly **increased yields and decreased irrigation inputs**.

Establishing water productivity benchmarks

In the 2017/18 season, we assessed water productivity and water use efficiency of 57 farms, spread across all of Australia's major cotton-growing areas. This accounted for more than 200 fully irrigated fields, which covered 18,673 ha and 232,194 bales of cotton. This represented around 8% of fully irrigated cotton in Australia. Our measurements followed the same procedure, and covered a similar proportion of the industry, as those made in 2006/07, 2008/09 & 2012/13 cotton growing seasons, making this the fourth iteration of our water productivity benchmarking (see Williams & Montgomery 2008; Montgomery & Bray 2010; Montgomery et al. 2014 for previous work).

We used grower records to conduct a water balance of each farm. To calculate water inputs, we collected data on all water accessed (brought onto farm), changes in dam storage

volume, changes in stored soil moisture, in-crop rainfall and rainfall runoff harvested during the growing season.

To calculate outputs, we estimated seepage losses in dams, channels and fields based on soil type, and we used weather data from the Australian Bureau of Meteorology to identify evaporation in conjunction with satellite imagery, which allowed us to:

- identify crop growth phases to estimate **crop water use**
- measure the surface area of water in storage-dams and irrigation-channels to estimate **losses due to evaporation**.

These data were used to calculate standardised water productivity indices and irrigation efficiency metrics, and to follow the fate of irrigation water on farm and identify where water is lost, and how much water is lost, in the system.

Standardised measures

Gross Product Water Use Index (GPWUI) is a measure of how productively water is used. It is the ratio of cotton yield (bales/ha) to all water potentially available for cotton crops (ML/ha). It accounts for all water from rivers and bores, plus any rain falling directly on the crop and all rainfall runoff harvested, plus all soil moisture used by the crop. It also includes all water lost through evaporation and seepage during storage and delivery to the field. GPWUI is the preferred metric for comparing water productivity across regions and seasons, as it takes into account all the water available to the crop (Equation 1).

$$\textbf{Equation 1.} \quad GPWUI = \frac{cotton\ yield}{irrigation\ water + rainfall + soil\ moisture\ change}$$

Whole Farm Irrigation Efficiency (WFIE) is a measure of how efficiently irrigation water is used (Tennakoon and Milroy, 2003). A high WFIE indicates that storage, transmission and field losses are low and the crop used most of the water brought onto farm. WFIE values are, however, also influenced by rainfall, and will be higher in drier years because a greater proportion of crop water-needs are met by irrigation. Any comparisons of WFIE across years needs to, therefore, take rainfall into consideration before making interpretations. WFIE is calculated by first identifying how much irrigation water was used by the crop. This is done by subtracting the effective rainfall and soil moisture from crop water use. The volume of irrigation water used by the crop is then divided by all irrigation water used and lost across the farm and throughout the season (Equation 2).

$$\textbf{Equation 2.} \quad WFIE = \frac{crop\ water\ use\ - effective\ rain - soil\ moisture}{irrigation\ water\ used\ on\ farm} \times 100$$

Water productivity for the 2017/18 cotton season

- **Water productivity (GPWUI) increased significantly**, from
    - 1.12–1.14 bales/ML in 2006/07, 2008/09 & 2012/13, to
    - 1.20 bales/ML in 2017/18 (see Figure 1)
- These improvements in water productivity are the result of **increased yield** and **reduced water input**
- To illustrate this change, it took an average of
    - 0.9 ML of total water (irrigation, rainfall & soil moisture) to grow a 227 kg bale of lint in 2007/08, 2008/09 & 2012/13, and
    - 0.8 ML in 2017/18
- The irrigation component of this total water accounted for
    - 0.6–0.8 ML per bale in 2007/08, 2008/09 & 2012/13, and
    - 0.5 ML in 2017/18
- **Whole farm irrigation efficiency (WFIE) increased significantly** from around
    - 70% in 2006/07 & 2008/09, to around
    - 83 & 81% in 2012/13 & 2017/18, respectively (see Figure 1)
- Higher values of WFIE suggest a reduction in losses from evaporation and seepage during storage and transmission, indicating that more of the water brought onto the farm was used directly by the crop. Higher values of WFIE may also come from reduced rainfall (see Equation 2), as more of the crop water-requirements are met by irrigation rather than rainfall. The average effective rainfall was relatively low in 2006/07 & 2012/13, with 140mm & 167mm, respectively, compared with 2008/09 & 2017/18, with 273mm & 205mm, respectively

  Through our water balance calculations of each farm, we were able to follow the fate of all irrigation water used throughout the season. **Storage losses were relatively low in 2017/18** compared to previously published data from the industry (Figure 2). We urge caution, however, when comparing these data as our trials cover a much greater extent of the Australian industry.

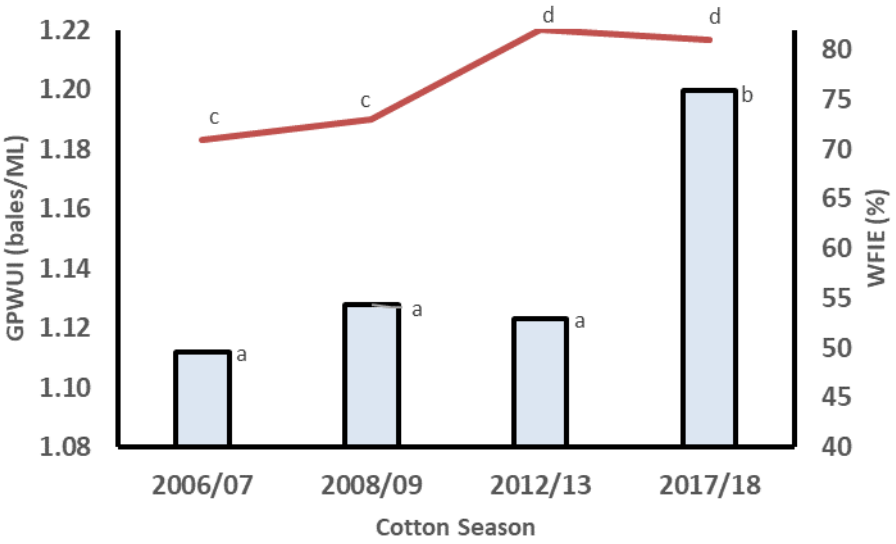

***Figure 1**. Comparison of the Gross Product Water Use Index (GWPUI), blue columns, and Whole Farm Irrigation Efficiency (WFIE), red line, over previous Water Productivity Benchmarking surveys. Different letters represent significant differences in analysis of variance.*

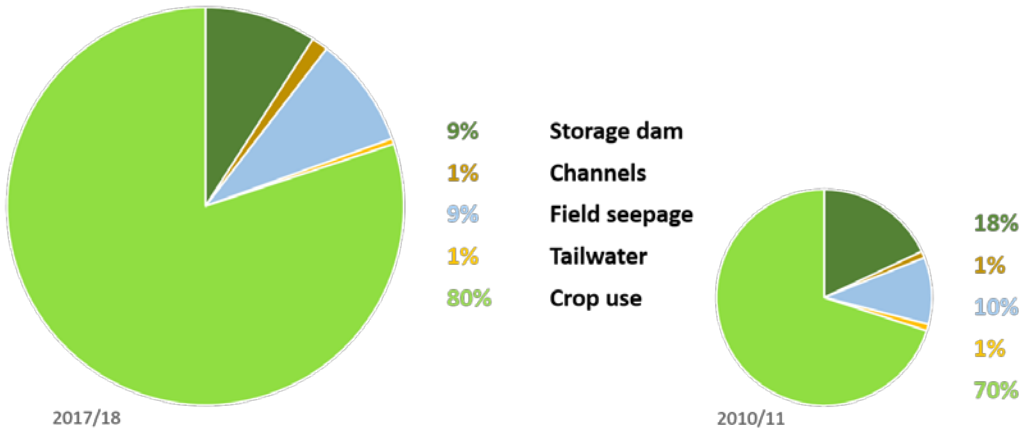

***Figure 2.** Fate of irrigation water on the farm from our work in 2017/18 compared to previous industry data from 2010/11 published in CRDC & CA (2014).*

Next steps

As a result of this comprehensive study, the DPI Agriculture Water Productivity Benchmarking team has developed more efficient techniques to monitor water productivity. We will now be benchmarking water productivity in the cotton industry annually in both irrigated and dryland systems.

Increasing water productivity continues to be a high priority for the Australian cotton industry. Further R&D is taking place to:

- assess and publish water productivity trends over longer time frames
- identify practices that growers can adopt to make rapid gains in water productivity, and
- present results to growers on an interactive dashboard, which allows them to compare their water productivity with their peers regionally and nationally.

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