The economics of measuring and improving Water Use Efficiency

Analysis for cotton production

KEY MESSAGES

- Water is an increasingly limiting factor in irrigated agriculture, not land.
- Maximising returns to the limiting resource is critical from a farm economic sustainability perspective, as well as having benefits from an in industry social and environmental sustainability perspective.
- Water Use Efficiency (WUE) incorporates irrigation system efficiencies (accounting for system losses) as well as water productivity measures (yield or return per ML of water).
- NSW DPI benchmarking for N NSW and S QLD showed the average whole farm irrigation efficiency (WFIE) was 59% in 2017-18, while for the top 25% of farms it was 70%.
- Measuring and monitoring farm WUE reduces production risk, and highlights areas for improved resource use and improved profitability.

ABOUT THE RESEARCH

Smarter Irrigation for Profit Phase 2 is tackling the challenge of reduced water availability by focusing on practical, cost-effective strategies to improve the water productivity of Australian cropping and pasture irrigators in the cotton, dairy, sugar, rice and grains industries.

THE ECONOMICS OF WATER USE EFFICIENCY — A COTTON EXAMPLE

Increased water productivity means more yield or return per megalitre of water (bales/ML and $/ML). Water productivity is closely related to irrigation system efficiency metrics, which compare water inputs to water outputs at different points in an irrigation system by accounting for water losses along the way. Irrigation efficiencies are typically measured for conduit efficiency (E_b) accounting for storage and channel losses; application efficiency (E_a) accounting for field losses; and whole farm irrigation efficiency (E_f or WFIE). Crop productivity and irrigation system efficiencies both sit under the umbrella of water use efficiency (WUE).

Understanding irrigation system efficiencies is central to water budgeting for each year's cotton crop — How much cotton can be grown with available water?

Getting irrigation system efficiencies wrong can lead to an over or under-estimate of water requirements, in turn risking wasted farm resources, or risking being short of water, losing crop yield or purchasing expensive water on a spot market.

At the same time, knowing your system efficiencies in detail helps to target WUE improvements, allowing greater production and profit from limited water resources.

For a N NSW or S QLD furrow irrigation system, an improvement from the average to the top 25% irrigation efficiency could lead to a 16% reduction in water use per ha, allowing 19% more cotton to be grown with the same water.

When these benefits are captured over a 10-year period with a 5% discount rate, the total farm benefits are equal to $524 thousand. This provides a comparison figure for the cost of WUE improvements

Table 1 shows a cotton water budget for two scenarios based on results published under the CRDC & NSW DPI co-funded project, *Trend & Drivers of Water Productivity in Australian Cotton* (DAN2002) for furrow irrigation in N NSW and S QLD. The two scenarios have the same farm irrigation water supply, but scenario 1 has average WUE (average irrigation system efficiencies generating average water productivity), while scenario 2 has improved WUE to the top 25% (irrigation system efficiencies generating improved water productivity).

Table 1. Farm cotton water budget for average WUE, and improved (top 25%) WUE*

Farm water **storage losses** averaged 25%, ranging from 17% to 38%.

Channel losses averaged 3%, ranging from 1% to 8%.

Field **deep drainage** losses averaged 13%, ranging from 2% to 43%.

Field runoff* averaged 20%, with optimised runoff 16%. Runoff is recycled, but this incurs additional system losses and pumping costs.

Improved irrigation efficiency means getting water to the plant with reduced losses along the way, so you can **grow more crop area with the same water**.

Improved irrigation efficiency has a small benefit to gross margin per hectare through **reduced pumping costs**.

The improvement in irrigation efficiency means **increased farm productivity** (GM per ML) of +21%, supporting **improved farm profit**.

Farm cotton water budget	Average WUE	Improved WUE
Farm irrigation water supply (ML)	**1,000**	**1,000**
Storage losses (% of farm water supply)	25%	20%
Channel losses (% of farm water supply)	3%	1%
Conduit efficiency (E_b) (farm supplied water delivered to the field)	**72%**	**79%**
Deep drainage (% of farm water supply)	13%	9%
Field runoff (recycled) (% of farm water supply)	20%	16%
Application efficiency (E_a) (field supplied water available to the plant)	**82%**	**89%**
Farm efficiency (E_f) (=E_b x E_a) (farm supplied water available to the plant)	**59%**	**70%**
Plant evapotranspiration (ET) requirement (ML)	7.7	7.7
Effective rainfall (ML/ha)	1.6	1.6
Used soil moisture (ML/ha)	0.6	0.6
Plant irrigation water requirement (ML/ha)	5.4	5.4
Field irrigation water requirement (ML/ha)	6.6	6.1
Farm irrigation water requirement (ML/ha)	9.2	7.8
Planted area (ha)	**108**	**129**
Yield (b/ha)	11.6	11.6
IWUI (farm) (bales/farm irrigation ML)	1.26	1.49
WFIE (plant available water/farm used water)	0.59	0.70
GPWUI (farm) (bales/total farm ML)	1.01	1.16
Gross margin ($/ha)*	$ 3241	$ 3302
Gross margin ($/ML farm irrigation water)	**$ 351**	**$ 425**

* Water budget based on NSW DPI data for 2017-18, WATERpak (field runoff data), and CottonInfo Gross Margins 2021-22

CONCLUSIONS

Understanding and monitoring WUE supports improved crop water budgeting, which in turn reduces production risk. Insights can identify areas where farm efficiencies are underperforming industry benchmarks, highlighting potential areas for investment in WUE improvements. In addition, by incorporating the above water budgeting and gross margin process into a capital budgeting process, the benefits of improved WUE can be compared to the cost of improving WUE. In the example, when the cumulative benefits of moving from average to top 25% WUE are captured over a 10-year period with a 5% discount rate, the total farm benefits are equal to $574 thousand. This value provides a comparison figure for the cost of WUE improvements such as storage evaporation mitigation solutions, system redesign, or new irrigation technologies.

Farm WUE can be affected by a range of factors including soil types, climate, irrigation system design, and irrigation practices. When considering investment in WUE improvements, growers should undertake individual farm analysis and consider specific production system and market dynamics.

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