Fact sheet July 2023

Gross Margin risk analysis: Water Use Efficiency

Season conditions and irrigation water requirement

Recent years have seen a lower average requirement for irrigation water due to[2] the wetter climatic conditions, with applied water averaging 5.6 ML/ha in 2021-22 and 6.3 ML/ha in 2020/21, compared to 7.7 ML/ha in both 2018-19 and 2017-18 (CRDC Grower Surveys).

With the Bureau of Meteorology (BOM) giving a 70% chance that El Nino may develop later in 2023 (three times the normal likelihood), there is a good chance that irrigation water requirements will increase for the 2023-24 crop.

While growers cannot influence climate, the associated risk can be managed by improving farm water use efficiency (WUE).

WUE often focusses on productivity metrics such as irrigation water use index (IWUI) (bales per ML of irrigation water) and gross production water use index (bales per ML of total water including irrigation, soil moisture use, and rainfall).

A big influence on both productivity metrics is a farm's irrigation system efficiency, which compares water inputs to water outputs at different points in an irrigation system to account 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; which combine to form *whole farm irrigation efficiency* (E_f or WFIE).

Industry water use benchmarks generated by CRDC Grower Surveys and the NSW DPI benchmarking project provide good resources for checking how a farm's water use compares to other growers in the region.

KEY POINTS

- A 70% chance of El Niño returning later in 2023 could mean higher plant evapotranspiration (ET) and lower in-crop rainfall for the 2023-24 crop. Meaning more irrigation water is required per ha.
- Improved whole farm irrigation efficiency (WFIE) can mitigate these climatic risk factors.
- Industry benchmarking shows average WFIE was 61% in 2021-22 compared to 74% for the top-25% of growers.
- In a dry year, the reduced water use and water pumping costs per ha for the Top 25% result in a 24% higher GM return per ML of water.
- For a farm with 1000 ML of water, the difference between average and Top 25% WFIE could mean an additional $109,820 in a dry year.
- Monitoring your field and farm WUE can identify areas where efficiencies can potentially be improved to reduce production risk.

So, what are the implications of moving from a wet year to a dry year for the cotton gross margin?

Using the CottonInfo customisable gross margin (GM) spreadsheet (fully irrigated 12 bales/ha @$600/bale), we first look at the implications of moving from a wet year (based off 2020-21 benchmarking) to a dry year (based off 2018-19) for a farm with an average WFIE of 61% (61% of farm water supply reaches the crop, from the NSW DPI 2020-21 benchmark) (Figure 1).

In this scenario, the higher plant ET and lower effective rainfall of the dry year mean that 2.6ML (39%) more water is required per hectare. More water per hectare means pumping costs per hectare also increase, decreasing the cotton GM by $165/ha (4%). The change in pumping costs could be more significant if a higher proportion is sourced from groundwater (the example uses 10% groundwater, 90% surface water).

However, this change in GM per ha does not account for the "opportunity cost" of water, i.e., the lost revenue that would have otherwise been generated with the additional water. This opportunity cost may have been planting additional cotton area, carrying over water to next season, using the water for other crops, or selling the water on the temporary market. The opportunity cost is reflected in the GM per ML figure, which in the example has increased by 31%.

The whole farm implications of moving from a wet year to a dry year are demonstrated in a scenario of 1000 ML available water. With the higher per ha water demand, the farm has decreased planted area from 151 ha to 109 ha (–28%). When combined with the lower GM, the net effect is a whole farm GM decrease of $198,359 (–31% as per GM/ML)

Cotton Water Budget and Gross Margin	Average WFIE "wet"	Average WFIE "dry"
TOTAL INCOME $/ha (A) 12 bales lint/ha @ $600/lint bale, $95/bale seed.	**8340**	**8340**
WATER BUDGET:		
Whole Farm Irrigation Efficiency (WFIE) (% of farm supplied water available to the plant)	**61%**	**61%**
Plant evapotranspiration (ET) requirement (ML/ha)	7.3	7.7
Effectively field rainfall (ER) (ML/ha)	2.8	1.6
Soil moisture use (SM) (ML/ha)	0.5	0.5
Farm irrigation water requirement (ML/ha) (C) (ET - ER - SM)/WFIE	**6.6**	**9.2**
Total irrigation costs $/ha (water access and pumping)	418	584
Other variable costs $/ha	3623	3623
TOTAL VARIABLE COSTS $/ha (B)	**4040**	**4206**
GROSS MARGIN $/ha (=A-B)	**4300**	**4134**
GROSS MARGIN $/ML (=(A-B)/C)	**648**	**449**
Potential area grown (1000 ML total water supply)	**151 ha**	**109 ha**
GM change from area grown		– 28%
GM change from increased pumping costs		+ 3%
Total GM change (farm level GM, or GM/ML)		**– 31%**
Farm level change ($)		**– 198,359**

Higher ET and lower rainfall mean more irrigation water is required in a dry year.

More irrigation water per ha means higher pumping costs per ha.

More water per ha means less planted area for a given water availability. For a farm with 1000ML available, this could result in nearly $200,000 (31%) lower cash profit (excluding labour and other fixed costs).

Figure 1: Water Budget and Gross Margin Budget for the industry average WFIE (wet and dry years)

So, what are the gross margin implications of improving WFIE?

While growers cannot influence climate, the associated GM risk can be managed by improving farm water use efficiency (WUE).

Again using the CottonInfo customisable gross margin (GM) spreadsheet (fully irrigated 12 bales/ha @$600/bale), we next look at how a "dry year" GM compares for the industry average WFIE of 61%, to the top 25% WFIE of 74% (Figure 2). The water budget detail is expanded to show the drivers between the average and Top 25% WFIE.

From this benchmarking process, we see that the top 25% need 1.6 ML (17%) less water per hectare due to reduced storage and field losses. The reduced water use per hectare means lower pumping costs per hectare, resulting in a $104 (3%) increase in the GM per ha. Again, to understand the additional value of the opportunity cost, we look at the GM per ML figure, which in the example has increased by 24%.

In the same 1000 ML of available water scenario, with the improved WFIE the farm can increase planted area from 109 ha to 132 ha (+21%). When combined with the improved GM, the net effect is a whole farm GM increase of $109,820 (+24% as p

The top 25% are getting 10% more farm water to the field, primarily due to lower storage losses.

The top 25% are making 10% more field water available to the plant through reduced field losses.

The reduced losses mean the top 25% are getting 21% more farm water to the crop.

This means the top 25% need 1.6ML/ha (21%) less farm water per cotton ha.

Less water per ha means lower pumping costs per ha.

For a farm with 1000ML available, improved IWUE in a dry year means 21% more cotton area and an improved GM per ha, together increasing cash profit by $109,820 (24%) (excluding labour and other fixed costs).

Cotton Water Budget and Gross Margin	Average WFIE "dry"	Top 25% WFIE "dry"
TOTAL INCOME $/ha (A) 12 bales lint/ha @ $600/lint bale, $95/bale seed.	**8340**	**8340**
WATER BUDGET:		
Storage losses (% of farm water supply)	17%	8%
Channel losses (% of farm water supply)	3%	3%
Conduit efficiency (E_b) (farm supplied water delivered to the field)	**80%**	**89%**
Field losses (deep drainage % of farm water supply)	20%	15%
Application efficiency (E_a) (field supplied water available to the plant)	**75%**	**83%**
Whole Farm Irrigation Efficiency (WFIE) (=Eb x Ea) (% of farm supplied water available to the plant)	**61%**	**74%**
Plant evapotranspiration (ET) requirement (ML/ha)	7.7	7.7
Effectively field rainfall (ER) (ML/ha)	1.6	1.6
Soil moisture use (SM) (ML/ha)	0.5	0.5
Farm irrigation water requirement (ML/ha) (C) (ET - ER - SM)/WFIE	**9.2**	**7.6**
Total irrigation costs $/ha (water access and pumping)	584	480
Other variable costs $/ha	3623	3623
TOTAL VARIABLE COSTS $/ha (A)	**4206**	**4103**
GROSS MARGIN $/ha (=A-B)	**4134**	**4246**
GROSS MARGIN $/ML (=(A-B)/C)	**449**	**559**
Potential area grown (1000 ML total water supply)	**109 ha**	**132 ha**
Farm level GM ($)	**449,404**	**559,224**
GM benefit from increased planted area		+ 21%
GM benefit from reduced pumping cost/ha		+ 3%
Total GM change (farm level GM, or GM/ML)		**+ 24%**
Farm level change ($)		**+ 109,820**

Figure 2. Water Budget and Gross Margins for industry average WFIE and Top 25% in a "dry year"

Final notes

Irrigation efficiencies and the related water productivity metrics (IWUI and GWPUI) can be affected by a range of factors including soil types, climate, irrigation system design, and irrigation practices. Monitoring conduit and application efficiencies helps to understand the drivers of WUE and supports improved crop water budgeting and gross margin budgeting— "how much cotton can I grow, and what does this mean for my bottom line?". Comparing WUE across individual fields or comparing with other farms using industry WUE benchmarking data can identify areas where efficiencies can potentially be improved to reduce production risk, particularly when faced with warmer and dryer growing conditions.

See CottonInfo Crop Water Management for additional information and resources for improving WUE. *For more information on this analysis or the CottonInfo gross margins contact Ag Econ's George Revell george@agecon.com.au*

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