Assessing the marginal benefit of irrigation water

A SUPPLEMENTARY IRRIGATED SUGARCANE SCENARIO, CENTRAL REGION QLD

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KEY MESSAGES

- Climate sensitivity analysis in the Central Region over the period 1990-2020, found rainfall to be more plentiful and more reliable in the months of January and February, meaning opportunities to optimise plant available water through irrigation occurs more frequently in September, October, November and December – early in the growing season.
- The economic impact of additional 1 ML/ha irrigation was negligible when 3 t/ha yield resulted. Return on Investment increased rapidly when crop yield response to irrigation exceeded 6 t/ha yield benefit.
- The price of sugar does impact on the marginal benefit of applying additional irrigation water under current energy pricing scenarios. When sensitivity tested, a high energy price and a low sugar price combination resulted in a negative crop GM outcome.
- Assuming a 37 kW pump size and a reduction in annualised cost of energy from a solar PV install, the marginal benefit of applying irrigation water showed the greatest gain in crop GM and the highest resilience to sugar cane price fluctuations.

About the research

Smarter Irrigation for Profit Phase (SIP2) is a partnership between the irrigation industries of sugar, cotton, grains, dairy and rice, research organisations and farmer groups. The objective of SIP2 is to improve the profit of over 4,000 irrigators.

As part of the collaborative research, the University of Southern Queensland (USQ), in partnership with Sugar Research Australia (SRA) and the Federal Department of Agriculture and Water Resources (now the Department of Agriculture, Water and the Environment), aims to improve the capability of growers and extension staff to use irrigation information and tools and make cost-effective irrigation decisions through on-farm demonstration[1].

Central Region - High energy prices and sub-optimal irrigation application

Energy is one of the fastest growing costs for irrigated sugarcane growers, with electricity from pumps accounting for a significant portion of total farm input costs. In Queensland, electricity costs have increased by approximately 400% since the year 2000. Inflation over the same period has been around 45%.[2]. In the Central cane growing region around Mackay, supplementary irrigation occurs at various times throughout the season. Still, irrigation water is often relied upon early in the crop development stage until monsoon rains arrive. Industry and advisor feedback suggest high energy prices have stifled timely use of irrigation water, at the expense of sugar cane yield and cane gross margins. This analysis assumes irrigators have surplus water to apply to sugar cane crops during the growing season.

[1] https://www.crdc.com.au/sites/default/files/Improved%20irrigation%20system%20selection%20sugarcane.pdf
[2] https://www.irrigators.org.au/wp-content/uploads/2018/03/NIC_Submission_Energy_Green_Paper_FINAL_4_Nov_2014.pdf

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Crop water use varies greatly throughout a season depending on the time of year and crop growth stage. Understanding the variation in crop water use is important for adjusting irrigation schedules and the volume of water being applied. If the water holding capacity of the soil is known, the crop water use can be used to estimate when the next irrigation will be. For example: if we have a crop at 100% canopy on a soil with a water holding capacity of 80 mm, and the soil profile is full; then the crop will need watering in about two weeks (assuming crop uses 41 mm per week), providing the weather conditions are similar. A soil that only holds 40 mm of water will need watering after a week.

Figure 1 shows a simple Co-efficient of Variation (CoV) test on growing season rainfall from 1996-2020, found January and February to have the largest monthly totals (line graph) and highest reliability (lowest CoV values – blue bars) from the September to March growing period. With smaller, less reliable monthly totals occurring in Sep/Oct/Nov, crop moisture deficits and yield penalties are most likely to occur in the first half of the growing season. With these findings in mind, the next section investigates the economic outcomes associated with applying additional irrigation water in the Central region.

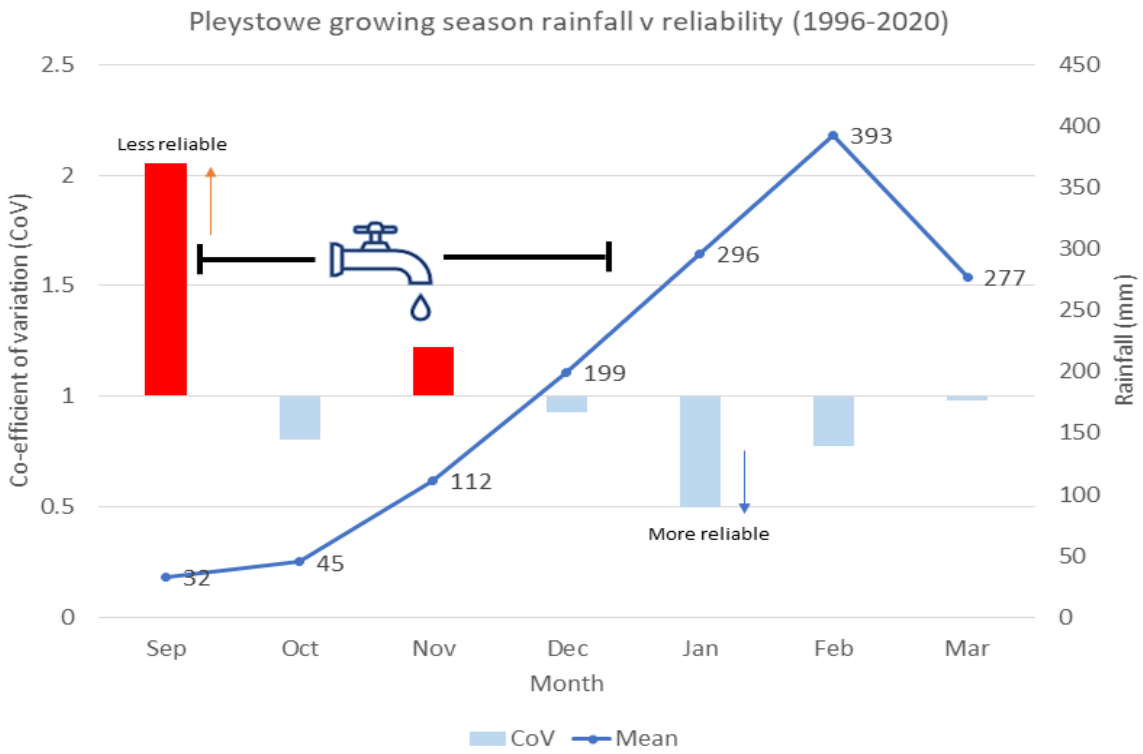

Figure 1 Pleystowe (Central Region) rainfall reliability analysis (red and blue bars) vs monthly rainfall totals (line graph) over the period 1996-2020.

Gross Margin sensitivity yield analysis – applying an additional 1 ML/Ha

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Economic principles can be used in deciding what to produce and how to do it efficiently. If a cane grower chooses to use resources in a certain way, then they have given up the opportunity to use their resources in some alternative way. When investigating these scenarios, the crop Gross Margin (GM) is calculated to identify the contribution the activity makes to farm total GM. In the case of investigating the economic outcomes of additional irrigation water to a sugar cane crop, the Farm Economic Analysis Tool (FEAT) can assist[3]. A custom-built GM model for the Central cane growing region around Mackay was used to further refine the analysis, benefitting from prepopulated regional data, developed in consultation with industry advisors. The core operations, input costs and yields used in this case study scenario reflect broad Central Regional trends and are not reflective of any one individual situation. The baseline production assumptions are summarised below.

Table 1 Central Region sugarcane Gross Margin baseline assumptions

Water Use = 2 ML/Ha	**37 KW Electric pump**	**R&M Irrigation = $16 /ML**
Big Gun irrigation	**Pumping day (20%) night (80%)**	**Water charges = $16.26 /ML**
Sugar Price (IPS) = $400[4]	**Time of Use energy rates** **Day = 31 c/kWh Night = 17 c/kWh**	**Labour = $35/hr**

To estimate changes to crop GM with an additional 1 ML/Ha applied, a sensitivity analysis was undertaken to better understand economic impacts. The relationship between resources used in production (in this case water) and the production which results (output – sugar cane yield) is called a response function. Irrigation yield response data from SIP II research[5] was used to derive an irrigation/yield response function showing a range of outcomes, dependent on current individual soil and rainfall plant available water. In this example, analysis undertaken assumed four separate yield responses from a constant irrigation amount – 1 ML/Ha. These yield responses attempt to capture what may occur because of additional applied water which will be a function of timing, access to nutrients, plant growth stage etc. on an individual field. From there, changes in crop GM and subsequent Return on Investment (%) from new costs incurred was calculated to establish the marginal benefit of this practice change. Figure 2 shows the Return on Investment (ROI) being very sensitive to additional yield response from the 1 ML/ha applied. A low yield response barely yielded an economic response in this analysis. Where estimated sugar cane yielded an additional 14 t/ha, the marginal cost of achieving a higher crop response was a stellar outcome, achieving a 310% ROI.

[3] https://www.daf.qld.gov.au/business-priorities/agriculture/plants/crops-pastures/sugar/farm-economic-analysis-tool
[4] https://www.msfsugar.com.au/2020/10/20/pool-price-market-update-october-2020/#:~:text=As%20at%20the%201st%20of,from%20the%20August%20Advance%20value.
[5] Scobie, M. (2020) Pers. Comms. Sugarcane crop water production function. Received via email 16 Oct. 2020.

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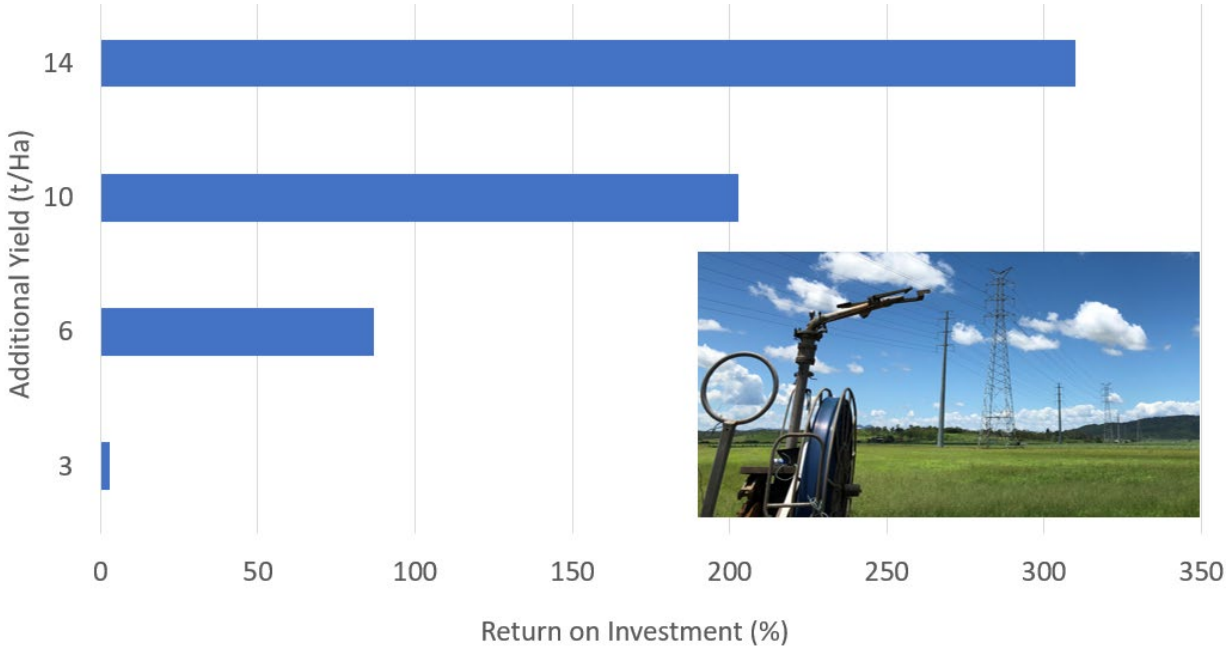

Figure 2 Marginal sugarcane yield response (t/ha) scenarios resulting from additional 1 ML/ha and Return on Investment

Sensitivity testing sugar cane and energy prices with 1 ML/ha additional irrigation

Sensitivity analysis, broadly defined, is the investigation of impacts of changing assumptions and their flow-on impacts on conclusions to be drawn from the model. Further analysis was undertaken to test the sensitivity of sugar cane price and energy tariff structure and energy prices under a generic assumption of a 10 t/ha irrigation yield response (additional 1 ML/ha). The results found the model was indeed sensitive to various combinations of sugarcane price, energy rate and tariff configuration. The energy tariffs applied reflect various iterations of Tariffs 20[6] (T20 - flat rate), Tariff 22 (T22: time of use – TOU) and a reduced annualised energy rate, assuming the addition of a 39 kW solar PV array, based in previous SRA research[7]. This is an average rate based on solar PV energy blended with grid tariff whilst achieving a Feed-in-tariff. The analysis found a flat rate tariff, similar to T20 concurrently with a low cane price ($380) delivered the greatest exposure to economic losses. An inflated pricing of T22 under the current model was negative or close to break-even (red shading), under the lowest sugarcane price scenario ($380). As sugar cane price increased, so too did the marginal benefit of applying irrigation water. As energy prices eased, reflecting a lower marginal cost of pumping – per hectare gross margin responded positively (green shading), with the low-cost solar option turning a profitable gross margin at even the lowest sugar cane price. It should be noted that daytime energy usage profile will impact results (and has not been considered in this analysis). Table 2 provides a summary of the sensitivity results.

[6] https://www.ergon.com.au/retail/business/tariffs-and-prices/small-business-tariffs
[7] https://research-repository.uwa.edu.au/en/publications/can-applying-renewable-energy-for-australian-sugarcane-irrigation

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Table 2 sensitivity test results of combined per hectare economic ($/ha) Gross Margin response, assuming 10t ha sugarcane yield increase from an additional 1 ML/ha irrigation water applied.

		Energy price configuration			
		Flat 26 c/kWh	**TOU 36/20c kWh**	**TOU 31/17c KWh**	**Solar 15c/kWh**
Sugar cane price (IPS)	**$380**	-$37	-$2	+$40	+$124
	$390	+$45	+$80	+$121	+$205
	$400	+$127	+$161	+$203	+$286
	$410	+$208	+$243	+$286	+$368
	$420	+$290	+$324	+$367	+$450

For information on the SIP II Program research visit https://smarterirrigation.com.au/ or contact Sugar Research Australia.

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