Economics of irrigation system conversion: - big gun irrigation to furrow irrigation, Bundaberg Region QLD.

KEY FINDINGS

- **Providing field slope and soil type are suitable for furrow irrigation, economic analysis indicates 13% return on marginal capital to change from big gun to furrow irrigation**.
- Owing to the high costs attributed to pressurised water needed for big gun application, even at sub-optimal irrigation application rates of furrow irrigation, the analysis found the marginal return on capital to remain above 10%.
- The capital costs of converting to furrow irrigation were understood to be relatively sensitive in the Partial Budget approach, when compared with the inelasticity (small changes) of application efficiency scenarios of a proposed furrow irrigated system.
- Although labour costs were assumed double that of big gun irrigation systems, the substantial energy requirements expose irrigators to increases in gross margin variable costs from future energy price rises.

Southern Region – Furrow irrigation as a low-cost alternative to big gun / water cannons

To maximise returns, farmers should adapt production activities to influences such as changing market requirements, technology and changes in production costs. When considering irrigation application methods for irrigated sugar cane, alternatives may not always be practical on some fields due to paddock size, shape, access to labour and capital.

Around Bundaberg, big guns or water cannons are commonly used to irrigate sugarcane. A low-cost alternative is furrow irrigation if field slope and other relevant factors such as soil type, paddock size, access to labour and capital enable conversion. Research previously undertaken by SRA[1] shows the difference in irrigation cost between furrow irrigation and big gun irrigation is largely determined by pumping Total Dynamic Head (TDH) and energy requirements of the system. The two systems have relatively similar application efficiencies and while furrow has a higher labour requirement, the main difference is the high energy costs of the high-pressure water cannon.

Figure 1 Big Gun irrigation (LHS) and furrow irrigation (RHS) on sugarcane crops

[1] https://sugarresearch.com.au/wp-content/uploads/2018/01/Energy-in-irrigated-cane_2017x.pdf

Table 1 provides a cost summary of both furrow and big gun irrigation systems on a per mega litre (ML) basis, including a qualitative assessment on labour component for each.

Table 1 comparative irrigation costs (Welsh and Powell 2017)[2]

	COMPARATIVE IRRIGATION COSTS							
Irrigation system	**Capital cost** $/ha	**Irrigation application efficiency** % (approx)	**Labour requirement**	**Water source**	**Total pumping head**[3] (metres)	**Energy required to pump 1ML**[4] (kWh)	**Pumping costs ($ per ML)** Electricity cost @ 27c/kWh[5] = $/ML	Diesel cost @ 78.8/L[6] = $/ML
Furrow	$4,500-$6,000	70	High	River/ channel	10	44	**11.90**	**9.30**
				Bore	30	132	**35.71**	**27.90**
High pressure overhead Travelling Gun	$4,900-$6,500	65	Medium	River/ channel	70	309	**83.33**	**65.09**
				Bore	85	375	**101.19**	**79.04**
				Piped scheme	45	199	**53.57**	**41.84**

Big gun irrigators with significant pumping Total Dynamic Head have a much higher exposure to future energy price rises and cost of production in context of furrow irrigators.

A partial budget approach: furrow v big gun irrigation

A useful approach for assessing the benefits and costs involved in changing from one irrigation practice to another, is a Partial Budget method. A Partial Budget is a technique used to assess the likely value of introducing a new activity by comparing it with the existing situation. Put simply, you are comparing the extra costs and returns of the new activity with those of the present activity. The net returns or losses can then be expressed as a percentage return on extra (or marginal) capital, providing a preliminary basis for comparison with other alternatives.

Previous SRA irrigation research shows, not all soil types are suited to furrow irrigation due to several factors including water penetration issues associated with water quality and soil texture or sodicity – ultimately impacting infiltration to the sugarcane root zone[3]. In this analysis, the application efficiency was sensitivity tested to better understand the impact of soil type on the analysis results. The other main driver of the success of the conversion from big gun to furrow

[2] https://sugarresearch.com.au/wp-content/uploads/2018/01/Energy-in-irrigated-cane_2017x.pdf
[3] https://sugarresearch.com.au/wp-content/uploads/2017/02/Irrigation-Manual-F-LowRes2.pdf

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irrigation is the capital cost of implementing furrow irrigation while accounting for an increase in labour costs.

Applying an 8 ML / ha water budget from a grid-connected irrigation bore in the Bundaberg region[4] and assuming double the per hectare labour costs of traditional big gun irrigation from $1.50 / ha to $3 / ha under furrow irrigation from industry Gross Margin budgets[5], **the mid-point was found to achieve a 13% return on marginal capital as a result of the system conversion**. The baseline application efficiencies applied from Table 1 (above) for big gun (65%) and furrow irrigation (70%) were applied. The cost per ML was then adjusted according to the water application efficiency. For example, an 8 ML / ha water applied at 65% application efficiency delivers 5.2 ML / ha to the crop root zone. In this instance, furrow irrigation would need only apply 7.4 ML / ha to achieve the same water to the root zone (at 70% application efficiency). Thereby saving water at a much lower cost per ML without the need for pressurised irrigation water.

Analysis was undertaken to test the sensitivity of capital costs of the furrow irrigation conversion and the anticipated application efficiency under the new scenario. The analysis found the results far more sensitive to the capital costs of the conversion when changes ranged from $4,000 / ha to $6,000 ha. Conversely, water application efficiency from the new furrow irrigated scenario did not alter returns on the same scale as capital conversion costs, owing to the much lower cost of water delivered to field through low pressure furrow, from a reduced energy requirement.

Water application efficiency from the new furrow irrigated scenario did not alter returns on the same scale as capital conversion costs, owing to the much lower cost of water delivered to field.

Table 2 sensitivity testing the marginal return (%) on capital following a conversion from Big Gun to Furrow irrigation under varied capital cost and water application assumptions.

		Irrigation application efficiency (% water reaching the root zone)				
		80%	**75%**	**70%**	**65%**	**60%**
		% Return on Marginal Capital Big gun v Furrow irrigation conversion				
Capital costs of conversion to furrow ($/Ha)	**$6,000**	11%	11%	11%	10%	10%
	$5,500	12%	12%	12%	11%	11%
	$5,000	14%	14%	**13%**	13%	12%
	$4,500	16%	15%	15%	14%	14%
	$4,000	18%	18%	17%	17%	16%

Although not tested in this analysis, big gun irrigators with significant pumping TDH have a much higher exposure to future energy prices in context of furrow irrigators. Irrigators with high grid energy consumption should consider SRA solar PV feasibility research as an alternative to reduce

[4] https://eprints.usq.edu.au/1406/2/baille_craig_2004_whole.pdf

[5] https://www.daf.qld.gov.au/business-priorities/agriculture/plants/crops-pastures/sugar/farm-economic-analysis-tool/feat-regional-example

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pumping costs.[6] Recent advances in telemetry and remoted sensing has improved water application of furrow irrigation through greater accuracy of timing and duration of irrigation events. Precision irrigation technology has not been costed in this analysis. More information on precision technology can be found here: https://www.crdc.com.au/sites/default/files/Precision%20automated%20furrow%20irrigation%20for%20the%20Australian%20sugar%20industry%202021.pdf

Although labour costs were assumed double that of big gun irrigation systems, the substantial energy requirements expose irrigators to increases in gross margin variable costs from future energy price rises.

SRA-funded research on reducing energy costs of irrigation pumps can also be found here: https://sugarresearch.com.au/growers-and-millers/irrigation/#panel-energy

Smarter Irrigation for Profit Phase II is a collaboration between the cotton, sugar, dairy, rice, and grains industries. SIP II is supported by funding from the Australian Government Department of Agriculture, Water and the Environment as part of its Rural R&D for Profit program. For information on the SIP II research, including the USQ project underlying this case study, visit https://smarterirrigation.com.au/. For more information on the SIP I program visit https://www.crdc.com.au/smarter-irrigation-phase-1.

For more information on this economic analysis, please contact Jon Welsh, Principal Economist at Ag Econ, through jon@agecon.com.au.

[6] https://sugarresearch.com.au/growers-and-millers/irrigation/

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