Variable-rate irrigation using VARIwise

Application in centre pivot overhead cotton irrigation

KEY MESSAGES

- Variable-rate irrigation technology and prescription map development software (e.g. 'VARIwise') can match irrigation to crop water requirements with spatial and temporal changes in soil type and growth stage.
- Trials of variable-rate irrigation and VARIwise technology have demonstrated yield improvements as well as water and labour savings in centre pivot cotton production.
- In a 50ha field, these benefits generated an internal rate of return of 23% with a 5 year payback period.
- Technology can also be used in other crops in rotation and lead to further benefits.

ABOUT THE RESEARCH

As part of the ***Smarter Irrigation for Profit Phase 2*** (SIP2) project, the University of Southern Queensland (USQ) has developed and trialled software that automatically generates water requirement maps that integrate into variable-rate hardware, allowing individual nozzle flow control in centre pivot and lateral move (CPLM) irrigation. The software considers a wide range of factors to truly understand plant water requirements and optimise the site-specific irrigation. These inputs include weather, soil characteristics, and management information (e.g. sowing date, fertiliser application).

ANALYSIS OF FARM LEVEL COSTS AND BENEFITS

Drawing on the USQ SIP2 outputs, this case study analysed the economics of the VARIwise variable-rate technology in an overhead cotton irrigation system. Costs and benefits were analysed over a 15-year period using discounted cashflows (5% discount rate).

Investment costs

The USQ system included the following items for a field 400 m wide (50 ha for a centre pivot irrigation machine). A 400 m lateral move irrigation machine on a 1.25 km long field would have the same equipment costs and area.

- The software (currently undergoing commercialisation) is expected to be a subscription linked to a variable-rate irrigation controller or available from a precision agriculture software provider.
- Input weather information can be obtained for free from online network weather stations.
- If soil characterisation data is not already available for the field, soil samples can be conducted for $575 per location. This one-off sampling may be conducted in 3-4 locations across a field depending on soil variability.
- Commercially available variable-rate controllers are required on each nozzle. The variable-rate hardware is fixed to the machine, but the machine can be moved by the grower season to season with the cotton rotation. The trial costs for a centre pivot covering 50 ha with 190 nozzles were:
  - $264/nozzle for machine
  - $49/nozzle installation cost
  - Lifespan of approximately 15 years
  - Maintenance costs of approximately $366/year
  - Annual cost for remote access subscription of $450

The exact system requirements and costs will depend on the type of field layout and the variable-rate hardware manufacturer selected.

Investment benefits

The USQ trials identified the following benefits of the variable-rate irrigation using VARIwise:

- Yield benefits from more efficient and responsive watering; reducing over and under-watering. There was yield benefit of 1.8-5.4% (average 3.6%) in years in which the machine has system capacity to deliver the water requirements (i.e. two out of three years on the SIP2 project).

- Reduced average water use of 5.5-15.6% over three seasons (average 10.6%), leading to reduced pumping cost and opportunity cost of water.
- Labour saving of one-two hours each week of the cotton season from assessing the field and analyse different data sources and data layers (if they were using them).
- Additional labour saving through remote starting and stopping of irrigation machines, rather than needing to be at the machine during irrigations (approximately one hour/week).

Investment performance

Comparing costs and benefits in a discounted cashflow (DCF) highlights whether variable-rate technology using VARIwise is an economically viable investment. Table 1 presents the DCF results, which incorporate the USQ data with *CottonInfo Gross Margin (GM)* data for overhead irrigated cotton. Saved water was assumed to be used to irrigate otherwise dryland wheat, using *NSW DPI GM* data for marginal returns to irrigated wheat. All figures in table 1 are in present-value terms (a discount rate of 5% was applied to make future cashflows comparable to upfront costs).

Table 1. Baseline results of discounted cashflow analysis over 15 years with 5% discount rate

	Present values over 10 years	
	50 ha field	**Per ha**
Upfront hardware and installation costs	$59,470	$1,189
Maintenance and remote access costs	$8,470	$169
A. Total Costs	$67,940	$1,359
Yield benefit (baseline 12 bales/ha @ $639/bale lint and seed)	$80,586	$1,612
Water saving benefit (baseline 8 ML/ha @$89/ha marginal return per ML applied in irrigated wheat)	$79,125	$1,582
B. Total benefits	$159,711	$3,194
Net Present Value (A-B)	**$91,722**	**$1,835**
Internal rate of return	**23%**	
Payback period	**5 years**	

The above analysis shows the investment is viable given the positive Net Present Value (NPV). The baseline results also show that both yield benefits or water savings would alone be sufficient to cover the investment costs.

Through sensitivity analysis, the baseline results can also be tested for changes in key underlying variables. Table 2 shows the change in internal rate of return (IRR) for the full range of yield and water benefits identified in the trials. This sensitivity analysis shows the investment is viable in all scenarios with an IRR ranging from 8% to 37%, although the lower IRR may not meet individual investment criteria. As always, when considering new investments, growers should undertake individual farm analysis and consider their own specific production system and market dynamics.

Table 2. Sensitivity analysis of baseline IRR to changes in yield and water saving benefits

		Yield benefit		
		1.8%	**3.6%**	**5.4%**
Water savings	**5.5%**	8%	16%	24%
	10.6%	16%	**23%**	30%
	15.6%	23%	30%	37%

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For more information on this economic analysis, please contact George Revell, Principal Economist at Ag Econ, through george@agecon.com.au.

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