Responsive irrigation management with Canopy Temperature Stress technology

- *By supporting more accurate monitoring of a crop's stress levels and need for water, canopy temperature stress (CTS) technology can increase cotton yields while reducing labour and water costs.*
- ***Incorporating CTS technology into irrigation management has the potential to generate an additional $152/ha/season.***
- *Due to long water supply lead times, some growers may find it harder to adapt irrigation management unless there is sufficient on-farm storage or bore water supply.*

ABOUT THE RESEARCH

As part of ***Smarter Irrigation for Profit phase 1*** (SIP1), the CSIRO conducted on-farm trials of canopy temperature stress (CTS) technology in different cotton growing valleys in New South Wales (Wee Waa, Rowena, Walgett) and Queensland (Emerald, St. George).

The overarching philosophy of the trials was to provide farmers the opportunity to use an irrigation scheduling tool that is based on real-time monitoring of a crop's stress levels and need for water.

ANALYSIS OF FARM LEVEL COSTS AND BENEFITS

Drawing on the SIP1 research and other cotton industry research and data, this case study presents an economic analysis of implementing CTS technology in furrow-irrigated, solid configuration cotton production. The farm-level economic framework used partial budgeting to compare the seasonal costs and benefits of the investment (Table 1).

Table 1. Partial budget for using CTS technology in furrow irrigated, solid configuration cotton production. Data in formulas have been rounded so do not match presented figures.

Partial Budget			
Additional costs		**Additional revenue**	
GoField®Plus annual cost: $1225 over 50ha field =	$25/ha	3% cotton yield benefit 1 in 2 years: 3% x 12 bales/ha @$473/bale x 1/2 =	$85/ha
Reduced revenue		**Reduced costs**	
Nil		Save 1 irrigation 1 in 3 years:	
		Reduced irrigation water 1 in 3 years 1 ML/ha x $163/ML x 1/3 =	$52/ha
		Reduced irrigation labour 1 in 3 years 2.7hr/ha x $35/hr x 1/3 =	$32/ha
		Reduced irrigation energy 1 in 3 years 1ML/ha x 11.3L/ML x $1.1/L x 1/3 =	$4/ha
		Avoided cost of previously used soil moisture probes	$4/ha
A. Total additional costs and reduced revenue	$25/ha	**B. Total additional revenue and reduced costs**	$177/ha
Net change (B minus A)			**$152/ha**

Compared to using soil moisture probes alone, integrating CTS technology into irrigation management has the potential for increased yield every second year, and a saved irrigation every third year.

Investment costs. The CSIRO developed CTS technology is commercially available through GoannaAg as part of its GoFieldPlus irrigation management system. The GoFieldPlus package is available for seasonal hire for a cost of $1225[1], and includes:

- A GoProbe, providing a real-time soil moisture profile.
- A GoCanopy temperature sensor.
- GoSat platform access, which combines local weather data and forecasts with satellite imagery and analytics using CSIRO created algorithms to forecast crop water use on a day-by-day basis.
- LoRaWAN or CATM1 network access for data connectivity, available in most cotton valleys.
- The GoApp software for desktop and mobile.

For a 50ha field, the system costs $25/ha; however, this will depend on field dynamics including field size and in-field variation that may require more than one probe and sensor per field.

With an annual cost of $25/ha/yr and average benefits of $177/ha/yr (Error! Reference source not found.Error! Reference source not found.), the use of CTS technology in cotton production generated an additional $152/ha/yr.

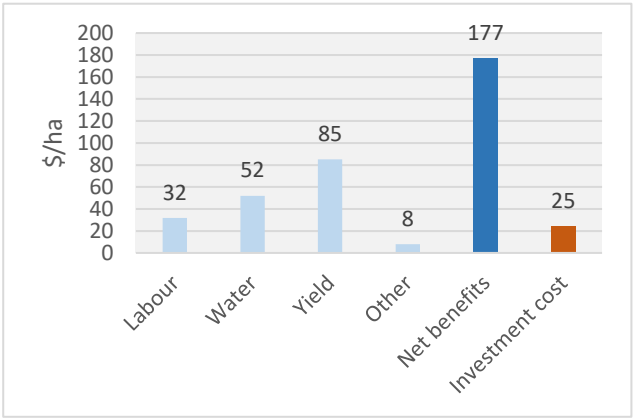

Figure 1. CTS annualised benefits and costs.

Yield changes. Trials, modelling, and early adoption CTS technology of have demonstrated a potential yield increase of 3% every second year as a result of improved responsiveness to crop stress levels and water requirements[2]. Applying these yield increases to a baseline 12 bales/ha[3], gives an average annual yield increase of 0.2 bales/ha. Change in yield were valued at $473/bale (including lint price and seed price less yield-based operational costs[4]).

Water use changes. By combining CTS technology with accurate local weather outlooks, opportunities may arise where producers can safely stretch out irrigation intervals to more effectively use in-crop rainfall. Trials and early adoption of CTS technology have demonstrated the potential to save one irrigation every three years[5]. Based on in-crop irrigation of 7.7 ML/ha across 8 irrigations[6], average annual water savings of approximately 0.3 ML/ha could be achieved. Depending on individual farm

[1] Pers comm with Tom Dowling, GoannaAg, Jan 2021.
[2] Pers comm with Dr Hiz Jamali and Dr Rose Brodrick, CSIRO, Nov/Dec 2020.
[3] Powell J. et al, 2019, *Furrow Irrigated Cotton Gross Margin*.
[4] Lint yield based on the 10y average US cotton price futures, real values. All other values from Powell J. et al, 2019 op cit.
[5] Pers comm with Dr Hiz Jamali and Dr Rose Brodrick, CSIRO, Nov/Dec 2020.
[6] Powell J. et al, 2019, op cit.

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dynamics, saved water may be used for additional crop production, such as cotton (with a gross margin (GM) of $343/ML[7]) or wheat (GM of $115/ML[8]), or may be temporarily traded (with a 10 year average price of $162/ML[9]).

Labour use changes. For every saved irrigation, there are associated labour savings. Depending on the farm characteristics, savings per irrigation may range from $67/ha[10] to $125/ha[11]. This analysis used a mid-point labour saving of $96/ha/saved irrigation in the baseline results. While current canopy sensors need to be progressively raised above canopy throughout the season, newer models will aim to eliminate this requirement.

Other operational cost changes. The cotton GM used in this case study already included contracted soil moisture capacitance probes with a seasonal cost of $4/ha/season[12]. As the GoField package includes capacitance probes the individual probes will no longer be required and represent an operational saving. Also included in other operational cost changes are reduced pumping energy costs associated with the saved irrigations equal to $4/ha/season[13].

Due to long water supply lead times, some growers may find it harder to adapt irrigation management unless there is sufficient on-farm storage or bore water supply.

CONCLUSIONS

Drawing on the SIP1 research and other industry research and data, this case study has evaluated the economic viability of CTS in cotton production, with the potential to generate an additional $152/ha/season. The Costs of $25/ha/season may vary depending on field dynamics such as field size and differing soil types. The benefits of $177/ha/season were driven by the potential for improved irrigation management with regards to crop stress and water availability, generating yield savings one in two years and irrigation savings one in three years. It has, however, been identified that where growers are faced with long water supply lead times they may find it harder to adapt irrigation management unless there is sufficient on-farm storage or bore water supply[14]. As such, when considering incorporating CTS technology into irrigation management, producers should undertake individual investment analysis while considering specific farm and market dynamics.

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[7] Using Powell J. et al, 2019 op cit, modified to long term average lint yields based on the 10y average US cotton price futures, real values
[8] NSW DPI, 2012, *Winter crop gross margin budgets, Dryland north-west*
[9] BOM, *Water Markets Dashboard*. 10year average real traded price in the Murray Darling Basin cotton growing valleys.
[10] Gall, L, 2016, *Grower Led Irrigation System Comparison in The Gwydir Valley, CRDC1606 Technical Research Report*, and Gall, L, 2020, *Benchmark Manual vs Automated Siphon Efficiencies, Smarter Irrigation for Profit Phase 2*.
[11] Roth, G. et al, 2018, *Smarter Irrigation for Profit Phase 1—Final Report combined*, and Gall, L, 2016, op cit.
[12] Powell J. et al, 2019, *Furrow Irrigated Cotton Gross Margin.*
[13] Based off NSW DPI, 2015, *Primefact 1425*, with a 10yr average real diesel price of $1.1 from FuelWatch, *Historical Price Search*.
[14] Quinn, J, 2016, Season Benchmarking with Canopy Temperature Sensors

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