Case study: A siphon-less irrigation system assessment

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THERE continues to be strong interest in siphon-less irrigation systems which require considerably less labour than the traditional siphon system. Despite the lack of scientific performance data, farmer experience has often claimed maintained or improved yields and/or reduced water used (based on timing of irrigation). Measurement of water around the farm is not commonly conducted, and as such the actual amount of water applied to a field is generally estimated.

An assessment of the performance of a 'siphon-less' conversion on 'Anderson's Block,' was conducted following the 2018–19 cotton crop and compared to an adjacent siphon irrigated field at 'Farm 121' also belonging to the farmer Rob Jakins.

The water measurement was possible, as each field was irrigated from water released from an on-farm water storage that was located adjacent to the fields and had an electronic storage meter installed allowing continuous measurement of the storage water volume. Therefore, an accurate comparison of the irrigation water applied to both the siphon-less and siphon system was possible.

This siphon-less head ditch with tail water backup (TWB) system was a case study presented as part of the Gwydir Valley 'Siphon-less Field Day' in 2019. The booklet, can be found here on the CottonInfo website.

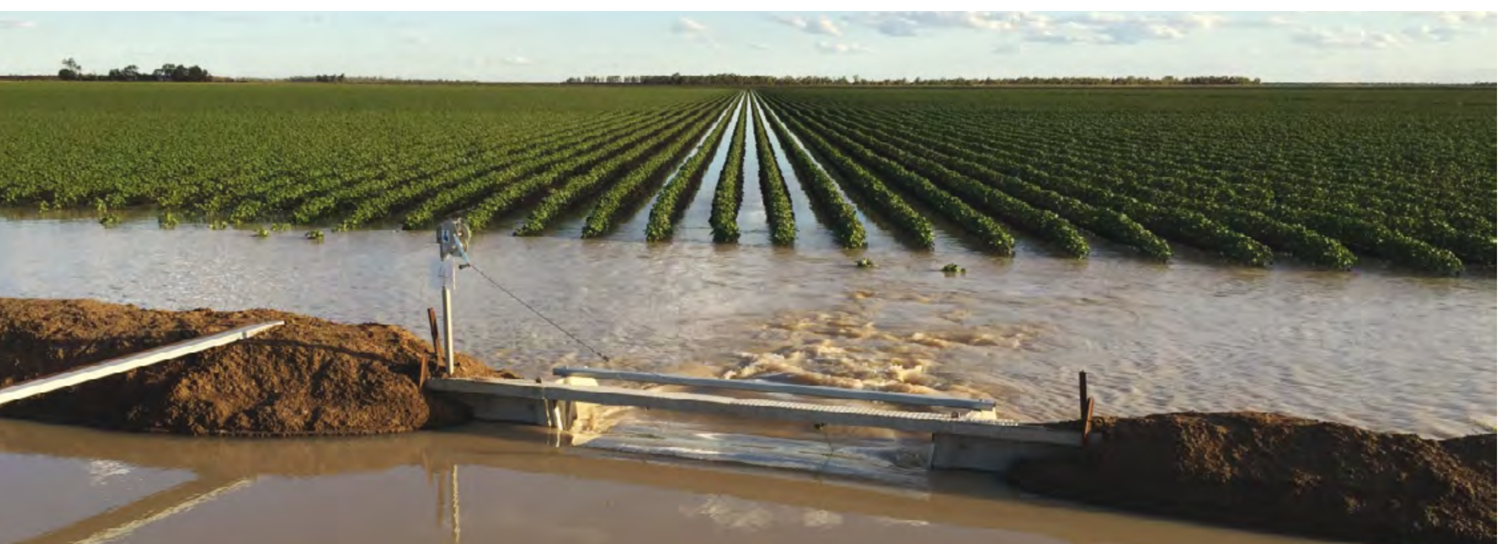
Production performance

The yield and water use details for the two fields are shown in Table 1. The comparison indicated a reduction in irrigation water applied of 1.54 ML per hectare in the TWB system compared to the siphon system. Similarly, the total water supplied (including irrigation water, effective rainfall and soil moisture) was 1.34 ML per hectare less in the TWB, or a 14 per cent saving in water. Combined with higher yield (12 per cent) in the TWB system, the resultant Gross Production Water Use Index (GPWUI) was

TABLE 1: Data from the 'siphonless head ditch with tail water backup' and 'siphon' irrigation systems 2018 cotton crop

	Andersons Block*	Farm 121
Irrigation system	TWB	Siphon
Description	10 Bays, row length 450 to 840 m	2x63 mm siphons, every 2nd row, row length up to 1100 m
Area (ha)	97	101
Irrigation water applied (ML)	848	1038
Effective rainfall (ML)	57	60
Soil moisture used (ML)	19	0
Total water supplied (ML)	924	1098
Yield (bales/ha)	15.7	14.0
Irrigation water applied (ML/ha)	8.74	10.28
Total water supplied (ML/ha)	9.53	10.87
Water use index IWUI* (bales/ML)	1.80	1.36
Water use index GPWUI** (bales/ML)	1.65	1.29

*Andersons Block came out of a wheat rotation followed by deep ripping and land reformation to convert to the Tail Water Backup system. The wheat crop and deep ripping will have contributed to the yield gain. Farm 121 had back to back cotton for the prior seven years.
* IWUI = Irrigation Water Use Index = Total Production for field (Bales) / Irrigation Water Applied to Field (ML)
** GPWUI = Gross Production Water Use Index = Total Production for field (bales)/Total Water Supplied to Field (ML), where total water includes irrigation water applied, rainfall received, and soil moisture used during the season.



Inlet to bay from head ditch.

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1.65 bales per ML compared to 1.29 bales per ML for the siphon system, a 28 per cent increase. These gains will reduce as the benefit in yield from the wheat rotation and ripping decreases in subsequent years.

Financial comparison

Financial data (taken from the Boyce and Co Australian Comparative Analysis, 2018) has been used as indicative expense and interest cost figures for a siphon system. The same expenses were used for the TWB system, but were adjusted using estimated savings for labour, fuel, desilting and no requirement for rotobucks. An extra interest cost was calculated to account for the development cost of the TWB system.

A comparison of profit from the different systems (siphons vs TWB) has been calculated based on water being the limiting resource. That is, assuming we have only 1000 ML irrigation water available to irrigate each system. The differences in yield and water use from Table 1 have been used to calculate area grown and income generated. The results are presented in Table 2.

The siphon system would produce 1288 bales and the TWB 1649 bales. With 1000 ML irrigation water available, the TWB production area is 14 per cent higher than a siphon system (based on reduced total water supplied in TWB system, 10.87 vs 9.53 ML per hectare).

This 14 per cent increase in production area, combined with the 12 per cent gain in yield per hectare, and the reduced growing costs, result in a 50 per cent increase in farm profit. Under these parameters, the payback period for the TWB is less than one crop, with a return on investment of 120 per cent.

Another way of analysing this data is determining the area of TWB system required to generate the same profit as the siphon system. In this case, 70 hectares of TWB would generate the same profit as 92 hectares of siphons but would use only 668 ML of water, not 1000 ML.

Or to generate the same farm profit as the 105 hectares of TWB system, an area of 138 hectares of siphons must be grown. This area would require 1498 ML of water. This is likely to be an investment upward of $2 million if the land and water were to be purchased to achieve this result.

Note that the type of system chosen by Rob required minimal movement of soil to ensure yield wasn't compromised, and as such, was relatively cheap ($1200 per hectare) when compared to other bankless designs that can cost as much as $5000 per hectare.

The water efficiency and yield gains experienced by Rob may not be obtained in other situations. A yield gain of only 5 per cent would reduce the profit gain from $151,000 to $95,000.

The results from this analysis show that Rob's investment to convert a siphon field to a siphon-less (TWB) system has paid off.

Future production years

There is currently no data for subsequent years for this system as the TWB system on Andersons Block due to a lack of available water. Assuming the water use gain reduced from 14 to 10 per cent, and that the yield benefit reduced from 12 to 5 per cent (rotation effect diminished), the financial outcome might look like that presented in Table 3.

The siphon system would produce 1288 bales and the TWB

TABLE 2: A financial comparison of the Siphon and Siphon-less with Tail water back-up (TWB) irrigation systems where water is the limiting factor (1000 ML available)

Using income and expenses from Boyce analysis		Siphons	TWB	% Gain of TWB
Water allocation	(ML)	1000	1000	
Area grown	(ha)	92	105	14% Water efficiency gain.
Income from Boyce at $542/bale	($/ha)	$7465	$8371	12% Yield gain
Expenses from Boyce	($/ha)	-$4153	-$4025	Expense reduction
Profit	**($/ha)**	**$3312**	**$4346**	
Farm profit growing with siphons 92 ha			$304,704	
Farm profit with tailwater backup 105 ha			$456,347	
Profit gain by TWB conversion			**$151,643**	**50% Increase in profit**
Capital cost of TWB system on 105 ha at $1200/ha			$126,000	
Payback time			**0.8**	**Crops**
Return on investment			**120**	**% per crop**

TABLE 3: A financial comparison of the siphon and siphon-less with TWB irrigation systems in future years, where yield increased by only 5 per cent and the reduction in water use was only 10 per cent compared to a siphon system

		Siphons	TWB	% gain of TWB
Water allocation	(ML)	1000	1000	
Area grown	(ha)	92	101	10% water efficiency gain
Predicted yield	Bales/ha	14.0	14.7	
Income from Boyce at $542/bale	($/ha)	$7465	$7838	5% yield gain
Expenses	($/ha)	-$4153	-$4025	
Profit	**($/ha)**	**$3312**	**$3813**	
Farm profit growing with siphons 92 ha			$304,704	
Farm Profit with tailwater backup 101 ha			$385,108	
Profit gain by TWB conversion			**$80,404**	**26% Increase in Profit**

1485 bales. With 1000 ML irrigation water available, the TWB production area is 10 per cent higher than a siphon system (based on reduced water applied in TWB system, 10.87 vs 9.78 ML per hectare). This 10 per cent increase in production area, combined with a 5 per cent gain in yield per hectare, and the reduced growing costs, result in a 26 per cent increase in farm profit.

In this case, 80 hectares of TWB would generate the same profit as 92 hectares of siphons but would use only 791 ML of water, not 1000 ML.

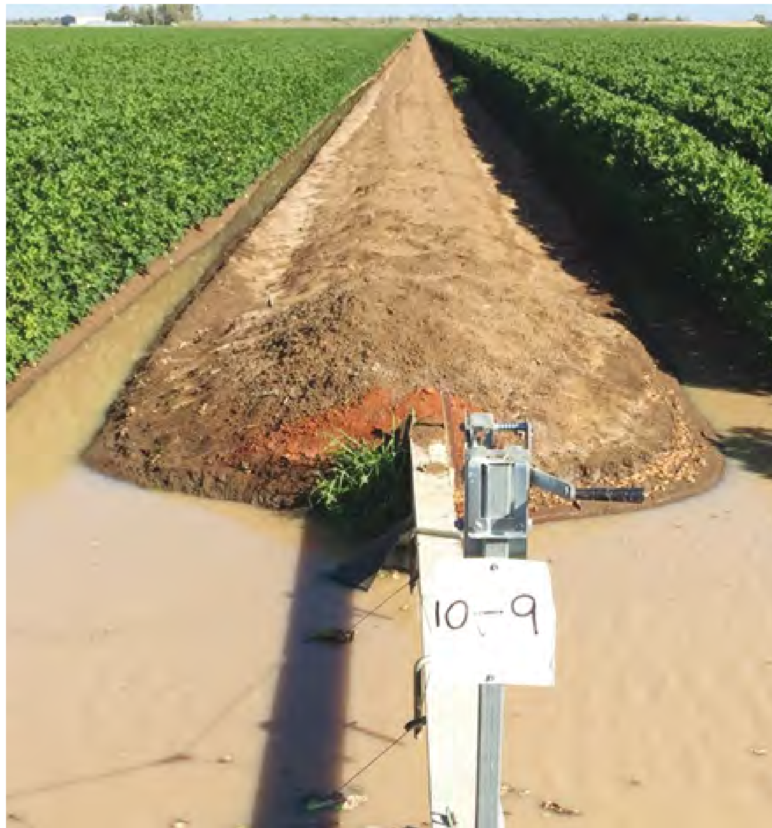
To generate the same profit as the 101 hectares of TWB system, an area of 116 hectares of siphons must be grown. This area would require 1264 ML of water. This is likely to be an investment upward of $1 million if the land and water were to be purchased to achieve this result.

Conclusion

This analysis suggests a conversion to siphon-less with TWB may have a payback period of one crop, and that the ongoing financial benefit from the TWB system is around $80,000 per 1000 ML of water per year. The ongoing gain in farm profit from the TWB system is around 26 per cent, compared to the siphon system.

Disclaimer: The financial outcomes presented in this case study are indicative only and may not represent those achieved in other situations. A grower's own financial data should be incorporated into the analysis to gain more relevant outcomes. Not all siphon fields can be converted to the TWB system. It is recommended an irrigation consultant be engaged to assess the suitability of a field.

1. Irrigation consultant
2. CottonInfo.



Check bank separating bays 9 and 10, with check structure in tail drain.

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