Automated broad-acre irrigation with small Pipe Through Bank (sPTB)

KEY MESSAGES

- Compared to manual siphon irrigation systems, automated small pipe through bank (sPTB) reduces labour inputs and costs.
- **Investment in automated sPTB was found to generate a NPV of $364/ha when compared to manual siphon irrigation.**
- Up-front investment costs can be heavily influenced by individual farm characteristics and could range from $500/ha to $1000/ha.
- The seasonal net benefits of $153/ha were driven by irrigation labour savings of up to 85%.
- In years of low water allocation there may be insufficient irrigation water to fully use the sPTB area, leading to reduced return on investment.

ABOUT THE RESEARCH

As part of the ***Smarter Irrigation for Profit Phase 1*** (SIP1) project the National Centre for Engineering in Agriculture at the University of Southern Queensland (USQ) completed successful trials of a blind head-ditch and small pipe through bank (sPTB) irrigation system at "Red Mill" near Moree, NSW, and supported early adoption of the technology at "Waverley" near Wee Waa, NSW.

The trials highlighted the potential benefits related to commercially available sPTB systems, including:

- Reduced labour requirements in starting and stopping siphons and monitoring water levels.
- Remote control of furrow irrigations from an office computer, smartphone or tablet.
- Remote monitoring of water levels in channels and ditches, with alerts based on level.

ANALYSIS OF FARM LEVEL COSTS AND BENEFITS

Drawing on the USQ SIP1 outputs and other cotton industry research and data, this case study presents an economic analysis of converting a 1m spaced manual siphon irrigation system to automated sPTB. Solid configuration cotton is produced in a two-year rotation with dryland winter crops. The analysis applied discounted cashflows to compare the costs and benefits of the investment using a 5% discount rate[1] over 25 years. The results are summarised in Figure 1 and Table 1.

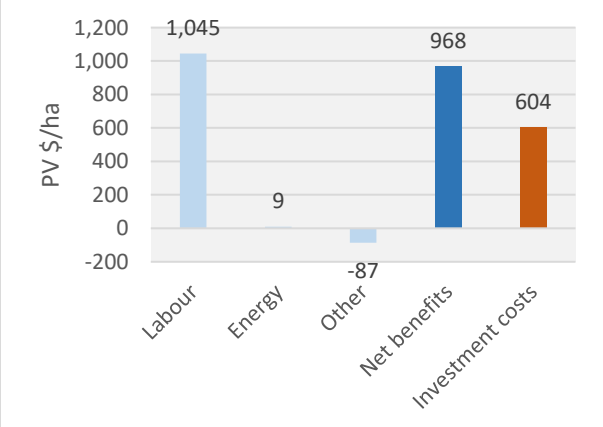

Figure 1. sPTB present value of benefits and costs.

With an upfront cost of $604/ha and net benefits of $968/ha over 25 years, investment in automated sPTB with a blind head-ditch was found to generate a net present value (NPV) of $364/ha.

[1] Discounted cashflows reflects the time value of money, where $1 today is worth more than $1 in the future. To make all figures comparable, future cashflows are discounted to "present values" using a "discount rate" (here 5%) reflecting the business cost of capital.

Table 1. Summary of results. Total change is in present value (PV) terms using a 5% discount rate and 90% investment use efficiency over 25 years.

	Manual siphon	Blind head-ditch sPTB	Seasonal benefit ($/ha)	Total change ($/ha)
Irrigation labour costs ($/ha)	$192	$27	+$165	+$1,045
Irrigation energy (vehicle fuel) costs ($/ha)	$2	$0	+$1	+$9
Other operational costs ($/ha)		$14	-$14	-$87
A. Net Benefits ($/ha)			+$153	+$968
B. Investment cost ($/ha)		$604		-$604
Net Present Value (A-B)				**+$364**
Internal rate of return				**10%**
Payback period				**12 years**

Investment costs. The up-front cost of $604/ha included the following items[2]:

- Head-ditch re-design with blind-head ditch.
- sPTB every 2nd furrow.
- Box culvert sealed rubber lay-flat gates.
- Remote gate actuators.
- Water level sensors in channels & head-ditches.

Cost per hectare can be influenced by field dimensions and total area developed. In addition, individual farm characteristics may negate the need for a blind head-ditch, and gate actuators and water sensors can be moved each season, reducing the whole farm sPTB cost.

Depending on the farm, the up-front cost may vary from $500/ha to $1000/ha.

In this analysis, a cost below $945/ha is required to generate an NPV greater than zero. Of note, individual investor hurdle rates will likely require an NPV above zero.

Labour use changes. As the main driver of the economic benefits, changes in the achieved labour savings have a large impact on the results. Avoided labour includes throwing and collecting siphons, starting and stopping siphons, and monitoring channel water levels.

By allowing the remote control of irrigations, automated sPTB can reduce labour requirements by up to 85% compared to manual siphon systems[3].

Irrigation labour costs in a manual siphon system vary depending on the farm characteristics, with estimations varying from $134/ha/season[4] to $250/ha/season[5]. This analysis used a mid-point of $192/ha/season with 85% labour savings therefore equal to $165/ha/season. Seasonal labour savings of at least $107/ha/season are required to generate a positive return in this analysis. While not included in the results, other labour and lifestyle factors such as reduced reliance on casual staff, reduced human error, and improved work-life-balance have also been identified as drivers for adoption of automated irrigation systems such as sPTB.

Water availability. The ability to derive a return from the investment is tied to water availability.

In years of low availability there may be insufficient irrigation water to fully use the land developed to sPTB, leading to reduced return on investment.

[2] Foley, J., 2018, *Smarter Irrigation for Profit Phase 1—Autonomous Furrow Irrigation with small Pipe Through Bank (sPTB)*. Modified in discussion with J. Foley Nov-Dec 2020.
[3] Roth, G. et al, 2018, *Smarter Irrigation for Profit Phase 1—Final Report combined.*
[4] Gall, L, 2016, *Grower Led Irrigation System Comparison in The Gwydir Valley, CRDC1606 Technical Research Report.*
[5] Roth, G. et al, 2018, op cit; and Farquharson R., Welsh J., 2017, *The Economics and Perspectives of Site Specific Irrigation Management.*

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The analysis used a baseline figure of 90% investment use, equivalent to 1 year in 10 of zero water availability. In comparison, the 10 year average general security allocation in NSW cotton growing regions was 73%, ranging from 64% to 90%[6]. Where available, bore water use may offset a low river water allocation. For this analysis, an average investment use of 57% over the life of investment is required to generate an NPV greater than zero.

Energy and other operational costs. Energy costs related to irrigation vehicle use, including starting and stopping siphons, and checking water levels. Other operational costs associated with sPTB include maintenance costs and foregone profits from the part of the field converted to a blind head-ditch. Maintenance costs were estimated at 1% of capital costs per year[7], equal to $6/ha/yr. Foregone profits were valued at the gross margin per hectare of the rotation crops (cotton and dryland wheat)[8], with an average loss of $8/yr for every ha developed to sPTB.

Smart automation. While not included in this case study, research of automated sPTB has identified the potential for system optimisation by integrating in-field sensors and advanced crop and irrigation modelling such as VARIwise and IrriMATE to work synchronously with the sPTB system. By leveraging the benefits of an automated system, optimisation or "smart automation" can autonomously control irrigation changes in line with plant water requirements. Smart automation has the potential yield increases of 10% and water savings of 15% in fully irrigated cotton[9]. Improved water application efficiency can also reduce fertilizer loss from leaching and denitrification, and thereby support reduced fertilizer application rates and greenhouse gas emissions.

CONCLUSIONS

While converting manual siphon irrigation to sPTB can represent a large upfront investment, this analysis has shown that the costs can be outweighed by operational savings particularly relating to irrigation labour. Drawing on the USQ SIP1 research and other industry research and data, this analysis has identified an NPV of $364/ha over 25 years, equal to an internal rate of return of 10%. When considering investment in sPTB, producers should undertake individual farm analysis and consider specific farm and market dynamics.

Smarter Irrigation for Profit Phases I (SIP1) was led by the Cotton Research and Development Corporation (CRDC) in conjunction with Dairy Australia, Agrifutures, Sugar Research Australia. SIP1 was 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 SIP1 research, including the USQ project underlying this analysis, visit https://www.crdc.com.au/smarter-irrigation-phase-1.

For more information on the SIP2 visit https://smarterirrigation.com.au/.

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

[6] NSW Gov, *Water allocations Dashboard*
[7] Farquharson R., Wesh J., 2017, op cit.
[8] Powell J. et al, 2019, *Furrow Irrigated Cotton Gross Margin*; and NSW DPI, 2012, *Winter crop gross margin budgets, Dryland north-west*
[9] Gall, L, 2020, *Benchmark Manual vs Automated Siphon Efficiencies, Smarter Irrigation for Profit Phase 2.*

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