A CASE STUDY ON THE ECONOMICS OF OVERHEAD IRRIGATION IN THE LOWER BURDEKIN

By

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Abstract

CONVERTING from an existing irrigation system is often seen as high risk by the land owner. The significant financial investment and the long period over which the investment runs is also complicated by the uncertainty associated with long term input costs (such as energy), crop production, and the continually evolving natural resource management rules and policy. Irrigation plays a pivotal part in the Burdekin sugarcane farming system. At present the use of furrow irrigation is by far the most common form due to the ease of use, relatively low operating cost and well established infrastructure currently in place. The Mulgrave Area Farmer Integrated Action (MAFIA) grower group, located near Clare in the lower Burdekin region, identified the need to learn about sustainable farming systems with a focus on the environment, social and economic implications. In early 2007, Hesp Faming established a site to investigate the use of overhead irrigation as an alternative to furrow irrigation and its integration with new farming system practices, including Green Cane Trash Blanketing (GCTB). Although significant environmental and social benefits exist, the preliminary investment analysis indicates that the Overhead Low Pressure (OHLP) irrigation system is not adding financial value to the Hesp Farming business. A combination of high capital costs and other offsetting factors resulted in the benefits not being fully realised. A different outcome is achieved if Hesp Farming is able to realise value on the water saved, with both OHLP irrigation systems displaying a positive NPV. This case study provides a framework to further investigate the economics of OHLP irrigation in sugarcane and it is anticipated that with additional data a more definitive outcome will be developed in the future.

Introduction

Irrigation plays a pivotal role in the Burdekin sugarcane farming system. At present, the use of furrow irrigation is by far the most common form due to the ease of use, relatively low operating cost and well established infrastructure currently in place (Qureshi *et al.*, 2001). With farming practices continually evolving over time, increasing environmental expectations and limited water resources there is a clear need to understand the integration of irrigation systems with various farming system practices.

The Mulgrave Area Farmer Integrated Action (MAFIA) grower group, located in the upper Burdekin region, identified the need to learn about sustainable farming systems with a focus on the environment, social and economic implications. ‘While many have advocated that Burdekin irrigators should convert from furrow irrigation to other forms such as drip or overhead low pressure systems (OHLP), there is a lack of confidence that the predicted benefits of other systems would be realised in a commercial scale operation’ (Attard *et al.*, 2009). The use of furrow irrigation is considered to be a limitation to the adoption of green cane trash blanketing (GCTB) because of agronomic difficulties. Conversion to an alternative irrigation system also requires a significant capital investment and therefore needs to be carefully considered to ensure that the change is adding value to the business.

In early 2007, Hesp Farming, with support from the Sugar Research and Development Corporation and NQ Dry Tropics, established a site to investigate the use of OHLP as an alternative to furrow irrigation and its integration with improved farming system practices, including GCTB. The purpose of this paper is to report a preliminary investigation on the economic component of this project and its possible implications for the wider sugarcane industry. The final outcomes of this project will have relevance to both farmers undertaking change and policy makers reviewing current (and developing future) water resource management strategies.

Why do farmers need to consider economics?

Economics is a study of how society manages its scarce resources’ (Stonecash *et al.*, 2003). A farm manager will be faced with many choices on how to allocate resources in a farming business, so economics forms an integral part of the decision making process and sound business management skills.

The evolution of farming businesses over time has seen an ‘increase in mechanisation, continued adoption of new technologies, growing capital investment per worker, increasing farm size, new marketing techniques and increased risk’ (Kay and Edwards, 1994) With all of these factors occurring, and many more, the importance of economics as part of business management is becoming increasingly important. Implementing a business strategy or investment decision without knowledge of the economic implications is a recipe for disaster, and as a result, today’s managers must have a clear understanding of the economic implication of a business decision (Ross *et al.*, 2008). The farm manager also needs to have a clear understanding of the risk or uncertainty associated with a particular decision.

When reviewing the implication of a change in farming practice it is important to take a whole of system approach. This not only applies to the consideration of economics across an entire farming system but also the environmental and social implications. Although this paper primarily focuses on the economic implications and potential risk associated with the adoption of OHLP and

GCTB, environmental and social aspects are equally as important and have been investigated in more detail in a previous paper by Attard *et al.* (2009).

Each farming business is unique in its circumstances and therefore the parameters and assumptions used in this economic analysis do not reflect each individual situation. Consideration of individual circumstances must be made in order to make an informed investment decision.

Methodology for economic analysis

Trial design

Hesp Farming is located in the upper Burdekin area, approximately 90km southwest of Townsville, and is part of the Burdekin – Haughton Water Supply Scheme (BHWSS). 'In early 2007, Hesp Farming set up two adjacent paddocks; one to be irrigated using furrow irrigation, the second to be irrigated with an OHLP system in the form of a lateral move irrigator' (Attard *et al.*, 2009).

The OHLP paddock was divided in to western and eastern sections, with GCTB and burnt cane practices respectively. Refer to Attard *et al*. (2009) for further details on trial design.

Data collection

Data was collected over the trial period with the cooperation of Hesp Farming and various extension/research collaborators. A comprehensive economic analysis was undertaken using biophysical, financial and farming system data for each of the farming system treatments. An explanation of each of the three farming system treatment terms is outlined below:

1. OHLP Green = Overhead low pressure irrigation with green cane trash blanketing.
2. OHLP Burnt = Overhead low pressure irrigation with burnt cane.
3. Furrow Burnt = Furrow irrigation with traditional burnt cane practices.

Data about variable and fixed costs is based on 2009 financial information provided by Hesp Farming. Labour requirements for each farming system were recorded by Hesp Farming and cross referenced with the Farm Economic Analysis Tool (FEAT) calculated labour hours.

The forecasted seasonal pool price for 2009 and current pricing formula was used to determine the cane price paid to Hesp Farming. Irrigation data was collected during the trial period to determine the amount of water applied, the proportion of recycled water for furrow irrigation and pumping costs (Smith and Richards, 2003). Water charges are based on the SunWater 2009/2010 fees and charges schedule (SunWater, 2009). Electricity charges are based on the Ergon Energy July 2009 prices for Tariff 66 (Ergon Energy, 2009).

A summary of the farming system characteristics is included in Table 1. Distinct differences were recorded between each of the systems, with the most notable being the amount of water applied and weed management operations. A slightly wider row spacing was required for the OHLP paddock to better align with the irrigator span lengths.

Table 1—Major characteristics of each farming system.

	OHLP Green	OHLP Burnt	Furrow Burnt
Fallow and plant cane land preparation	9 x cultivation, 1 x laser level* & 1 x bed former *reduced laser levelling cost in the OHLP		
Planting configuration	Single row 1.65 m		Single row 1.63 m
Planting method	Whole stalk double disc opener planter		
Plant cane insect and disease management	2 x chemical		
Plant cane weed management	2 x herbicide 3 x cultivation	2 x herbicide 3 x cultivation	3 x herbicide 3 x cultivation
Plant cane fertiliser and soil ameliorants	Gypsum, DAP planting & NKS top dress		
Plant cane irrigation	11ML applied 41 irrigations	11ML applied 41 irrigations	21.4ML applied 21 irrigations 9% recycled
Ratoon weed management	1 x chemical	2 x chemical	2 x chemical
Ratoon cane fertiliser	Custom blend		
Ratoon cane irrigation	6.07 ML applied 33 irrigations	7.44 ML applied 42 irrigations	15.8 ML applied 14 irrigations 20% recycled
Harvesting	Green cane harvesting	Burnt cane harvesting	Burnt cane harvesting

At present, trial data extends up to 1st ratoon and therefore extrapolation of data for older ratoon crops was required to enable a thorough economic analysis. Data for the older ratoons is based on information provided by Hesp Farming and expert advice from local extension agencies, CSIRO and BSES Limited. Production data were also collected for each of the treatments. However, due to wet conditions affecting harvest timing and limited replication of data, no definite conclusion can be drawn from the results. Average historical production data over a period of five years was applied across all treatments.

Economic analysis process

The economic analysis is based on Hesp Farming integrating an OHLP irrigation system as part of their larger farming business which still operates using the standard furrow irrigation practices. Because of the complexity involved in the calculations, a combination of the FEAT and a custom made spreadsheet was developed for the economic analysis. FEAT, developed by the DPI&F FutureCane initiative, is a computer based economic analysis tool designed specifically for the sugar industry (Stewart and Cameron, 2006). Figures calculated in the FEAT program were transferred to the custom made spreadsheet to develop gross margins, whole-of-farm static state analysis and a discounted cash flow analysis. The marginal cash flow differences for each farming system were simulated over a 20-year planning horizon to determine the Net Present Value and Benefit-Cost ratio. No new capital investment was required for the existing furrow irrigation farming system, while the OHLP system required the full investment in the fallow period. The irrigation equipment will have no salvage value at the end of the 20 year investment period.

Economic parameters

Net seasonal pool price = $450 per tonne IPS; Farm size = 580ha; OHLP irrigation system = 129ha; Green cane harvesting = $7.00/t; Burnt cane harvesting = $6.50/t; Fuel price = $0.85/L (includes energy rebate); Electricity price = 10.25c/kWh (Tariff 66); Part A water charges = $27.88/ML; Part B water charges = $17.87; Drainage Rates = $20.20/ha of land; value placed on saved water scenario = 100% of saved water is valued at Part A water charge; Permanent labour cost = $30/hr; Market value for machinery and equipment; Monetary figures are exclusive of Goods and Services Tax; Tax implications are not considered; Land and fixed improvements = $17 500/ha; Discount rate = 7.0%.

Results

OHLP investment

Table 2 outlines the required investment for Hesp Farming to implement an OHLP lateral move irrigation system. 'The 600 m, centre fed, Zimmatic™ lateral move irrigator comprises 12 × 48 m spans and has an ultra high, 5 m profile' (Attard *et al.*, 2009). With a total cost of $333 134, this equates to over $2 500/ha and is a significant investment for the farming business.

The most substantial costs include the lateral move irrigator and initial earthworks for construction of the open water feed-channel. The level of investment for an OHLP irrigation system will vary and is largely dependant on size of the system, terrain and source of irrigation water.

Table 2—Capital investment for OHLP (129 hectares).

OHLP	Capital investment ($)
Diesel motor and pump	13 000
Overhead irrigator	206 000
Mainline	29 615
Drop box checks and fittings	8 100
Earth works	76 419
Total value	333 134

Pumping cost and gross margins

Table 3 displays a comparison of pump variable costs for OHLP and furrow irrigation systems. As anticipated, pumping cost is vastly different because of the difference in pump characteristics and requirements of each system. The OHLP irrigation system uses an 112KW (150HP) John Deere diesel motor compared to the 18KW electric motor in the furrow irrigation system.

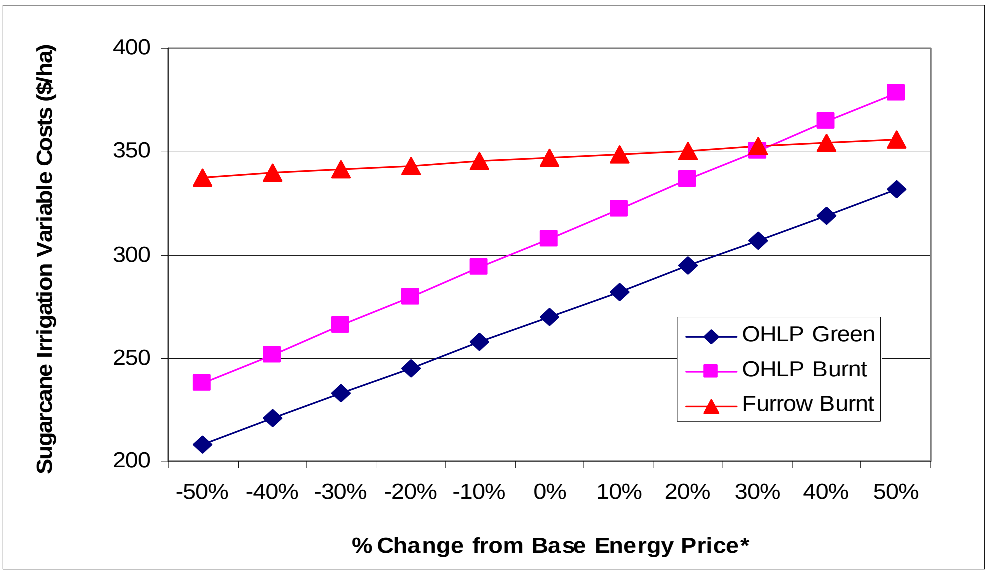
The furrow irrigation system also uses a diesel powered recycle pump for a small proportion of the water applied. It is generally accepted that the running cost per megalitre of an electric pump is less than a diesel powered system because of lower power and maintenance costs (Robinson, 2002). For Hesp Farming this difference is amplified by the low duty required for the furrow main pump. Duty is described as the head or flow that a pump is supplying (Smith, 2004).

Table 3—Pump variable costs for OHLP and furrow irrigation system.

Irrigation system	Flow rate (L/s)	Electricity consumed ($/hr)	Fuel & oil consumed ($/hr)	R&M ($/hr)	Pump cost ($/hr)	Pump cost ($/ML)
OHLP	204.7	NA	12.83	0.22	13.05	17.71
Furrow main pump	94.4	0.43	NA	0.10	0.53	1.56
Furrow recycle pump	94.4	NA	2.62	0.21	2.83	8.32

The variable cost for OHLP irrigation in sugarcane is very sensitive to changes in energy price, as illustrated in by the slope of lines in Figure 1. Irrigation variable expenses include Sun Water's Part B (usage charge for actual water used) water charges, energy cost and repairs and maintenance.

A large proportion of irrigation variable costs in the OHLP are attributed to energy expenses. Despite pump and irrigation variable costs highlighting several important issues, they only tell part of the story and do not account for farming system impacts and the amount of money invested.



* Base price: Electricity = 10.25c/kWh and Net Diesel = 85c/L

Fig. 1—Impact of electricity and diesel price on sugarcane irrigation variable costs.

The calculation of gross margins for each farming system enables the isolation of cost and revenue differences. Tables 4, 5 and 6 display the sugarcane fallow, plant and ratoon gross margin respectively for Hesp Farming.

Fallow laser levelling maintenance expense is higher in the furrow burnt system because of the need for a constant slope (Table 4). Land preparation cost is the same across all systems.

Table 4—Fallow gross margin for each farming system.

	OHLP green	OHLP burnt	Furrow burnt
	$/ha	$/ha	$/ha
Land preparation	168.83	168.83	168.83
Laser levelling	186.00	186.00	372.00
Gross margin	–374.83	–374.83	–560.83
Labour (hrs/ha)	3.57	3.57	3.57

Compared to the standard furrow burnt system, plant cane gross margin for both OHLP systems reveals a saving of $66.70/ha and $46.14/ha for weed management and irrigation expenses respectively (Table 5).

A small reduction in the levies for OHLP Green is also evident due to the removal of the burnt cane deduction fee. To some extent the savings in the OHLP Green system is offset by the increase in green cane harvesting costs of $71.81/ha.

In order of ranking, OHLP burnt has the highest gross margin, followed by OHLP green and furrow burnt.

Table 5—Plant cane gross margin for each farming system.

	OHLP green ($/ha)	OHLP burnt ($/ha)	Furrow burnt ($/ha)
Gross revenue	7239.33	7239.33	7239.33
Less:			
Planting	560.00	560.00	560.00
Fertiliser	556.58	556.58	556.58
Weed management	125.80	125.80	192.50
Insect and disease	31.64	31.64	31.64
Irrigation	406.90	406.90	453.04
Harvesting	1047.34	972.53	972.53
Levies	91.27	98.75	98.75
Gross margin	4419.80	4487.13	4374.29
Labour (hr/ha)	8.43	8.76	12.51

Ratoon cane gross margin is taken as the average gross margin across all OHLP irrigated ratoons. Ratoon cane gross margin for OHLP Green display a saving of $26.21/ha in weed management, $86.75/ha in irrigation and $7.48 in levies compared to the furrow burnt system (Table 6).

The savings in OHLP burnt are not as high as in plant cane due to greater input requirements (weed management, irrigation and levies). Harvesting expenses are $53.03/ha higher in the OHLP green system.

In order of ranking, OHLP green has the highest gross margin, followed by OHLP burnt and furrow burnt.

Table 6—Ratoon cane gross margin for each farming system.

	OHLP green ($/ha)	OHLP burnt ($/ha)	Furrow burnt ($/ha)
Gross revenue	5070.36	5070.36	5070.36
Less:			
Land preparation	0.00	0.00	0.00
Fertiliser	496.06	496.06	496.06
Weed management	34.37	60.58	60.58
Irrigation	226.10	276.34	312.85
Harvesting	742.46	689.43	689.43
Levies	64.70	70.00	70.00
Total growing cost	3506.67	3477.95	3441.44
Labour (hrs/ha)	5.89	7.51	7.56

Difference in gross revenue is not evident because of the same production figures being applied to each system. Labour requirements are lower in both of the OHLP systems because of time savings in irrigation operations, weed management and burning (only applicable OHLP Green). The increased number of irrigations in the OHLP systems did reduce the extent of labour savings.

Investment analysis

Investing in an alternative irrigation system will effect the operations of Hesp Farming for years to come, primarily because fixed asset investments are generally long lived and not easily reversed once they are made (Ross *et al.*, 2008).

For this reason, the analysis of the cash flow implications over time and consideration of the investment required is necessary to determine if the decision is adding value to the farming business.

Results from the preliminary investment analysis are outlined in Table 7 along with the value placed on the saved water scenario. The investment analysis is displayed in terms of Net Present Value (NPV) and Benefit–Cost ratio.

The results indicate a negative NPV for both OHLP farming systems. OHLP Green presents a lower negative result because of greater water and crop production savings compared to a burnt cane system.

When viewing the saved water valued scenario, the results indicate a positive NPV, with OHLP green ranking the highest.

This scenario provides another dimension in the analysis and indicates the potential benefit if saved water is able to be valued through trading or some other form (*e.g.* reduced need to buy water above allocation).

The ranking of the two farming systems remains the same in this scenario, with OHLP green being the highest.

Table 7—Net present values and benefit-cost ratios for the implementation of two irrigation systems, OHLP green and OHLP burnt.

Irrigation system	NPV	Benefit cost	NPV value placed on saved water*	Benefit-cost value placed on saved water *
OHLP green	–$132 918	0.58	$164 111	1.52
OHLP burnt	–$174 344	0.44	$91 929	1.30

*Assumed that entire amount of water saved is valued

Risk analysis

The sensitivity of several key parameters was tested in the analysis to determine their impact on NPV values for OHLP Green and OHLP Burnt farming systems. Assessment of these variables aids in determining the potential risk involved for Hesp Farming when integrating an OHLP irrigation system as part the existing business operations. Key parameters included Part B water price, capital cost, discount rates, sugarcane yield and value placed on saved water. Unless specified, it is assumed that no value is placed on the water saved from using OHLP irrigation (*e.g.* water is not traded).

Figure 2 displays the sensitivity of Part B water price on the NPV. Both farming systems are sensitive to Part B water price, with a positive NPV being reached at $35/ML and $45/ML for OHLP Green and OHLP Burnt, respectively. This indicates that, as part B water price increases, the benefit of changing to a more efficient irrigation system increases because of the significant saving in water applied. However a higher part B water price will have a detrimental impact on overall farm profitability.

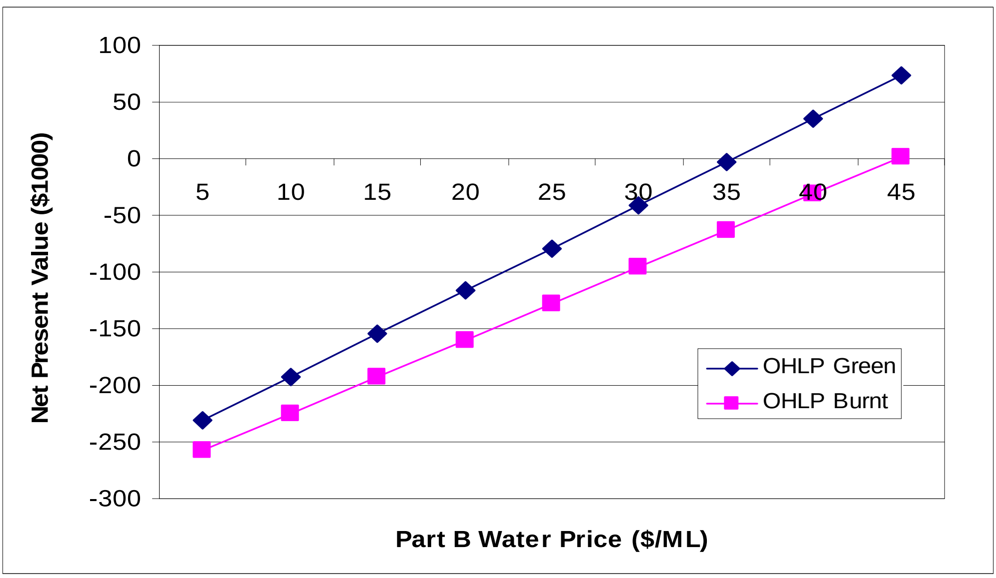


Fig. 2—Sensitivity of Part B water price.

A reduction in the capital investment required to implement an OHLP irrigation system results in an improvement in NPV values. The NPV only becomes positive if the capital investment is reduced to less than $200 000 in the OHLP Green farming system (Figure 3). A much higher capital investment reduction is required in the OHLP Burnt system. The level of capital investment may vary because of foreign exchange rates, incentive schemes or technological advances. Although this level of reduction in capital investment is unlikely, it does present an indication of the financial incentive that would be required to make the change worthwhile.

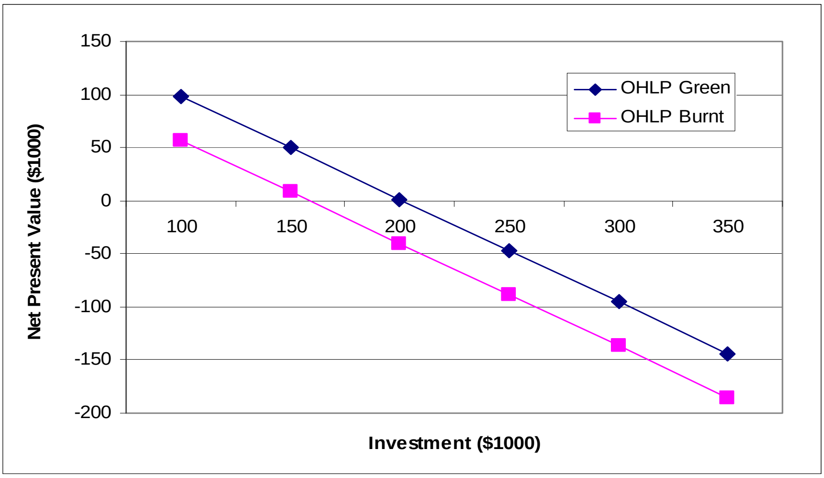


Fig. 3—Sensitivity of capital investment.

Altering the discount rate did not result in a positive NPV for both of the OHLP farming systems using the standard parameters and assumptions (Figure 4). If we assumed that 100% of the water saved is valued through trading or some other form, a positive NPV remains up to 13.0% and 10.5% for OHLP Burnt and Green farming systems respectively.

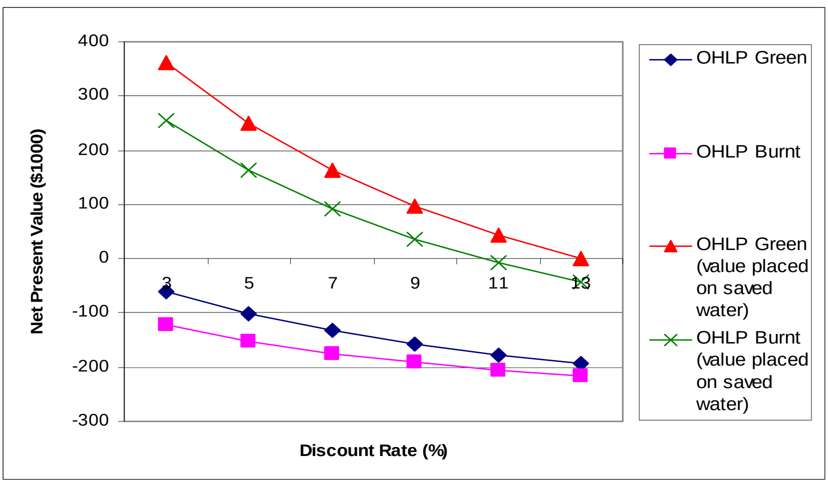
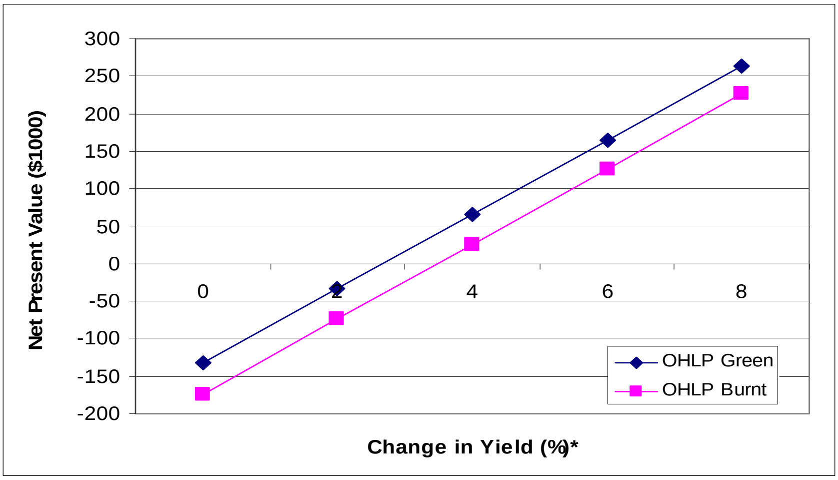


Fig. 4—Sensitivity of discount rates.

Results from the trial did not reveal any definitive conclusions for yield and CCS levels under the various farming systems. One might expect that over the long-term the implementation of improved irrigation practices and green cane trash blanketing may result in yield improvements through improved soil health. Figure 5 displays the effect of yield increases on NPV for both OHLP farming systems. NPV for both systems are very sensitive to yield, with an increase of greater than 3.75% (4.37 t/ha) resulting in a positive NPV.



* An increase of 1% is equal to 1.2t/ha

Fig. 5—Sensitivity of sugarcane yield.

The ability to trade water or obtain a monetary value on the water saved through some other method would present some opportunities to increase revenue. The ability to reliably trade water in the BHWSS is questionable because of a very reliable water allocation and the ability to usually purchase additional water from SunWater at the normal Part A price. Figure 6 displays the effect of being able to value the water saved on NPV for both OHLP farming systems.

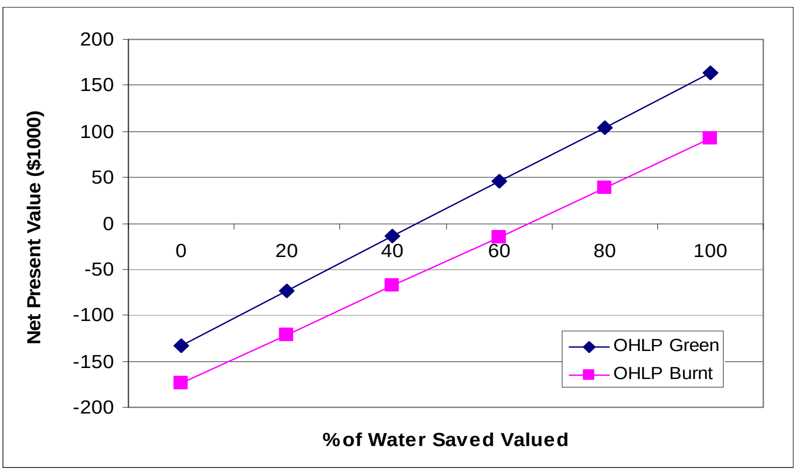


Fig. 6—Sensitivity of value placed on saved water.

The results indicate that if Hesp Farming were able to realise the Part A value on 45% of the water saved, the OHLP Green farming system will have a positive NPV. The OHLP Burnt is not as favourable, with a requirement to find Part A value on 65% of the water saved.

Triple bottom line

Consideration of economic, environmental and social implications, also termed the triple bottom line, is essential in providing an overall picture on the new farming systems. The major environmental and social implications observed from the OHLP irrigation treatments include:

- ability to adopt green cane trash blanketing in areas where furrow irrigation is the restrictive factor
- reduced demand on water resources
- water efficiency is greatly improved, reducing deep draining and run-off
- cessation of burning in the GCTB system
- use of GCTB is likely to improve soil health with the input of organic matter
- nutrient losses are highly likely to be reduced significantly, although currently there is no data to support this claim
- labour savings in irrigation management and tractor operations
- management requirements may be high during the initial stages of implementation of OHLP irrigation and GCTB
- adoption of improved practices such as fertigation is a possibility.

Discussion and conclusion

Assessment of the Hesp Farming case study provides an insight into the possible economic challenges faced when implementing OHLP irrigation in combination with either burnt cane or green cane practices. Given the size of the capital investment, the financial benefits need to be substantial in order to add value to the business.

Review of the results reveals savings in water, sugarcane growing costs and labour with OHLP Green and OHLP Burnt. The integration of GCTB with OHLP irrigation further enhances these financial benefits. To some extent, the saving in production costs were offset by higher pumping costs per megalitre and increased green cane harvesting charges.

Significant labour savings occurred in the OHLP systems, with OHLP Green having over 20% saving for both plant and ratoon operations. Further labour savings may be achieved if the number of irrigations can be reduced for the OHLP systems.

Results from the preliminary investment analysis indicate that the implementation of OHLP irrigation systems is not adding financial value to the Hesp Farming business. A combination of high capital costs and other offsetting factors resulted in the benefits not being fully realised. Offsetting factors include high energy costs, additional harvesting costs and increased number of irrigations. A different outcome is achieved if Hesp Farming is able to realise value on the water saved, with both OHLP system displaying a positive NPV. In order of ranking, OHLP Green is the preferred option because of greater water savings and lower sugarcane growing costs.

The risk analysis raises several important issues and food for thought for future research and policy direction. The current market environment for water in the BHWSS provides little incentive to the switch to alternative irrigation technologies. Issues such as the ability to trade water and current water pricing system appear to be part of the barrier for greater adoption.

A large capital investment is required to implement OHLP irrigation and presents a further deterrent for many farmers to implement alternative irrigation technologies. The results indicate that capital investment would need to reduce by over 40% to justify the adoption of OHLP Green. Altering the discount rate did not produce a favourable result for OHLP systems using the standard parameters and assumptions.

Using the value placed in the water saved scenario, the internal rate of return was 13.0% and 10.5% for OHLP Green and OHLP Burnt respectively. Although production benefits could not be defined in this case study, there is a clear need for more research in this area because of the profound effect it may have on the economic outcomes.

The ability to successfully implement sustainable irrigation practices and GCTB are likely to be some of the major challenges facing Burdekin sugarcane farmers in the future. The trial conducted by Hesp Farming demonstrates the ability to use OHLP irrigation in sugarcane in conjunction with green cane trash blanketing.

Although significant environmental and social benefits exist, the preliminary economic assessment indicates several possible barriers to greater adoption.

Continued research is required on the integration of alternative irrigation systems with new farming systems, especially its effect on sugarcane production levels.

Various policy options should also be investigated to identify a possible strategy to encourage the adoption of more efficient irrigation technologies.

This case study provides a framework to further investigate the economics of OHLP irrigation in sugarcane and it is anticipated that with additional data a more definitive outcome will be developed in the future.

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