The Dual Herbicide Sprayer

Economic Analysis Case Study
2013

(A. Blair, Department of Agriculture Fisheries and Forestry, 2013)

Acknowledgments:

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Introduction

This report evaluates the economic viability of the Dual Herbicide Sprayer (DHS), which is currently being trialled by the Queensland Department of Agriculture, Fisheries and Forestry (DAFF). This trial is specifically focussed upon assessing the efficacy of the DHS in providing effective weed management. The sprayer was essentially developed in view of the introduction of Queensland Reef Regulations that limit the use of various PSII herbicides. The DHS is constructed by modifying the conventional spray bar of an existing Irvin Boom; whereby a 12-volt low pressure/low volume spray tank is retro-fitted to enable two different herbicide solutions to be applied simultaneously. In particular, the spray bar of the DHS enables application of Glyphosate to be directed into the inter-row via a centre air-inclusion nozzle, while two wing nozzles direct a residual/knockdown mix into the stool area at the same time.

Key economic drivers of change:

- Greater efficiency during application - decreased production costs
- Strategic benefit - superior capability to strategically target weeds
- Environmental benefits - decreased residual use
- Regulatory benefit - greater ability to comply with new/existing laws

Results from recent replicated trials found that the DHS had no significant impacts on cane growth. Therefore, the economic analysis assumes yields are held constant. However, a sensitivity analysis was completed to identify potential impacts to the economic viability of the DHS assuming changes to cane yield. Harvest data should be available after August 2013.

Methodology

To determine the economic viability of the Dual Herbicide Sprayer, an investment analysis was completed to determine the net present value (NPV) of purchasing and utilising the DHS. The calculation of the NPV involves two steps to evaluate the benefits from using the DHS over time. First, the total gross margin for the same farm is calculated using both a standard Irvin Boom and the DHS. The resulting difference between the farm gross margins is then considered to evaluate the economic benefits of the DHS over time. This involves discounting a series of the future benefits at the required rate of return to determine the value of the investment in today's dollar terms. This value is then compared with the initial capital investment to determine its NPV. A positive NPV indicates an economically acceptable investment on the basis that the present value of the benefits is greater than the initial cost of the DHS.

The gross margins, used in this report, were determined using DAFF's Farm Economic Analysis Tool (FEAT). FEAT is a computer-based economic analysis tool designed specifically for the sugar industry. Analyses using FEAT take into account numerous farm-specific details to calculate the gross margin. These details include growing expenses such as chemical and fertiliser usage, machinery operations and fallow crop costs, as well as cane yields, CCS levels and the sugar price.

Furthermore, to provide the requisite information to perform the FEAT analyses, the report has drawn on the precise details of a farm in the Herbert area that is configured with 1.8m row spacing and employs best management practices.

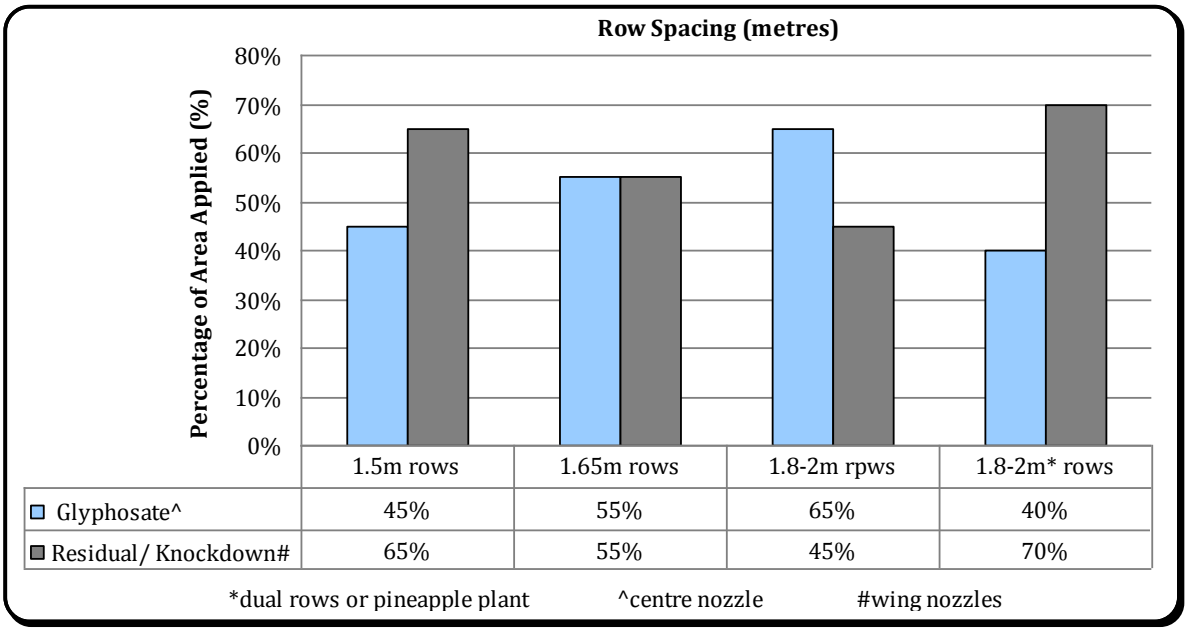
To focus the analysis explicitly on changes to farm profitability from purchasing and using the DHS, the following parameters have been assumed:

- 120 hectare sugarcane farm (100 hectares under cane, excluding fallow)
- Sugar price = $409 per tonne (5-year average)
- Labour cost = $30 per hour
- Capital investment required for DHS= $2,500 (salvage value = $0)
- Investment horizon = 10 years
- Discount rate = 7%
- The DHS is utilised in 40 hectares of cane per year.

Benefits of the Dual Herbicide Sprayer

Previous trials have found that the DHS uses approximately half as much residual chemicals during application, depending on row width. Essentially, the implement is band spraying both glyphosate and a residual/knockdown blend. On a farm with 1.5-metre rows, the DHS will spray 45% of the paddock area with Glyphosate (out of its centre nozzle) and 65% of the paddock area with a residual/knockdown blend (out of two wing nozzles), leaving a 10% overlap of herbicides. On a farm with wider row-spacing, however, it will spray a larger percentage of the paddock area with glyphosate and a smaller percentage of the paddock area with a residual/knockdown blend. Figure 1 presents the percentage of area applied with the chemicals using the DHS for a variety of row spacing's.

Figure 1: Dual Herbicide Sprayer's Herbicide Usage at Different Row Spacing's



Note: The above data accounts for 10% overlap of herbicides.

Example 1 on the following page illustrates the Dual Herbicide Sprayer's spray bar in operation. The centre nozzle distributes glyphosate to the inter-row while the wing nozzles spray a residual/knockdown mix into the stools.

Example 1: The Dual Herbicide Sprayer's spray bar

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Herbicide Usage

The following analysis examines one herbicide blend that is popular for weed control in ratoon cane. Table 1 outlines the herbicide application rate per hectare assumed in the analysis as well as the herbicide usage per hectare for both a standard Irvin Boom and that required for the DHS on a cane farm with 1.8m row spacing. Herbicide usage refers to the amount (kg) of product used over a hectare. The analysis also assumes a single application per annum. As noted in Table 1, the DHS uses less Velpar K4®, Gramoxone®, 2,4-D Amine® and BS 1000 Wetter® per hectare than a standard Irvin Boom by applying them only onto the cane rows while substituting their use with Glyphosate to spray onto the inter-rows.

Table 1: Rate and Usage of Herbicides for both Spraying Methods

Rate	Usage		Herbicide	Price
	Standard Irvin Boom	*Dual Herbicide Sprayer*		
1kg/ha	1kg/ha	0.45kg/ha	Velpar K4®	$20/kg
1L/ha	1L/ha	0.45L/ha	Gramoxone®	$5.20/L
1L/ha	1L/ha	0.45L/ha	2,4-D Amine®	$5.88/L
0.2L/ha	0.2L/ha	0.09L/ha	BS 1000 Wetter®	$13.25/L
1.5L/ha	-	0.98L/ha	Glyphosate	$5.88/L

Results

The economic analysis examines the use of the DHS compared to the standard Irvin Boom across 40 hectares of ratoon cane. Table 2 outlines the weed control costs in ratoon cane as well as the respective average farm gross margins using both a standard Irvin Boom and the DHS. The table shows that weed management costs in ratoon cane are lower using the DHS than when using a standard Irvin Boom. The decrease in weed control expenses is primarily attributable to the reduction in area sprayed with residual herbicide.

Table 2: Weed Control Costs and Gross Margins for both Spraying Practices

	Standard Irvin Boom	Dual Herbicide Sprayer
Weed control costs (in ratoon cane)	$53.30/ha	$40.48/ha
Average Farm Gross margin	$1395.28/ha	$1400.41/ha

Table 3 presents an investment analysis of the DHS scenario, which suggests it is economically acceptable. In particular, the results indicate that using the DHS across 40 hectares of cane will provide a positive NPV of $1,101 over a 10-year investment period. Moreover, the results indicate a 15.77% Internal Rate of Return on the DHS. The Benefit-Cost Ratio indicates that for every dollar spent on the DHS it will return $1.44 to the grower.

Table 3: Investment Analysis

Investment Analysis	
Net Present Value	$1,101
Benefit-Cost Ratio	1.44
Internal Rate of Return (%)	15.77%

The results of a breakeven analysis are presented in Table 4. Since different growers would utilise the DHS over a varying number of hectares, it is interesting to determine how much usage is required in order for the investment to breakeven.

Table 4: Breakeven Analysis of Dual Herbicide Sprayer Usage

Dual Herbicide Sprayer Usage *(hectare)*	Farm Gross Margin *($/hectare)*	Change in Gross Margin		Net Present Value *($/hectare)*
		($/hectare)	*(%)*	
80ha	1,405.53	0	0	$4,703
60ha	1,402.97	-2.56	-0.18	$2,902
40ha	1,400.41	-5.13	-0.37	$1,101
27.7ha	1,398.83	-6.7	-0.48	$0
20ha	1,397.84	-7.69	-0.55	-$699

The break-even analysis suggests that the DHS must be utilized across at least 28 hectares of cane per annum over 10 years to be economically acceptable. Furthermore, this outcome would be realised by all growers who spent $2,500 to modify their Irvin Booms.

Nevertheless, growers may need to invest differing amounts to modify their Irvin Boom Sprayers depending on what equipment they already possess. Some growers may have already modified their Irvin Booms to utilise two tanks; in which case, this would require a smaller capital outlay. Estimates have placed the modification costs between $1,000 and $1,200 if a grower has already fitted their Irvin Booms with a 12 volt low pressure/low volume spray tank and between $2,000 and $2,500 for an Irvin Boom requiring both the spray bar and tank. Taking both of these factors into account, Table 5 presents the results of various present value calculations of the DHS at increments of potential usage. These results outline the minimal use requirements for the sprayer to result in a positive economic return. For example, if it cost the grower $1,200 to modify their Irvin Boom, then the DHS would need to be used on more than 13.3 hectares of cane over 10 years to provide a positive economic return.

Table 5: Usage Required to Recover Cost of DHS

Cost to modify Irvin Boom *($)*	**Usage of DHS required to Breakeven *(hectare)***
$1,000	11.1ha
$1,200	13.3ha
$2,000	22.2ha
$2,500	27.7ha

The discounted payback period refers to the period of time required to payback the initial capital investment whilst taking into account the time value of money. The measure provides detailed investment information relevant to growers considering adoption of the DHS. Table 6 presents the discounted payback period for the DHS at several usage scenarios (20-200ha/yr) as well as assumed DHS modification costs ($1,000-$2,500/yr). Assuming DHS modification costs of $2,000 (shaded in light gray), the payback period will be 0.8 years if used in 200ha of cane per year, 1.7 years if used in 100ha/yr, 4.7 years if used in 50ha/yr and 11.7 years if used in 20ha/yr.

Table 6: Discounted payment periods under several scenarios

DHS usage *(ha/yr)*	**Herbicide cost savings *($/yr)***	**Discounted payback period *(years)***			
		DHS cost			
		$1,000	*$1,200*	*$2,000*	*$2,500*
200ha	$2,564	0.4	0.5	0.8	1
150ha	$1,923	0.5	0.7	1.1	1.4
100ha	$1,282	0.8	1	1.7	2.2
70ha	$897	1.2	2	2.5	3.2
40ha	$513	2.2	2.6	4.7	6.1
27.77ha	$356	3.2	4	7.4	10
20ha	$256	4.7	5.9	11.7	17

Notwithstanding the positive trial results thus far, some stakeholders may be concerned about the potential implications arising from the DHS affecting cane yields. In view of addressing this issue, a sensitivity analysis of the new gross margin to reductions in ratoon cane yields identifies the yield losses required to render the DHS unprofitable relative to the standard Irvin Boom. Table 7 on the next page presents the results.

Table 7: Sensitivity Analysis of the GM & NPV to reductions in ratoon yields

Plant *(t/ha)*	Ratoon Yield *(t/ha)*				Average Ratoon Yield *(t/ha)*	Change in average ratoon yield *(%)*	Farm Gross Margin *($/ha)*	Change in Gross Margin		Net Present Value *($/ha)*
	1st	*2nd*	*3rd*	*4th*				*($/ha)*	*(%)*	
93	84.37	78.56	73.31	67.76	76	**0**	**1,400.4**	0	0	**$1,101**
93	84.3	78.5	73.3	67.7	75.95	**-0.07**	**1,399.3**	-1.1	-0.08	**$341**
93	84.28	78.48	73.28	67.68	75.93	**-0.10**	**1,398.8**	-1.6	-0.11	**$0**
93	84.2	78.4	73.2	67.6	75.85	**-0.20**	**1,397.2**	-3.2	-0.23	**-$1,168**
93	84.1	78.3	73.1	67.5	75.75	**-0.33**	**1,395.0**	-5.4	-0.39	**-$2,677**
93	84.0	78.2	73.0	67.4	75.65	**-0.46**	**1,392.9**	-7.5	-0.54	**-$4,186**

The analysis presented in Table 7 indicates that a slight reduction to the average ratoon cane yield (0.10%) will cause the DHS investment to be un-acceptable from an economic perspective. Results also show that the economic viability of the DHS (indicative of its NPV) appears to be quite sensitive to even minor reductions in yield. Despite the potential for the DHS to reduce herbicide application costs significantly, growing expenses as a whole are reduced by a relatively small amount due to herbicide costs in ratoon cane accounting for only a small proportion of total annual growing expenses (just 1.2% of total variable costs in this particular scenario). The sensitivity table highlights the importance of validating the impact of the DHS on sugarcane yield and ensuring the equipment is set-up correctly for the weed management situation.

Using Balance® with the Dual Herbicide Sprayer

Balance® is a popular alternative residual herbicide used in sugarcane. Table 8 outlines the assumed rates of herbicide usage per hectare and prices applicable under this scenario.

Table 8: Rate and Usage of Herbicides for both Spraying Methods

Rate	Usage		Herbicide	Price
	Standard Irvin Boom	*Dual Herbicide Sprayer*		
0.1kg/ha	0.1kg/ha	0.045kg/ha	Balance®	$385/kg
1L/ha	1L/ha	0.45L/ha	Gramoxone®	$5.20/L
0.2L/ha	0.2L/ha	0.09L/ha	BS 1000 Wetter®	$13.25/L
1.5L/ha	-	0.98L/ha	Glyphosate	$5.88/L

Table 9 presents the weed management costs for ratoon cane and the gross margins under both spray methods when using Balance®. This shows that the cost to manage weeds in ratoon cane is considerably lower when using the DHS compared to the standard Irvin Boom. For instance, the costs when using a Balance® blend with the DHS are lower than for using a Velpar K4® blend with the standard Irvin Boom ($46.16/ha versus $53.30/ha).

Table 9: Weed Management Costs and Gross Margins under Balance® Scenario

	Standard spraying practice	Dual Herbicide Sprayer
Weed Management Costs (ratoon)	$65.92/ha	$46.16/ha
Average Farm Gross Margin	$1385.18/ha	$1,393.09/ha

Table 10 presents a detailed investment analysis of this scenario. As previously noted, results suggest that an investment in the DHS will provide the grower with a positive return.

Table 10: Investment Analysis

Investment Analysis	
Net Present Value	$3,051
Benefit-Cost Ratio	2.22
Internal Rate of Return (%)	29%

Conclusion

The Dual Herbicide Sprayer substitutes the use of residual herbicides for glyphosate, which is likely to provide economic and environmental benefits. Trials have found that it can reduce residual usage by up to 55%, depending on the width of the cane farm's row spacing.

The economic assessment using FEAT, investment analyses, breakeven analysis and sensitivity analysis revealed a positive economic benefit associated with the modification of the grower's Irvin Boom to the DHS if used across greater than 28 hectares of the cane farm area per year. However, the sensitivity analysis found that the economic viability of the DHS is quite sensitive to relatively minor reductions in yield. Further trial work includes the collection and analysis of harvest data, which will provide more certainty to yield concerns, and trials assessing the required training to obtain competency in the use of the DHS.

Economic outcomes from adopting different management practices can vary considerably between farms due to unique farm variables such as the scale of the operation, production system and soil type. Therefore, caution must be taken when interpreting the specific results from this report.

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