CASE STUDY
OPTICAL SPOT SPRAYING

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

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PA for Profit: Show me the money

Introduction

This is one of five case studies in the Profit First PA communication series derived from 'Assessing the economic value of precision agriculture tools for grain farming businesses in the Southern Region' funded by GRDC. Other project outputs have included:

- a review of existing information on the economics of PA
- a management guideline to aid growers and advisers decision making in adoption of PA
- a series of short videos, podcasts and fact sheets to further highlight the economics of PA when done well

Previous work has found financial results ranging from -$2/ha to $4/ha were possible for optical spot spraying technology (RDP00013 2015). This case study compares the experiences of four growers who are using weed sensing 'camera' spraying for selective spot spraying of weeds. The two commercial units currently available for this technology are the WeedSeeker® and WEEDit®.

The project has identified a 5-step process (Table 1) to make sound financial decisions for adoption of PA.

TABLE 1 PROFIT FIRST PA QUESTIONS

FIVE PROFIT FIRST PA QUESTIONS
1. What are the profit gain opportunities for the farm business using the profit driver's framework
2. Does PA have a role in addressing those constraints/opportunities?
3. What is the cost and benefit of implementing the PA practice as determined using a partial budget approach.
4. Are there other benefits or barriers to consider?
5. Does the business have the capacity to usefully implement the technology?

The following table is a broad guide to where optical spot spraying application is likely to have fit (Questions 1 and 2).

TABLE 2 AREAS OF LIKELY RESPONSE FOR OPTICAL SPOT SPRAYING

RAINFALL ZONE	SUBREGION	OPTICAL SPOT SPRAYING
LOW	Upper EP	
	Western EP	
	Upper North	
	SAVIC N Mallee	
	SAVIC S Mallee	
	Vic C Mallee	
MEDIUM	Lower EP	
	Central YP	
	Lower YP	
	NorthYP/Mid North	
	Wimmera-Bordertown	
	SA Upper SE	
	Central Vic	
	Nth Central Vic	
HIGH	SA Lower SE/KI	
	Southern Vic	
	NE Vic Slopes	
	Tas Grain	

Key: Green = highly likely, yellow = sometimes likely, orange = unlikely

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This case study assumes that the profit opportunity has been correctly identified, and that PA is an appropriate way for the farm to tackle it (questions 1 and 2). We focus on answering the remaining 3 questions.

Details of each participant and their involvement in this survey are listed in Table 3. Several other growers were also interviewed but did not provide economic analysis. Their insights also form part of the background discussion.

Doing you own numbers is a critical part of the decision making process with PA. The examples shown here are not universal, and are intended as examples of what is possible.

QUESTION 3: What is the cost and benefit of implementing the PA practice as determined using a partial budget approach. (Do the economics stack up?)

Financial benefits

TABLE 3 BACKGROUND INFORMATION FOR CONTRIBUTING FARMS

	FARM 1	FARM 2	FARM 3	FARM 4
Location	Mallee, VIC	Lower North, SA	Upper North, SA	Southern Mallee, SA
Annual rainfall (mm)	290	350	340	330
Property size (ha)	18,000	3,600	4,100	6,000
Participant description of farming system	Minimum till, direct drill, continuous cropping	Zero till, 80% cropping intensity	No till, continuous cropping	No till, continuous cropping
Profit opportunity	Reduce cost of summer weed control	Reduce cost of summer weed control without compromising the job	Reduce cost of summer weed control	Reduce cost of summer weed control
Previous Practice for Summer Weed Control	3 blanket sprays ($11.60/ha chemical mix) on 100% of arable area	2 blanket sprays ($12/ha chemical mix) on 100% of arable area and manual spot spraying	3 blanket sprays ($11/ha chemical mix) on 100 % of arable area	1 to 4 blanket sprays ($15/ha chemical mix) on 100% of arable area and patch outs using main boom
PA Approach	Two Croplands WEEDit®'s with Camera assisted and full coverage spraying, purchased new	Purchased a trailed WeedSeeker®	Purchased a used (6yo) trailed WeedSeeker®	Croplands Dual Line WEEDit® with spot spraying and full coverage, purchased new
Change in practice for summer weed control	1 blanket spray ($11.60/ha chemicals) on 100% of arable area, 3 WEEDit® sprays using 70% less chemical per pass ($15.36/sprayed ha for chemical mix)	1 blanket spray ($10/ha for chemicals) on 100% of arable area, 2 WeedSeeker® sprays using 80% less chemical per pass ($12/sprayed ha for chemical mix)	1 blanket spray (now only $7/ha chemical mix) on 100% of arable area using cheaper chemical mix, 2 WeedSeeker® sprays using 90% less chemical per pass ($15/sprayed ha for chemical mix)	1 blanket spray ($15/ha chemical mix) on 100% of arable area, 2 to 3 WEEDit® sprays using 85-90% less chemical per pass ($18/ha chemical mix) 2 out of 5 years a pre-seeding knockdown is applied with the WEEDit® instead of a blanket rate on targeted areas, which uses 20% less chemical in those years ($14/ha chemical mix)

TABLE 4 ECONOMIC ANALYSIS FOR CONTRIBUTING FARMS (PARTIAL BUDGET ANALYSIS)								
	FARM 1		FARM 2		FARM 3		FARM 4	
Location	Mallee Vic		Lower North, SA		Upper North, SA		Southern Mallee, SA	
Annual rainfall (mm)	290		350		340		330	
Property size (ha)	18,000		3,600		4,100		6,000	
Area that will benefit (ha)	18,000		3,600		4,100		6,000	
GAINS	**TOTAL**	**PER HA**	**TOTAL**	**PER HA**	**TOTAL**	**PER HA**	**TOTAL**	**PER HA**
Labour cost saving			$3,825	$1.06			$720	$0.12
Variable cost saving[1]	$222,768	$12.38	$54,720	$15.20	$118,900	$29.00	$99,720	$16.62
Total Annual Gains	$222,768	$12.38	$58,545	$16.26	$118,900	$29.00	$100,440	$16.74
CAPITAL								
Hardware purchase price	$620,000	$34.42	$160,000	$44.44	$70,000	$17.07	$350,000	$58.33
Software purchase price	-	-	-	-	-	-	-	-
Total Capital Investment	$620,000	$34.42	$160,000	$44.44	$70,000	$17.07	$350,000	$58.33
OPERATING COSTS								
Additional Variable Costs	$4,000	$0.22	$500	$0.14	$1,000	$0.24	$11,000	$1.83
Finance cost (5% of purchase price)	$31,000	$1.72	$8,000	$2.22	$3,500	$0.85	$17,500	$2.92
Depreciation (15% of purchase price)	$93,000	$5.17	$24,000	$6.67	$10,500	$2.56	$52,500	$8.75
Total Annual Costs	$128,000	$7.11	$32,500	$9.03	$15,000	$3.65	$81,000	$13.50
NET ANNUAL BENEFIT	$94,768	$5.27	$26,045	$7.23	$103,900	$25.35	$19,440	$3.24
Payback Period[2] (Years)	2.8		2.8		0.6		3.8	
Annual Margin[3]	43%		44%		87%		19%	

[1]Savings in chemical and operational costs.
[2]Capital Investment divided by Total Annual Gain minus Additional Variable Costs (excludes Finance and Depreciation costs).
[3]Net Annual Benefit divided by Total Annual Gain (includes Finance and Depreciation costs). A measure of how much of the initial gain is retained as profit.

In each of these four examples, the practice change outlined in Table 2 enabled only one blanket spray combined with two to three rounds of selective spraying, applying chemical to 10% to 25 % of the arable area and achieving the same or better level of weed control as the prior practice.

Considerable variable costs savings of $12 to $29/ha/year were achieved from using less chemical and reduced operating costs (Table 4). The net benefit however was strongly influenced by the capital cost of the technology, due to the impact of capital cost on annual depreciation.

Outright capital costs ranged from $70,000 ($18/ha/year) for a used WeedSeeker®, to $600,000 ($44/ha/year) for two new WEEDit® units with dual lines capable of selective and full coverage spraying. In each case the new equipment was not in place of an existing item, so there was no changeover, and the full capital cost was incurred. On an area basis, the highest capital cost was $58/ha for Farm 4. Annual operating costs, comprising mainly of depreciation (15% of capital value), ranged from $3.66 to $13.50/ha/year.

The highest net benefit per year was for Farm 3 with a benefit of $25/ha, which also had the lowest capital outlay. Annual gains between Farm 2 and Farm 4 were only $0.48/ha different, however Farm 2 had lower costs resulting in a net benefit that was $4/ha stronger (123% stronger than Farm 4). Farm 4 was the only farm to occasionally use the technology when applying a knockdown which added to the total benefit. Farms 1 and 3 had a payback period of 2.8 years, Farm 4 had a payback period of 3.8 years and Farm 3 had a payback period of 0.6 years.

The analysis was conducted based on grower experience in their 'average' summer. In each case the weed densities after the first blanket spray were sufficiently low to generate substantial cost savings from changing to selective spot spraying.

Starting weed densities are one of the major drivers for economic benefit from selective spot spraying. If weed density is less than 30%, selective spot spraying is more likely to be justified. The threshold though will vary from farm to farm based on machinery operating costs.

The economic benefit in wetter or drier summers will vary based on weed populations, frequency of germination, and the number of passes required. Factors increasing the likelihood of a positive return from using optical spot spraying include a combination of:

- Weed population on less than 30% of total area
- Minimum of 2 passes replacing blanket coverage
- Chemical cost/ha above $10/ha
- Annual operating costs below $10/ha.

Table 5 illustrates the sensitivity of these variables on results. For example, if only 1 pass was completed with a 20% chemical saving then the cost of chemical would be $4/ha instead of the blanket rate at $12/ha. This creates the net operational benefit of $8/ha before fixed costs (any costs associated with the camera sprayer such as depreciation and finance) are taken out. Having low fixed costs of $4/ha leaves a net benefit of $4/ha however, a high fixed cost of $12/ha leaves a net loss of -$4/ha.

TABLE 5 SENSITIVITY OF NUMBER OF PASSES, PERCENTAGE OF CHEMICAL USED, AND FIXED COSTS, ASSUMING REPLACING BLANKET RATE APPLICATIONS OF HERBICIDE ($12/HA) WITH SITE SPECIFIC APPLICATIONS WITH A MORE EXPENSIVE CHEMICAL MIX ($20/HA)

NUMBER OF PASSES REPLACED BY CAMERA SPRAYER	PERCENTAGE OF CHEMICAL USED	NET OPERATIONAL BENEFIT	NET BENEFIT AFTER $4/HA FIXED COSTS	NET BENEFIT AFTER $8/HA FIXED COSTS	NET BENEFIT AFTER $12/HA FIXED COSTS
1	15%	$9	$5	$1	-$3
	20%	$8	$4	$0	-$4
	30%	$6	$2	-$2	-$6
	40%	$4	$0	-$4	-$8
	50%	$2	-$2	-$6	-$10
2	15%	$18	$14	$10	$6
	20%	$16	$12	$8	$4
	30%	$12	$8	$4	$0
	40%	$8	$4	$0	-$4
	50%	$4	$0	-$4	-$8
3	15%	$27	$23	$19	$15
	20%	$24	$20	$16	$12
	30%	$18	$14	$10	$6
	40%	$12	$8	$4	$0
	50%	$6	$2	-$2	-$6

QUESTION 4: Are there other benefits or barriers to consider?

Perceived operational benefits

Several other benefits were cited by growers.

- Weeds were controlled with better timeliness and efficacy as the reduction in chemical costs made it easier to justify spraying a paddock earlier even if it meant a repeat operation later. Previously spraying would have been deferred until there were more weeds to spray.
- Higher rates or different mode of action chemicals that are too expensive on a full coverage basis enable better weed kills on the case study farms.
- The growers suspect there is a yield benefit from increased stored soil moisture and less disease carry over. This yield benefit is difficult to quantify and was omitted from the economic analysis, however, would likely increase the economic benefit significantly if it could be estimated.
- Better control of harder to kill weeds meant labour cost savings, due to less manual spot spraying (accounted for in the economic analysis). Spray operators were also happier and safer as less time was spent spraying with hand held spray guns, more time in the preferred space of the tractor cab and there was less direct exposure to chemical.

Perceived whole farm benefit

Whole of farm impacts noted by growers included:

- Less spread of hard to kill weeds
- A reduction in the number of hours on the higher value self-propelled boom (used for other spray applications), hence extending the life span and reducing the total depreciation cost each year. Whilst tractors are still used to tow trailed camera sprayers, it was noted that these tractors often had lower running costs compared to tractors/self-propelled sprayers that were used previously.

Barriers

Purchase cost of a new machine is the biggest barrier to economic benefit, as the gains can be eroded by depreciation costs if scale is insufficient. Solutions include partnerships with other farms or undertaking contract spraying to fully utilise the machine.

Few label registrations for chemicals applied by optical spot spraying restricts chemical mix options and increases the risk of inadvertently using off-label rates.

Total time spent spraying is greater as there are more passes and spraying speed is slower (16 km/h). This adds to labour and operational pressure in the summer months when the spraying window is narrow.

The sensors do not detect small thin weeds such as ryegrass or emerging brome grass. Weed sizes greater than 25 mm are ideal.

The sensors are sophisticated technology which can be a deterrent as it is unfamiliar equipment that cannot be easily repaired in house.

QUESTION 5: Does the business have the capacity to usefully implement the technology?

Questions to consider include:

- Are there other more important profit drivers to direct resources to before investing in selective weed control?
- Is there the enough technical support, on and off farm, to implement and maintain the technology?
- Is the farm landscape suitable for selective spot spraying technology?
- Does the farm have the logistical capacity, including labour and tractors to run a conventional boomspray and an optical boomspray?

The bottom line

Did it solve the profit constraint?

Yes. Each farm felt that the investment had improved out of season weed control and reduced the cost of spraying. This was shown in the economic analysis where each grower had a positive net benefit and a payback period of <4 years. The economic outcomes from this technology is highly situational due to scale, weed populations and likelihood of repeat spray.

Works best when....

- Capital outlay is matched to scale or contracting is done to achieve the extra area needed to keep fixed costs below $10/ha.
- Weed coverage is less than 30% of total area.
- More than one pass with the selective spot sprayer is required.
- Logistical capacity allows timely operations.
- Chemical cost of mix for selective spot spraying spot is similar in price to full coverage mix. (Net benefit can be eroded if the cost of mix is too high).

Traps to look out for:

- Risk of overcapitalising, particularly if purchasing new dual technology and the full coverage unit gets minimal use.
- Extra time required to conduct spray operations.
- Eroding potential gains by spending more than required on selective spray mixes.

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References

GRDC RDP00013 (2015), Output 8 – Potential trade-offs between scale and precision use of inputs, authored by Rural Directions Pty Ltd, Macquarie Franklin, Meridian Agriculture, Agripath, and Corporate Agriculture Australia

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