PA investment pays its way in grains

Report author Michael Robertson (R) with David Forrester, one of the case study participants.

Does investing in precision agriculture (PA) pay? That is the question commonly posed by producers in all industry sectors. Two projects supported by GRDC, or GRDC with the SA Grains Industry Trust, have generated case studies on the economics of PA using real data from 12 grain growers in WA, NSW and SA. Both projects showed investment in PA provided annual improvements in gross margin that can result in capital payback within three years. Complete copies of both reports are available on the SPAA website - www.spaa.com.au

'The Economic Benefits of Precision Agriculture' by CSIRO Sustainable Ecosytems researchers Michael Robertson, Peter Carberry and Lisa Brennan concluded that *"Australian grain growers have adopted PA systems that are profitable, recover the initial financial capital outlay within a few years, and provide growers with a number of non-monetary benefits ."*

Their report produced six farm case studies that cover a range of agro-climatic regions (Mediterranean, uniform and summer dominant rainfall patterns), cropping systems (wheat-lupin, wheat-canola, and winter and summer crops), farm sizes (1,250 to 5,800 ha cropping program), soil types (shallow gravels to deep cracking clays), and production levels (average wheat yields from 1.8 to 3.5 t/ha).

The growers studied had been involved in PA from two to 10 years and used the range of PA technologies that are commonly adopted by Australian graingrowers. Among the six growers, all had invested in guidance and were practising some form of variable rate fertiliser management. However, only some were using autosteer and tram lining. One grower was using satellite imagery (NDVI) and another, the GreenSeeker™ technology for in-season nitrogen management. As such, the data set covered the range of likely situations confronting practitioners of PA in the Australian wheatbelt.

Each grower was interviewed and information was collected on:

- Area of cropping program, crops grown, area of the cropping program to which PA technologies are applicable, average cropping gross margin;
- PA equipment purchased, including date and cost, management actions associated with PA technology implementation;
- Estimated reduction in overlap for tram lining/guidance, the rates of fertiliser applied in each zone for zone management, areas of management zones in each paddock, rates of fertiliser applied for uniform zone management, yield in each management zone;
- Their opinions of non-monetary benefits of PA.

Standard economic analyses were applied including gross margin calculations and discounted cash flow analysis.

The level of capital investment in PA varied from $55,000 to $189,000, which is typically at the medium to high end of investment for Australian grain growers (Table 1). When expressed as capital investment per hectare cropped it varied by a factor of three from $14 to $44/ha.

The estimated annual benefits from PA ranged from $14 to $30/ha and consequently the investment analysis showed that the initial capital outlay was recovered within 2-5 years of the outlay, and in four out of the six cases within 2-3 years (Table 2).

Guidance

The greatest benefits reported related to reduced overlap and increased efficiency due to the use of guidance, tram lining and auto-boom shut off. Generally the benefits due to reduced overlap for spraying were in the order of 10 per cent. The greatest benefits from autosteer where reported in systems that were not already set-up for

Economics of PA

tram lining or row crops and where paddocks were irregular shapes or undulating.

For example, for the Fulwoods who invested in 2cm RTK autosteer on two tractors plus a further system shared between the spray tractor and the header ($118,500), it was calculated that they saved an average of 8 per cent of inputs and labour over the 5000 hectare cropping program, equalling an annual saving of $93,600. A further $10-150 of savings were attributed to more accurate harvesting as the header front was nearly always full.

Yield mapping

Although yield mapping was often the entry point into PA no direct benefit was attributed to yield mapping in this study. Instead benefits were incorporated with variable rate as yield maps are a key attribute in the development of rate zone maps.

Variable rate (VRT) fertiliser

While highly accurate GPS systems are required to maximise the benefits from autosteer, these systems are not essential for variable rate.

For all growers the research quantified benefits to variable rate fertiliser management, ranging from $1 to $22/ha across six farms (Table 3). On a per paddock basis, benefits ranged from -$28 to +$57/ha/year. This wide range can be explained in part by two factors.

1) Most growers varied starter fertiliser as well as nitrogen topdressing, however, one grower (McAlpine) only varied topdressing and consequently the benefits from VRT were lower than the other case studies.

2) The degree of within-paddock yield variation contributed to differences in the benefits gained from VRT between the farms.

For example, within-paddock variation was noticeably less in the case of McLaren where VRT

Table 1. Typical configuration costs for investment in equipment and services for precision agricultural technology.

Level of Investment	Total cost	Equipment and services
Low	$17,300	Variable rate controller - $3,500 GPS - $800 Zone analysis (using NDVI) - $3,000 Existing seeder variable rate ready 10cm accuracy autosteer - $10,000
Medium	$45,000	Yield monitoring and mapping - $7,500 Conversion of machinery to be variable rate capable - $10,000 to $30,000 10cm accuracy autosteer - $10,000 Annual subscription - $2,000
High	$75,000	Autosteer - $32,000 per vehicle 2cm accuracy GPS - $18,000 - $22,000 Controllers for seeding, fertilser spreading, pesticide spraying - $16,000

Table 2. Farm case study summary including level of investment in PA, estimated annual gross margin benefits from this investment and period to initial investment recovery.

Farming family	Location	Cropping program	Years in PA	PA technologies used	Investment in PA		Annual estimated benefits to PA*	Years to breakeven
					Total	$/ha	$/ha	
Forrester	WA	2600ha wheat, barley lupins	9	Guidance Variable rate fertiliser	$90	35	21	4
Fullwood	WA	5800ha wheat, barley, lupins	2	Autosteer Tramlining Shielded spraying Guidance Variable rate fertiliser	$189,000	33	22	2
McAlpine	WA	3400ha wheat, barley, canola, lupins	6	Autosteer Tramlining Guidance Variable arte fertiliser	$65,000	19	21	2
Smith	NSW	1250ha wheat, barley, sorghum, chickpeas, canola, sunflowers	7	Autosteer Tramlining Guidance Variable rate fertiliser and pesticides	$55,000	44	30	2
Heath	NSW	3430ha wheat, barley, fababean, canola, sorghum, maize, sunflower	8	Autosteer Tramlining Guidance Variable rate fertiliser In season NDVI	$95,000	28	24	3
McLaren	NSW	4000ha wheat and canola	10	Guidance Variable rate fertiliser In season NDVI	$56,000	14	14	5

**excluding capital costs*

benefits were on average $7/ha, compared with Smith or Forrester where benefits were >$15/ha . The difference between the average yield of the pre-determined high and low zones was always positive and substantial, suggesting that growers were successful in identifying zones that perform differentially across seasons.

McLaren was the only grower who when adopting VRT reduced fertiliser inputs; others either maintained or increased fertiliser use. In the case of McLaren the reduction of fertiliser phosphorus (P) rates was due to a history of P build-up before the adoption of VRT and this necessitated lower application rates of P, especially on zones with medium and low yield potential.

Where VRT benefits were able to be estimated across a run of seasons for a given paddock, it was noticeable that benefits, albeit diminished, still accrued in below average years, such as the 2002 drought. This suggests that, once zones have been defined, benefits from VRT will occur in most seasons.

In the case of Fulwood, benefits to VRT were based on only one season's results and the estimate for McAlpine were based solely on grower estimates, rather than records of yield variation and fertiliser rates. Hence, results from these farms should be generalised with caution. The methodology for estimating the benefits of VRT requires further testing on paddock-scale data where yields and fertiliser rates are recorded for uniform and VRT-managed strips. Where such studies have been conducted the benefits recorded are in line with those estimated from grower records. There were no clear trends for differences in benefit due to crop type, with canola and wheat (McLaren), wheat and lupins (Forrester) performing similarly. In the case of Smith, chickpea gave lower returns to VRT than wheat because less nitrogen was applied on the former.

While all growers in the study are using VRT fertiliser in some form, the reality is that few have taken the plunge into full commercial implementation of VRT across their farms and input types. The research extrapolated results from the paddocks on the farm we analysed to represent the whole cropping program for that farm in that season. In some cases every paddock was analysed so extrapolation was not necessary.

An exception is Heath who is using in-season sensing with a Greenseeker™ to verify crops' actual nitrogen requirement against nitrogen rich strips rather than anticipating rates using zones developed from historic yield maps and other sources such as EM surveys. The Greenseeker™ cost $20,000, however, this investment was more than off-set by an increase in gross margin of $40,000 due to a saving in fertiliser of $20/ha compared to the fertilizer inputs calculated from soil tests.

Other benefits

Apart from guidance and VRT other benefits nominated by growers and estimated in the calculations included: savings in fuel and labour, reduced soil compaction and more timely sowing. Intangible benefits listed included the ability to conduct on-farm trials, increased knowledge of paddock variability, increased confidence in varying fertiliser rates and better in-crop weed control due to shielded spraying. It was noted that no growers nominated pest management, grain marketing or nutrient budgeting as benefits gained from the use of PA.

A clear impression gained through interviewing each grower was that they were all highly literate in the use of computers, GPS technology and variable rate controllers. All invested considerable time in setting-up their system, with considerable teething problems in some cases, but ongoing labour demands were minimal. Some did not use a consultant, while others placed heavy reliance on consultants for zone definition, yield map processing and variable rate map production.

All growers soil tested, often in conjunction with a fertiliser company representative and used this information to inform the setting of fertiliser rates. In two cases, growers told us that the extra soil testing that inevitably accompanies the use of more management zones on the farm under VRT, tended to be absorbed as a cost by the fertiliser company in return for the anticipated extra business.

The results from this study go some way towards informing the debate about the profitability of PA. They also illustrate that the use of and benefits from PA technology varies from farm to farm, in line with grower preferences and circumstances.

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Table 3. Summary across the six farm case studies of the $/ha benefits to precision agriculture technologies, in total and by category.

Farmer	Total	Reduced overlap	Fertiliser management	Less soil compaction	Fuel savings	Other
Forrester	21	5	16			
Fulwood	22	13	7			2
McAlpine	21	12	1		4	4
Smith	30	8	22			
Heath	24		20	4		
McLaren	14	7	7			

Economics of PA

PA investment pays its way in grains

Dr Matthew McCallum

SPAA research project 'Case Studies on the Economics of Precision Agriculture in South Australia' quantified the economic benefits of investment in PA on six grain growing properties, in different cropping regions of SA. Researched by Matthew McCallum, McCallum Agribusiness Consulting, the project gathered information on:

- Area of cropping program, crops grown, crop yields, gross margins, rainfall, soil types;
- Variable input costs including: fuel, fertiliser, seed, pesticides, machinery and labour per hectare;
- GPS and PA equipment purchases, costs and purpose;
- Evidence that PA is working on their farm, for example, less overlap, or variable rate applications;
- Other benefits of PA, for example, conducting on-farm agronomic trials and experiments.

This data was collated, analysed and a case study written on each farm.

Tables 1 and 2 summarise the farms involved and the costs and benefits from PA. In each case the annual benefits from cost savings and increased production were enough to cover the cost of purchasing guidance and autosteer equipment within one to five years. The savings in overlap per hectare (Table 3) are generally lower than in the CSIRO study, this may be due to farmers in the SA study being owner-operators or employing regular staff while the WA study farmers may use more casual labour. In SA air-seeder width is generally 20% less than in WA, which could influence this difference.

Farmer Andrew Woolford (R) discusses guidance options with Chris Slade (Rinex) at the SPAA EXPO where the results from the SA economic case studies were also presented.

The payback period for yield monitoring and variable rate technology (VRT) equipment ranged from one to 10 years. This large range is primarily due to the high price paid for yield monitoring equipment in the mid to late 1990's, before this equipment became standard, as is the situation on most harvesters less than 10 years old. Another factor was a 'lag phase' between purchasing and using VRT equipment. Although farmers had some information on paddock/yield variability they were not confident enough to use full VRT, until they had evidence it would work. Therefore, this lag between purchase and implementation increased the payback period. To implement VRT some farmers reduced overall fertiliser input, while others targeted inputs to increase production on low phosphorus areas within paddocks e.g. sand dunes.

I propose that farmers who are considering adopting PA are in a better positioned to make VRT pay within two to three years because of access to lower cost equipment, increased industry experience and more information on the likely financial returns.

Other major benefits

The reduction in fatigue was highly rated by all six farmers as a benefit

Table 1. Summary of the six broadacre cropping farms researched in SA

Farmer	Region	Annual rainfall (mm)	Soil types	Area cropped (ha)	Years of PA experience
Buckley	Mallee	250	Dune/swale, sandy loams, shallow red loams over limestone	3000	7
Sargent	Mid north	400	Clay loam, sandy loam	1600	8
Wilksch	Lower Eyre Peninsula	425	Red brown earths, sandy loam over sodic clay	2700	2
Turner	Mid north	400	Red brown earths, sandy loam over clay	2340	10
Baldock	Upper Eyre Peninsula	300	Dune swale, sandy loams, red loam over clay	4475	5
Branson	Lower North	475	Black cracking clay, red brown earths	1200	10

Table 2. Farm case study summary including level of financial investment in PA, annual gross margin benefit and period to initial investment pay back

Farmer	Capital invested in PA**		Annual benefit		Payback period (years)	
	total	$/ha	total	$/ha	VRT equipment	Autosteer & guidance
Buckley	$68,500	23	$32,850	11	1	4-5
Sargent	$98,500	62	$20,180	13	10	1-5
Wilksch	$73,000	27	$57,240	21*	-	1-2
Turner	$34,432	15	$35,100	15	6	1
Baldock	$52,000	12	$47,842	10*	-	5
Branson	$73,800	62	$44,880	37	9	3
Average	$66,705	34	$39,682	18	7	3

**estimated potential not proven, ** excluding capital costs*

Table 3. Summary across the six SA cases studies of $/ha benefit by category

Farmer	Annual benefit $/ha			
	Savings in overlap	Savings using VRT	Increased production using VRT	Other production increases**
Buckley	4		7	
Sargent	5	5		3
Wilksch	3			18*
Turner	5	10		
Baldock	2		8*	
Branson	10	9		18
Average	$5	$8	$7	$13

** estimated potential not proven, ** includes reduced soil compaction, inter row sowing etc*

gained from guidance and autosteer. The ability to conduct their own agronomic experiments was an important benefit for two farmers; these experiments have the capacity to lead to better whole-paddock or whole-farm decisions that increase profit.

Management time spent by farmers on PA

Most of the farmers interviewed spent three to seven days per year organising yield and variable rate maps. Most used basic software supplied by manufacturers and machinery dealers. Although the software was basic, it is fair to say the level of computer and GPS literacy amongst these farmers was high. This may be a significant barrier for further adoption of VRT. Some farmers used the advice of a PA or agronomic consultant in preparing variable rate maps. In contrast, it was found that guidance and autosteer take very little training and on-going management.

Evaluating the economics of PA on your farm

As with any capital investment decision, farmers need to evaluate the likely returns from PA before investing in equipment. To maximise the return on investment, PA equipment should pay for itself in two to three years, particularly given the expected lifespan of PA equipment is likely to be only five to 15 years. The rapid improvement in 'value for money' for new GPS products means that equipment is likely to be worthless after 10 years.

I propose a feasibility study of PA investment is an important first step. Those involved in the study reported that involvement with organisations such as SPAA and PIRSA were important in helping to verify potential returns from PA.

Key findings:

- Scale of operations. Larger farms can afford to invest more money in PA and will achieve a greater return over time. Smaller farmers should consider syndication or sharing of PA equipment.
- Computer literacy. A reasonably high level of GPS knowledge and computer skills are required for successful VRT implementation. This is not the case for autosteer and guidance.
- Conduct a feasibility study first to work out a budget, and then shop around the GPS manufacturers for a product that suits your requirements. Consult advisors and other farmers in making this decision.

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