The journey is great, but does PA pay?

Garren Knell, ConsultAg; **Alison Slade**, Department of Agriculture and Food, Western Australia, CFIG

KEY MESSAGES

Variable results were achieved in 2006 when matching fertiliser inputs to productivity zones. Results ranged from an increase in paddock returns of $2,700 to a loss of $4,500 compared to a blanket application of fertiliser.

After eight trials over four years it remains unclear if the adoption VRT and applying fertiliser according to the performance of each productivity zone is likely to generate significant profits when compared to blanket applications of fertiliser in the Corrigin district. The information gathered in the process does however allow farmers to better understand their paddocks and their crops fertiliser requirements to assist in making profitable fertiliser decisions.

Where soils have a high nutrition status (N, P, K, S) and low reactive iron there is scope for farmers to significantly reduce fertiliser inputs in the short term and still achieve profitable grain yields.

AIMS

To better match fertiliser inputs to productivity zones to increase whole paddock profitability.

To document and evaluate a practical procedure utilising tools and services that are readily available for zoning paddocks and matching fertiliser inputs to productivity zones.

METHOD

Zoning paddocks and estimating crop nutrition requirements

The Corrigin Farm Improvement Group in conjunction with ConsultAg and DAFWA conducted five trials looking at Precision Agriculture and Variable Rate Technology. Summarised within this paper are two trials from 2006. The rest of the trials performed in a similar manner. Paddocks were zoned using Silverfox's biomass imagery analysis. The analysis incorporated biomass data from five seasons of crop performance. This produces a biomass stability map. The biomass stability map identifies zones in the paddock that consistently show poor, average or good performance. This is a useful tool in precision agriculture because it also helps to identify those areas which are unstable in their performance through time.

Target yields for each productivity zone were set using the biomass images and farmer experience.

Soil testing was undertaken in each zone at a depth of 0-10 cm and 10-20 cm. The Nulogic crop nutrition model was used to generate the fertiliser requirements to achieve the target yield in each productivity zone. Target yields were reviewed post emergence due to the late break to the season and low rainfall. Where target yields were lowered the nitrogen requirements were amended to reflect the change in target yields.

The sites were tissue tested in August to evaluate nutrient uptake and to ensure that there were no trace element deficiencies that would influence the trial results. The paddocks were also flown by Air Agronomics to assess crop biomass in response to the nutrition treatments.

Trial designs

The paddocks were sown with the farmer's air seeder so that a seeding run would pass through at least two of the productivity zones but usually through all three. The plots were a full air seeder width wide and yield was measured with a weigh trailer from a minimum plot length of 100m in each zone.

Trial designs were a fully randomised design with three replications. In paddocks where the zone size was not large enough for three replications, two replications were used but two header cuts were taken down the length of each plot to provide four data points for each treatment.

Economic calculations

All financial calculations used 2006 list fertiliser prices. The grain prices were calculated individually for each treatment using the December 2006 AWB golden rewards premiums and discounts. The prices were then converted back to a farm gate price. The calculated returns for each treatment represent gross income minus fertiliser and application cost.

RESULTS

Example 1 – N. and G. Turner, Corrigin 2006

The trial paddock is a sandplain soil type ranging from loamy sand to deep white sand and was located high in the landscape. The paddock grew lupins in 2004 and Calingiri wheat in 2005 and 2006.

The paddock was ungrazed over summer and the stubble was burnt in late autumn prior to sowing. The paddock received *266 mm* of rain during January, February and March. It was a dry winter and the crop received *180 mm* of growing season rainfall.

Soil tests indicated that the site had relatively high phosphate levels and low to ideal reactive iron levels (see Table 1). This meant that the site was unlikely to be responsive to phosphate. The soil nitrogen levels were low and the paddock was wheat on wheat and the site was expected to be responsive to nitrogen. Table 2 shows the target yield for each productivity zone and the recommended rate of nitrogen and phosphate to achieve the target yield.

Table 1. Soil test results

Productivity zone	pH (CaCl)	Organic carbon	Nitrate nitrogen	Ammonium nitrogen	Phosphorus (Colwell)	Reactive iron	Potassium (Colwell)
Poor	4.8	0.46	8	1	21	127	34
Average	5.2	1.76	8	2	33	682	102
Good	5.5	1.37	17	1	23	488	81

Note: Sub soil data not included.

Table 2. Fertiliser recommendation to achieve target yield

Fertiliser treatment	Target yield $t.ha^{-1}$	Phosphate kg/ha	Nitrogen kg/ha	Potassium kg/ha	Cost $/ha
Low	1	5	11	3.5	$27
Medium	2	10	30	6.7	$59
High	3	10	65	6.7	$96

Grain yield and economics

All three productivity zones yielded very well, exceeding target yields by between 0.5-1 $t.ha^{-1}$ (Table 3). The zones performed as expected with the highest yield in the good, average and poor zones 3.65, 2.89 and 2.2 $t.ha^{-1}$ respectively.

The highest yield and returns in the poor productivity zone were achieved with the medium fertiliser input. This is not surprising given the grain yields were at least 1 $t.ha^{-1}$ greater than the target yield.

In the average productivity zone the medium and high input treatments achieved similar yields and grain quality, however the additional costs of the high input treatment meant that it generated lower returns (Figure 1). All three treatments failed to make ASWN quality because of low protein.

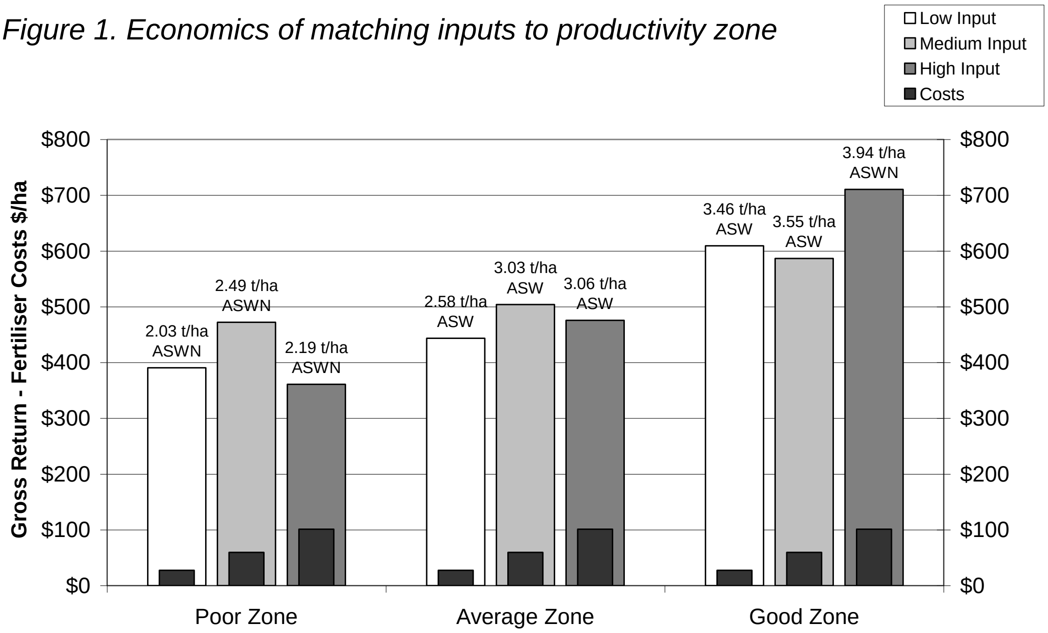
Table 3. Grain yield, quality and price of each fertiliser treatment in poor, average and good productivity zones

	Input	Yield t.ha	Hect wt	Screenings	Protein	Moisture	Pay grade	Price $/T
Poor zone	Low	2.03	82.1	3.2%	9.5%	10.0%	ASWN	$206.0
	Medium	2.49	81.5	3.2%	10.1%	10.0%	ASWN	$213.5
	High	2.19	81.5	3.0%	9.8%	10.0%	ASWN	$211.0
Average zone	Low	2.58	81.5	1.8%	8.9%	10.0%	ASW	$182.5
	Medium	3.03	82.1	1.7%	9.1%	9.9%	ASW	$186.0
	High	3.06	81.6	2.5%	9.4%	9.9%	ASW	$188.5
Good zone	Low	3.46	80	3.2%	9.2%	9.9%	ASW	$184.0
	Medium	3.55	81	2.2%	8.9%	9.9%	ASW	$182.0
	High	3.94	80	3.2%	9.5%	9.8%	ASWN	$206.0

In the good productivity zone the high input treatment achieved the highest yield and returns (Figure 3). The returns were further improved by the high input treatment achieving ASWN where as the medium and low inputs were down graded to ASW because of low protein.

Figure 1 shows the gross return minus fertiliser cost for the low, medium and high inputs in the good, average and poor productivity zones. The black bars represent fertiliser expenditure.

Figure 1. Economics of matching inputs to productivity zone



Zone management vs blanket treatment

To calculate the benefit or cost of managing this paddock according to productivity zone we extrapolated the findings across the whole paddock according to the areas of each zone in the paddock (Table 4). In this example VRT assumes fertiliser rates based on target yield in a zone; good (high), average (medium) and poor (low). The unstable areas of the paddock that fluctuate in performance from year to year were included in the average productivity zone.

This shows that in 2006, there would have been a net benefit of $2,693 in this paddock from matching fertiliser inputs to productivity zones (VRT) compared to applying the medium treatment as a blanket across the whole paddock. While this additional income is a step in the right direction it only represents a 5% increase in returns. Given the financial and time costs involved in setting up a VRT system many farmers would want a substantially greater increase in returns than 5% to warrant adoption.

If the whole paddock was blanketed with the high input treatments there would only be a $740 benefit compared to the medium input in 2006. This is a small additional return given the extra financial risk associated with spending an extra $37/ha on fertiliser. In an average or poor season the high input treatment would be highly unprofitable.

Table 4. Cost or benefit of matching fertiliser inputs to productivity zones

	ha	Low	Medium	High	VRT
Poor	10	$3,910	$4,720	$3,610	$3,910
Average	59	$26,137	$29,736	$28,084	$29,736
Good	31	$18,879	$18,197	$21,700	$21,700
Total		**$48,926**	**$52,653**	**$53,394**	**$55,346**
Difference from medium input		-$3,727	$0	$741	$2,693

Example 2 – P and A Groves Yotting 2006

The paddock was sown to lupins in 2005 and Calingiri wheat in 2006.

The paddock received around *260 mm* of rain during January, February and March. It was a dry winter and short spring and the crop received approximately *180 mm* of growing season rainfall.

Soil tests indicated that the site had high phosphate levels and low to ideal reactive iron levels (see Table 5). This means that the site was unlikely to be very responsive to phosphate. The soil nitrogen levels were not high. This was surprising considering the previous legume crop and mineralisation from summer rain. There may have been some leaching of nitrate from the soil surface.

Table 5. Soil test results

Productivity zone	pH (CaCl)	Organic carbon	Nitrate nitrogen	Ammonium nitrogen	Phosphorus (Colwell)	Reactive iron	Potassium (Colwell)
Poor	4.9	0.74	36	5	31	326	87
Good	4.6	0.4	11	1	27	451	87

Note: Sub soil data not included.

Table 6 shows the target yield for each productivity zone and the recommended rate of nitrogen and phosphate to achieve the target yield. The soil tests indicated that there was no additional phosphate or nitrogen required to achieve the 2T target yield in the low zone.

Table 6. Fertiliser recommendation to achieve target yield

Fertiliser treatment	Target yield $t.ha^{-1}$	Phosphate kg/ha	Nitrogen kg/ha	Cost $/ha
Low	2	0	0	0
Medium	3	5	15	$30
High	4	10	55	$91

Grain yield and economics

The paddock was high yielding, especially given the dry season, however the zones did not perform as predicted. The poor performing zone was the highest yielding with an average yield of 3.06 t/ha (Table 7, Figure 2). It is not clear why this occurred and will require further investigation. The average production zone achieved the lowest yield (2.6 t/ha) and the good zone achieved the median yield (2.87 t.ha).

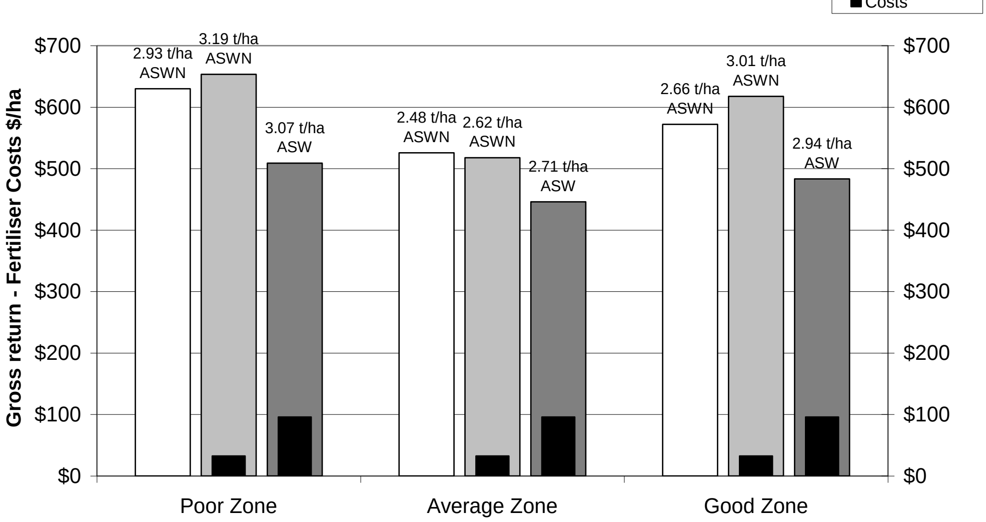
Table 7. Grain yield, quality and price of each fertiliser treatment in poor, average and good productivity zones

	Input	Yield t.ha	Hect wt	Screenings	Protein	Moisture	Pay grade	Price $/t
Poor zone	Low	2.93	80.9	2.4%	10.2%	10.1%	ASWN	$215
	Medium	3.19	81.2	2.1%	10.1%	10.1%	ASWN	$215
	High	3.07	78.0	5.0%	11.9%	10.1%	ASW	$197
Average zone	Low	2.48	80.6	2.7%	11.0%	10.3%	ASWN	$212
	Medium	2.62	80.6	2.9%	11.4%	10.2%	ASWN	$210
	High	2.71	79.0	3.8%	12.2%	10.2%	ASW	$200
Good zone	Low	2.66	81.2	2.4%	10.4%	10.3%	ASWN	$215
	Medium	3.01	81.1	2.1%	10.4%	10.2%	ASWN	$216
	High	2.94	78.1	4.5%	11.8%	10.2%	ASW	$197

Across all zones the medium input treatment achieved the greatest returns except in the average zone where it had equivalent returns to the low input treatment (Figure 2). The low and medium input treatments were able to achieve ASWN quality in all zones, however the high input treatment was discounted to ASW due to high protein. This is not surprising given the high nitrogen supply and sharp finish to the season. If a AH or APW variety had been grown the high input treatments would have received a protein premium rather than a discount and would have increased the returns. The grain yield failed to respond to the additional nitrogen and phosphate applied in the high input treatments and in most cases it suffered a yield penalty as well as grain quality discounts (Table 7).

The low input treatment exceeded the target yield (2 t/ha) in all productivity zones (average yield 2.69 t/ha). This is an exceptional yield to achieve across all 3 zones given there was no applied fertiliser.

Figure 2. Economics of matching inputs to productivity zone



Note: No costs associated with low input as no fertiliser used.

Zone management vs blanket treatment

To calculate the benefit or cost of managing this paddock according to productivity zones we extrapolated the findings across the whole paddock according to the areas of each zone in the paddock (Table 8).

If the paddock was sown using VRT and nutrition was applied according to predicted zone performance there would have been a net loss of $4,494 (8%) in this 105 ha paddock compared to a blanked application of the medium input (Table 8).

The most profitable management option for this paddock would have been a blanket application of medium inputs (fertiliser cost $30/ha). The blanked application of low input treatment (nil fertiliser) generated the next best returns which were only $1,186 less or a 2% reduction in income for nil fertiliser expenditure. This is a surprising result and it is pleasing to know that fertiliser inputs can be reduced (in the short term) without significantly compromising yield where soil nutrition levels are high (N, P,K,S) and reactive iron levels are low.

Results would have been different if there had been a better finish to the season; however the site still achieved above 5 and 10 yr average yield for the district.

Table 8. Cost or benefit of matching fertiliser inputs to productivity zones

	ha	Low	Medium	High	VRT
Poor	10.5	$6,615	$6,857	$5,345	$6,615
Average	63	$33,138	$32,634	$28,098	$32,634
Good	31.5	$18,018	$19,467	$15,215	$15,215
Total	**105**	**$57,771**	**$58,958**	**$48,657**	**$54,464**
Difference from medium		-$1,186	$0	-$10,300	-$4,494

CONCLUSION

The Corrigin Farm Improvement Group (CFIG) has replicated these types of trials more than eight times over four years with similar results and as yet it is unclear if the adoption of VRT and applying fertiliser according to the performance of each productivity zone is likely to generate significant profits when compared to blanket applications of fertiliser in the Corrigin district.

The information gathered in the process does however allow farmers a better understanding of their paddocks and the crops fertiliser requirements to assist in making profitable fertiliser decisions.

In most situations there are trends or small increases in profit that suggest that zone management may have merits, however the seasonal variability in yields (wet, dry, drought, frost) seems to prevent the treatments achieving their full response.

Our previous trials have indicated that zone management to ameliorate soils and correcting potassium deficiencies can be highly profitable.

It would appear logical to use VRT to assist growers to play the season with post emergent applications of nitrogen. The paddock could be sown with blanket nutrition and if there is an above average season addition nitrogen could be applied to the higher yielding zones in the paddock. CFIG will focus on this in the final year of the project.

KEY WORDS

zone management, precision agriculture, VRT, nutrition, profitability

ACKNOWLEDGMENTS

Corrigin Farm Improvement Group and participating farmers, GRDC, James Easton CSBP.

Project No.: CFIG 00002

Paper reviewed by: Michael Odea, Summit Fertilisers