Can adjusting zones within N1 paddock at Minnipa improve VRT outcomes?

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RESEARCH

Location: Minnipa Ag Centre

Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2011 Total: 404 mm
2011 GSR: 252 mm

Yield
Potential: 4.1 t/ha (B)
Actual: 3.1 t/ha (good and medium zone - high input)

Paddock History
2011: Barley
2010: Wheat
2009: Wheat
2008: Wheat

Soil Type
Sandy loam to sandy clay loam

Soil Test
Outlined in article

Diseases
Rhizoctonia

Plot Size
Paddock trial, sowing widths 9 m

Yield Limiting Factors
Rhizoctonia
Dry spell in spring

Environmental Impacts

Soil Health
Soil nutrients: Needs to be monitored

Resource Efficiency
Energy/fuel use: Standard
Greenhouse gas emissions (CO_2,NO_2, Methane): Standard

Social Practice
Time (hrs): Standard
Clash with other farming operations: Standard
Labour requirements: Standard

Economic
Infrastructure/operating inputs: VRT technology
Cost of adoption risk: Low if improving returns

Key messages

- **Compared to 2008 map, rezoning based on 2009 yield monitor map improved variable rate technology (VRT) performance in 2009, 2010 and 2011 seasons.**
- **The highest gross margin was returned from paddock N1 as a result of zoning whereby no fertiliser was being applied to 89% of the paddock.**
- **A limited yield response to applied fertiliser has restricted any gross margin benefit from the VRT technology from this paddock with high soil P reserves.**

Why do the trial?

Variable rate technology (VRT) offers farmers the ability to adjust sowing and fertiliser rates during the seeding process, in order to change inputs according to the production capability of different paddock zones or soil types. At Minnipa Agricultural Centre (MAC) on paddock N1, the opportunities to increase profits through the use of VRT has been studied through zoning the paddock based on pre-2008 yield monitor maps, and incorporating EM38 and elevation maps.

The initial results have shown little benefit being derived using VRT technology based on the 2008 zone map. Thus the question was raised as to the opportunity to rezone the paddock, by altering the relative proportions of each zone, in an attempt to increase the relative yield differences between the zones and associated fertiliser inputs.

With 4 years of yield monitor data from the variable rate case study paddock N1 at MAC we thought it timely to evaluate the performance of our variable rate strategy by asking the following questions:

1. How well did the original zone map perform over the 4 years?
2. Is there evidence to suggest that the paddock needs rezoning?
3. What is the economic impact of the current paddock zoning compared to rezoning?
4. What is the capital investment of PA and the estimated return on investment?
5. What is the annual cost associated with using PA?

How was it done?

Paddock N1, at MAC, was segregated into 3 zones in 2008 using a combination of yield, EM38 and elevation maps to produce 3 distinct production zones (good, medium and poor). In each year, 2008 to 2011, low, standard and high seed and fertiliser rates were sown in alternating 9 m seeder rows across the paddock.

Wheat was sown in 2008, 2009 and 2010, Hindmarsh barley on 4 May 2011 (Table 1). The 3 rates of seed and fertiliser were applied in the same seeder rows in each of the 4 years. In 2011 foliar N was applied as recommended by Yield Prophet® on 4 July at growth stage (GS) 31 to the high input treatment and to the high and standard input treatments on 4 August at GS37 (Table 1). Inputs in the previous 3 years are documented in EPFS Summaries 2008, 2009 and 2010. The paddock received standard weed control across all zones in all years.

Table 1 The percentage of paddock within each 2008 zone map, seed and fertiliser rates, and mid season foliar N applications

Paddock Zone	Paddock Area (%)	Input strategy	Barley seed rate (kg/ha)	DAP (kg/ha)	Foliar N 4 July 2011 (kg/ha of N)	Foliar N 4 August 2011 (kg/ha of N)
Good	52	High	50	60	21	13
		Standard	50	40	0	13
		Low	40	nil	0	0
Medium	22	High	50	60	21	13
		Standard	50	40	0	13
		Low	40	nil	0	0
Poor	26	High	50	60	21	13
		Standard	50	40	0	13
		Low	40	nil	0	0

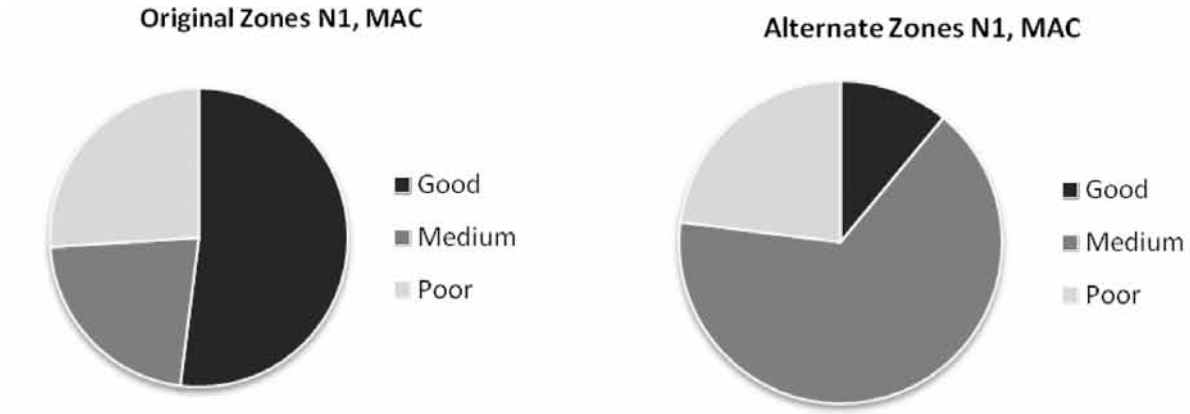

Figure 1a & b Paddock percentage represented by the 3 production zones in the original zone map (left) and the alternate zone map (right)

Table 2 2011 soil P and N levels in 3 original zones following fertiliser inputs in 2008, 2009 and 2010

Zone	Colwell P 0-10 cm (mg/kg)			Total mineral N 0-60 cm (kg/ha)		
	High	Standard	Low	High	Standard	Low
Good	30	37	29	46	53	37
Medium	28	39	28	124	93	78
Poor	33	35	37	54*	78	52*

* *0-40 cm only due to rocks*

To compare the original zoning, and evaluate if farmers could commence using VRT without the expense of EM38 mapping, an alternative second zone map was created from the 2009 yield monitor map. The header has a 9 m front that harvests each alternate 9 m sown strip independently, allowing accurate data in relation to the 3 treatments applied across each zone. The yield monitor readings were calibrated to align with total paddock tonnages delivered to the receival point to ensure accuracy.

The original map had 52% zoned "good", 22% "medium" and 26% "poor" of the 64 hectare N1 paddock (Table 1 and Figure 1a). The alternate zone maps created by using the 2009 yield monitor zoned 11%, 66% and 23% as "good", "medium" and "poor" respectively (Figure 1b.).

What happened?

Phosphorus levels measured prior to seeding in 2011, within the original map zones, were similar in the poor zone irrespective of previous high, medium and low (2008 – 2010) inputs (Table 2). Phosphorus levels were higher in the good and medium zones with standard inputs compared to low and high inputs (Table 2).

Total nitrogen tended to be higher in the medium and poor zone compared to the good zone. P and N levels in the previous 3 years are documented in EPFS Summaries 2008, 2009 and 2010.

In a dry year, 2008, the original zone map has calculated the medium zone producing yields similar to the poor zone; however in an average, 2011, and above average growing season rainfall years, 2009 and 2010, the medium zone produced yields similar to the good zone (Table 3).

Compared to the original zone map, the alternate map calculated less variation in yield between zones in 2008, with an increase in yield for the medium and poor zone in 2008 (Table 3). In the following three years it calculated an increased variation between zones with higher yields in the good zone and lower in the poor zone.

Table 3 Grain yield (t/ha) from the 3 paddock zones with low, medium and high inputs using the original (Orig) and 2009 alternate (Alt) zone maps

Zones	Input strategy	2008 Yield (t/ha)		2009 Yield (t/ha)		2010 Yield (t/ha)		2011 Yield (t/ha)	
		Orig	Alt	Orig	Alt	Orig	Alt	Orig	Alt
Good	High	0.65	0.65	4.1	**4.8**	3.6	**3.8**	3.1	**3.3**
	Standard	0.64	0.61	4.1	**4.9**	3.5	**3.7**	2.9	**3.1**
	Low	0.59	0.59	3.7	**4.8**	3.2	**3.5**	2.9	**3.1**
Medium	High	0.40	**0.54**	4.0	4.1	3.6	3.6	3.1	3.1
	Standard	0.34	**0.53**	4.1	4.1	3.6	3.5	3.1	3.0
	Low	0.38	**0.50**	4.0	3.9	3.4	3.3	3.0	3.0
Poor	High	0.39	**0.47**	3.6	**3.1**	3.0	**2.7**	3.0	**2.6**
	Standard	0.40	**0.47**	3.6	**3.1**	2.9	**2.6**	2.6	**2.4**
	Low	0.36	**0.45**	3.4	**3.0**	2.7	**2.5**	2.8	**2.2**

***Bold values** indicate a significant yield difference from the original to the alternate zone map.*

Gross margins followed the yield trends with the alternate zone map increasing returns from the "good" zone and reducing returns from the "poor" zone, but there was little variation in the "medium" zone (the exception for the medium zone being 2008, where the higher yields are reflected in the improved returns). The low (nil) fertiliser input treatment generally maintained a similar or higher gross margin in all zones (Table 4).

To explore what, if any, advantages can be gained by applying VRT a number of combinations of input level by production zone, and the effect of these combinations on gross margins are outlined in Table 5. The combinations used in calculations are presented in Table 5 as 'Go for Gold!' and 'Hold the Gold!'

The VRT -'Go for Gold!' aim is to increase overall profitability by reducing inputs on areas with poorer yield potential and increasing on high potential areas. The VRT – 'Hold the Gold!' treatment keeps inputs at standard (good zones) and low (medium and poor zones), an approach to reduce risk.

These two VRT combinations were then compared to the gross income of a standard blanket treatment if the different treatments had been applied to the whole paddock (Figure 2), taking into consideration the percentages of each zone within the paddock as summarised earlier in this article (Figure 1). The low, standard and high inputs for 2011 are presented in Table 1.

Table 4 Gross margins (GM) ($/ha) from the 3 paddock zones with low, medium and high inputs using the original (Orig) and 2009 alternate (Alt) zone maps

Zones	Inputs	2008		2009		2010		2011	
		GM ($/ha)	GM ($/ha)	GM ($/ha)	GM ($/ha)	GM ($/ha)	GM ($/ha)	GM ($/ha)	GM ($/ha)
		Orig	Alt	Orig	Alt	Orig	Alt	Orig	Alt
Good	High	25	28	688	**842**	605	**742**	335	**375**
	Standard	48	40	725	**899**	693	**755**	354	**398**
	Low	62	62	735	**948**	643	**724**	418	**464**
Medium	High	-41	-12	679	686	616	618	352	352
	Standard	-15	19	727	721	650	638	394	377
	Low	0	29	675	747	794	767	439	437
Poor	High	-32	-19	563	**462**	468	**401**	324	**253**
	Standard	-10	3	602	**497**	487	**407**	310	**256**
	Low	13	26	637	**546**	466	**401**	393	**290**

Gross income is yield x price delivered cash 1 December 2008, 2009, 2010 and 2011, Pt Lincoln less all input costs. $350/t used for seed value for wheat and $220/t used for seed value for barley.
***Bold values** indicate where the alternate zone map has made potential improvements in the value of the VRT through increasing the yield variations between zones.*

Table 5 Treatments applied to VRT gross income analysis

Paddock Zone	VRT - Go for Gold!	VRT - Hold the Gold	High input blanket approach	Standard input blanket approach	Low input blanket approach
Good	High	Standard	High	Standard	Low
Medium	Standard	Low	High	Standard	Low
Poor	Low	Low	High	Standard	Low

What does this mean?

1. On returning to the original questions:

How well did the original zone map perform over the 4 years?

The original zone map correctly projected a good zone in 2008 as opposed to medium and poor zones that had similar yields (Table 3). In 2009 and 2010 the good and medium zones had similar yields, the poor zone generally lower yields. In 2011 there was little variation between zones. Therefore, the original zone map correctly identified the opportunity to apply extra inputs to the good zone in 2008 and lower inputs in the poor production zone in 2008, 2009 and 2010 (Table 3).

2. Is there evidence to suggest that the paddock needs rezoning?

The value of the VRT is controlled by identifying zones within paddocks of significantly different production potential whereby inputs can be tailored to the potential yield. The medium zone produced similar yields to the good zone over the 2009 to 2011 period in the original zone map irrespective of the level of input (Table 3). Therefore there was the opportunity to alter the zone structure to reduce inputs on a least a proportion of the good zone in line with the medium zone in those seasons of average and above average rainfall. In the dry 2008 season the zone map never differentiated between the yields of the medium and poor zones providing a further indication of potential for rezoning improvement between those 2 zones to reduce inputs on at least a proportion of the medium zone.

It is important to ensure that the zones are correctly identified, as reducing inputs and drawing on nutritional reserves in paddocks with high P reserves is an easy way for farmers to reduce risk while not losing any crop potential, and matching zone inputs to early seasonal conditions may be of benefit in the future. Rezoning the paddock by using a yield map only was also explored to see if farmers could commence using VRT without the expense of EM38 mapping, which is an option.

3. What is the economic impact of the current paddock zoning compared to rezoning?

Using the original zone map the "Hold the Gold" approach resulted in a return $84/ha more than the standard input blanket approach over 4 years, 2008-2011. This increased to $210/ha with the alternate 2009 map. This improvement in gross margins is due to more hectares being included in the medium zone in the alternate zone map and therefore a larger proportion of the paddock has not received any fertiliser over the 4 years. By using the alternate zone map there was a slight reduction in profitability using the "Go for Gold" approach compared to the original zone map, but remains similar to the standard input blanket approach.

In N1 over the 4 years of data collection the most profitable treatments were the "Hold the Gold" alternate zone map and the low (nil fertiliser) input regime over all zones (Figure 1). Given the excellent fertiliser history at MAC, the lack of response to no fertiliser is not typical of many farms across the upper EP, so undertaking this approach on other paddocks would require soil testing of nutritional reserves.

4. What is the capital investment of PA and the estimated return on investment?

To enable the application of variable rate, a capital investment in GPS guidance and a variable rate controller on the seeder is required. The cost of GPS guidance ranges from $14,000 for a sub metre guidance system (this can also include an annual subscription cost to access satellites) to $20,000 for RTK for 2 cm accuracy (with no additional annual costs). The cost of the variable rate controller starts at approximately $9,000 for a hydraulically driven 2 tank seeder box and $15,000 for uni-electric drive 2 tank seeder box. Software to communicate between the variable rate controller and the zone map is approximately $1000. The total cost of investment is approximately $40,000.

The return on investment if the comparison is made between a conservative (standard) blanket fertiliser approach and the alternate "Hold the Gold" strategy was approximately $50/ha/year. If this increase was spread over 1000 hectares, the figures look good in a paddock with high P reserves.

However it must be highlighted that the "Hold the Gold" strategy projected fertiliser on only 11% of the total good area and should only be used in a situation where there are high levels of soil fertility, and if used would need to be monitored carefully to ensure nutrient reserves do not run down to deficient levels.

The other comparison may be the "Go for Gold" strategy which has high, standard and low (nil) fertiliser inputs applied to the good, medium and poor zones respectively with the high and standard blanket treatments. Given the lack of response to higher fertiliser rates in this paddock there was no advantage in using this approach over the standard blanket approach, but due to the reduced input costs there is an advantage using this approach over the high input blanket approach.

5. What are the annual costs of using PA?

There is an annual expense of roughly $2/ha to employ a consultant to ensure the business is gaining full benefit from the system by running any analysis on trials and potentially fine tuning of zones.

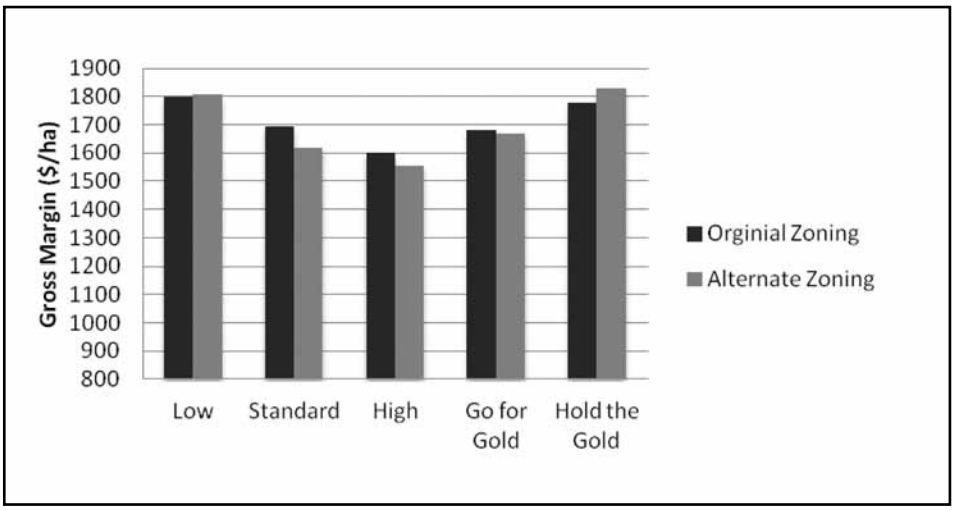

Figure 2 Comparison of the cumulative gross margins of different sowing regimes 2008-11 using the original 2008 zone map and the alternate 2009 yield zone map. Note: Y axis scale starts at $800.

The difference in gross margins under the blanket input treatments is due to the variation in mean yields and the difference in zone area represented under the different maps; when multiplying out these values to calculate the gross margins any differences are accentuated.

Over the 4 years of evaluation the lack of response to applied P irrespective of zone has limited any gross margin benefit from separating production areas. This could be due to the Colwell P levels in this paddock continuing to be maintained at greater than a 27 mg/kg "critical" response to applied P level (Holloway, pers. com.). Reducing the "good" area with the 2009 alternate zone map to 11% of total area as opposed to 55% in the original zone map has supported a slightly higher gross margin to a low (nil) blanket fertiliser strategy; however the benefit may not warrant the capital and ongoing cost associated with the technology.

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