Responsive Farming Using Variable Rate Sowing at Minnipa

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RESEARCH

Location: Minnipa Ag Centre
Rainfall
Av Annual: 325 mm
Av GSR: 242 mm
2010 Total: 410 mm
2010 GSR: 346 mm

Yield
Potential: 4.7 t/ha (W)
Actual: 4.1 t/ha (medium zone - standard input)

Paddock History
2009: Wheat
2008: Wheat
2007: Wheat

Soil Type
Sandy loam to sandy clay loam

Plot size
Paddock trial, sowing widths 9 m

Yield Limiting Factors
Rhizoctonia
Mice damage
Yellow leaf spot

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 message

- **After two good seasons a variable rate approach is as profitable as a low input blanket approach and more profitable than a standard blanket approach.**

Why do the trial?

It is important that low rainfall farming systems are low risk, flexible and responsive. Paddock inputs need to balance the best agronomic and economic advice with the need to ensure reliable outcomes at low cost. Paddock North 1 (N1) at Minnipa Agricultural Centre, one of three focus paddocks in the current farming systems project, is being used to evaluate variable rate technology using low, standard and high seed and fertiliser inputs on 3 soil types of poor, medium and good production potential. Yield Prophet® decision support simulations are being used to make decisions relating to in-crop fertiliser inputs. This also provides a comparative measure between physical crop measurements (water use, grain yield etc.) and model simulations to help validate the model outputs for our environment.

Variable rate technology (VRT) offers farmers the ability to adjust sowing and fertiliser rates during the seeding process, allowing the opportunity to change inputs according to the production capability of different paddock zones or soil types. One basis for developing the variable rate strategy has been previous research investigating crop canopy size effects on crop growth and yield on different soil types. For example this research has shown that in a poor season, like 2006, grain yield increased with smaller canopies on heavy/shallow soil types (EPFS Summary 2006 p 91-92). This means that a lower seeding rate, with less fertiliser was more profitable on the shallow constrained soils in a paddock as opposed to a paddock wide blanket fertiliser and seeding rate.

To further evaluate variable rate sowing as a tool to improve profitability in low rainfall upper EP farming systems, this broad acre trial began in 2008 and has continued through to 2010.

How was it done?

Paddock N1, at Minnipa Agricultural Centre, 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). Soil chemical analysis was carried out on the soils within these zones to document the extent of any chemical constraints. In 2010 seed and fertiliser rates for each zone were maintained at similar levels to 2009 (Table 1). Low, standard and high seed and fertiliser rates were sown in alternating 9 m seeder row strips across the paddock with Wyalkatchem wheat on 4 June, in the same positions as those treatments in 2008. Due to the high mice numbers the paddock was prickle chained in an attempt to reduce mice collecting seed. Foliar N (UAN@10 units of N/ha) was applied on 17 August at growth stage 31 to the high input treatment. This was in line with Yield Prophet® growth stage 31 outputs as to the N requirement to achieve optimum grain yield. The paddock received standard weed management across all zones.

Table 1 Sowing and mid season seed and fertiliser rates in paddock N1 at Minnipa, 2010

Paddock Zone	Paddock Area (%)	Input strategy	Seed Rate (kg/ha)	DAP (kg/ha)	Foliar N (kg/ha of N)
Good	55	High	65	60	10
		Standard	65	40	0
		Low	55	nil	0
Medium	20	High	65	60	10
		Standard	65	40	0
		Low	55	nil	0
Poor	25	High	65	60	10
		Standard	65	40	0
		Low	55	nil	0

Measurements collected were soil chemical analysis, plant establishment, early tillering, anthesis and maturity dry matter, grain yield and quality and soil water content at seeding and harvest. Calculations of gross margins and the YieldProphet® projections are also presented.

What happened?

Pre-seeding Colwell P levels tended to be lower in the good zone as compared to the other zones. Within each zone P levels were similar irrespective of the 2008 and 2009 P treatments (10, 5 and nil kg) P rates applied to the same sites in 2008 and 2009. There was more total mineral N measured in the medium zone than the good or poor zones (Table 2). The 2008 analysis of the depth to chemical plant root constraints is shown in Table 2.

The anticipated plant density based on seeding rate was 120 plants/m^2 for the low input and 150 for the standard and high input treatments. However, due to mice damage and the prickle chaining to protect sown seed from mice there was only 60-70% of the anticipated plant density established (Table 3). The low input treatment had lower plant numbers in all zones than the high and standard treatments, as a result of the lower seeding rate.

The lower seeding rate reduced the biomass production of the low input system. The medium zone with standard inputs produced more biomass than the good zone at all sampling times. The poor zone produced less than the medium zone at the anthesis and maturity sampling times. This biomass production reflected the higher nitrogen figures measured in the medium zone.

Soil water contents measured at sowing showed the medium and poor zones had greater volumetric soil water content in the 0-40 cm soil profile (more than 20 mm compared to 13 mm in the good zone). The anthesis biomass was similar for the 3 high input treatments, but the poor zone had less biomass at harvest. This may be due to the shallow soil profile and possible soil water deficit in late September, through October (late dough stage). However 55 mm of rain in late October masked any measurable difference in plant available water between treatments.

Table 2 Soil characterisations for zones in paddock N1, Minnipa 2010

Zone	Colwell P 0-10 cm (mg/kg)			Total Mineral N 0-60 cm (kg/ha)			*Depth to soil $CaCO_3$ > 25% (cm)	* Depth to B > 15 mg/kg (cm)	* Depth to Cl > 1000 mg/kg (cm)
	High	Standard	Low	High	Standard	Low			
Good	32	34	29	124	117	108	60	100	80
Medium	38	37	37	215	220	186	40	60	60
Poor	39	38	37	93	88	65	20	80	40

** 2008 Data*

Table 3 Plant establishment, biomass at tillering, anthesis and maturity from the 3 paddock zones for each 2010 input strategy

Zones	Inputs	Establishment (plants/m²)	Dry matter (t/ha)		
			Early Tillering	Anthesis	Maturity
Good	High	106	0.7	6.7	7.1
	Standard	109	0.7	5.5	6.9
	Low	74	0.4	4.3	6.7
Medium	High	129	1.1	7.2	7.5
	Standard	106	1.0	6.5	7.8
	Low	76	0.6	4.4	6.2
Poor	High	109	1.1	6.8	5.9
	Standard	124	1.1	5.3	5.7
	Low	81	0.5	4.3	5.9
LSD (P=0.05)		*11*	*0.1*	*0.8*	*0.5*
Good		97	0.6	5.5	6.9
Medium		104	0.9	6.0	7.1
Poor		105	0.9	5.4	5.7
LSD (P=0.05)		*NS*	*0.1*	*0.6*	*0.4*
	High	115	1.0	6.8	6.8
	Standard	113	1.0	5.8	6.8
	Low	77	0.5	4.3	6.3
LSD (P=0.05)		*7*	*0.1*	*0.4*	*0.4*

Table 4 Grain yield, harvest index, grain quality and gross income from the 3 paddock zones with low, standard and high inputs

Zones	Inputs	Grain Yield (t/ha)	Protein (%)	Test Wt (kg/hL)	Gross Margin[1] ($/ha)
Good	High	3.9	10.1	74.9	959
	Standard	3.7	10.2	74.7	939
	Low	3.3	10.0	74.1	892
Medium	High	3.9	11.3	72.2	889
	Standard	4.1	10.8	73.3	973
	Low	3.8	10.5	74.3	999
Poor	High	2.9	10.7	72.3	639
	Standard	2.7	10.0	72.5	623
	Low	2.7	10.5	72.9	656
LSD (P=0.05)		*0.8*	*0.7*	*NS*	
Good		3.7	10.1	74.9	
Medium		3.9	10.8	73.3	
Poor		2.7	10.4	72.6	
LSD (P=0.05)		*0.8*	*0.5*	*NS*	
	High	3.6	10.7	73.1	
	Standard	3.5	10.5	73.5	
	Low	3.2	10.2	74.2	
LSD (P=0.05)		*0.2*	*0.4*	*NS*	

[1] Gross margin is yield x price less seed and fertiliser costs delivered to cash pool on 2 December 2010, Pt Lincoln. $350/t used for seed value

The poor zone produced lower grain yields than the good and medium zones irrespective of treatment (Table 4). Grain protein levels from the medium zone were similar or higher than from the good and poor zones. The test weights of the good zone were all above 74 kg/hL, but lower for the poor and medium zones. Screenings were less than 2% irrespective of treatments. Gross margins were obviously correlated with yield, but with adjustment for test weights less than 74 kg/hL.

Yield Prophet® reports were run for the 3 soil zones on 2 dates over the growing season, 4 August (early tillering) and 27 September (anthesis) (Table 5). The estimated biomass was similar or higher than the actual biomass produced and the predicted grain yield was similar or lower (10% probability) than the harvested yields for all zones.

The treatments applied to VRT combinations used for gross margin analysis are outlined in Table 6. The '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 (Table 6) taking into consideration the percentage of each zone within the paddock as outlined in Table 1.

Both VRT approaches were more profitable in 2010 than if any of the input strategies had been applied across the whole paddock. After 2 consecutive good growing seasons the low input approach maintains a similar profit level to the variable rate treatments (Figure 1).

Table 5 Yield Prophet® biomass and grain yield projections (from 90 – 10% probability) at tillering and anthesis, rainfall decile ranking and measured biomass and grain yields on the 3 soil zones in 2010

Date	Zone	Biomass projections (t/ha)	Measured biomass (t/ha)	Grain yield projections (t/ha)	Measured grain yield (t/ha)	Decile ranking
4 August (tillering)	Good	1.4	0.6	0.5 - 3.5	3.7	5
	Medium	1.4	0.9	0.5 - 3.5	3.7	
	Poor	1.2	0.9	0.5 - 2.2	2.7	
27 September (anthesis)	Good	6.0	5.5	3.0 - 3.8	3.7	8
	Medium	7.4	6.0	2.5 - 3.8	3.9	
	Poor	5.0	5.4	1.6 - 2.1	2.7	

Table 6 Treatments applied to VRT gross income analysis for N1, Minnipa 2010

Paddock Zone	VRT - Go for Gold!	VRT - Hold for 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
2010 Gross margin ($/ha)	903	885	864	865	877
Accumulated gross income (compared to standard input treatment) ($/61ha paddock)	2365	2405	-3991	0	2440

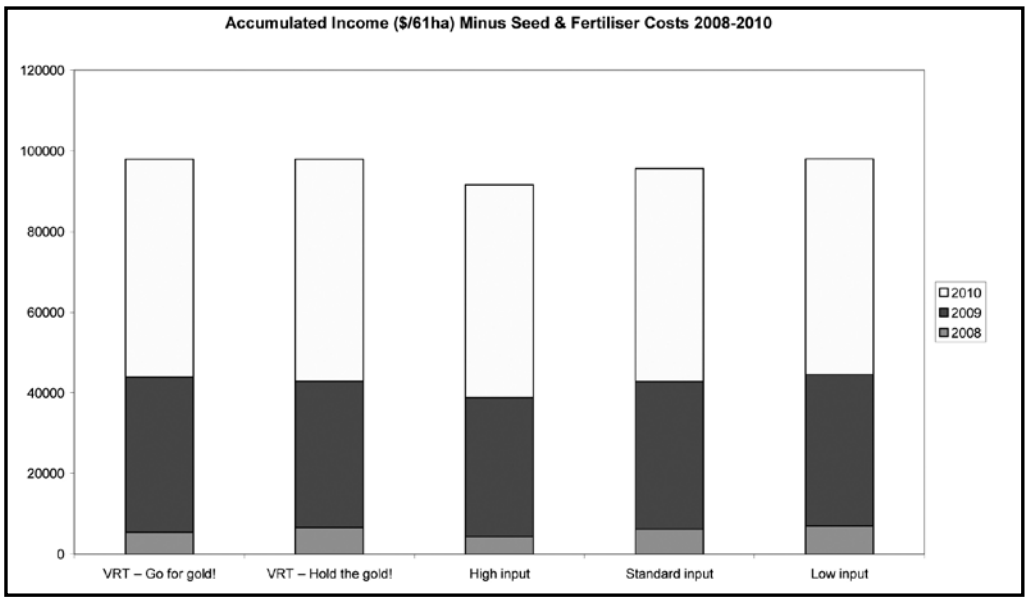

Figure 1 Comparison of accumulated income minus seed and fertiliser costs of different sowing regime vs. VRT rates across the whole 61 ha paddock.

What does this mean?

In 2010, the second consecutive above average growing seasons, the VRT 'Go for gold!' approach was the most profitable. The previous 2 years a low input approach was the most profitable due to low yields in 2008 (EPFS 2008 pp 77-80), in 2009 there were high levels of available soil nutrients due to the run of 3 poor seasons (EPFS 2009 pp 87-90) and thus only low levels of nutrition required to obtain yields. The conservative VRT approach -'Hold the gold!' is as profitable as the 'Go for gold!' approach, but carries a much lower level of risk due to the reduced input costs.

The Yield Prophet® projections under-predicted the grain yields in all zones and gave too wide a range of yields to be of value in terms of crop response to additional N early in the season. As the season progressed the range of yields narrowed, and may have been of some use if a decision about the application of a rust spray later in the season was required.

The impact of these treatments will be monitored in this paddock for at least the next 2 years to track the long term impact of changing inputs, how the different zones respond to different treatments in different seasons, and how the overall economics stack up.

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