Precision Agriculture ASSOCIATION

Precision Ag Trials

Nutrient type and rate

Paringa-Murtho, South Australia

Although PA tools have been available to Australian grain growers for many years, and the benefits have been well documented, it is estimated that less than 1-% of grain growers utilise PA 'beyond guidance' in any form.

The objective of this GRDC / SPAA funded project is to increase the level of adoption of PA 'beyond guidance' by broadacre farmers. The project specifically aims to increase the level of adoption of variable rate (VR) by growers in the project to 30% by 2013. This goal will be achieved by demonstrating how to use PA tools to growers at a regional level and by increasing the skills of growers and industry in PA to a level where they can then use PA tools in their farming systems to achieve economic, environmental and social benefits.

Trials and demonstrations are conducted on growers' properties and are visited throughout the season using farm walks and workshops to discuss the advantages and disadvantages of PA techniques with the involvement of other regional growers.

This information sheet presents the outcomes of the SPAA trial Precision Ag, Paringa-Murtho from season 2010.

Aims:

- To encourage Mark Stoeckel, Paringa-Murtho grain grower, to test a small range of nutrient and rate treatments on his paddock.
- To use precision yield mapping to provide an accurate analysis of the trial.
- Te demonstrate Precision Agriculture technologies, especially Variable Rate to demonstrate reduced risk and maximised return in continuous cropping systems.
- Show the benefits of using EM38 and 'Your Soils Potential' soil testing service to map subsoil constraints.
- To demonstrate and extend the benefits of precision agriculture technology to SA Mallee growers..

Background:

Paringa-Murtho cereal grower, Mark Stoeckel, has been keen to find those varieties or fertiliser rate or Nitrogen application that have a yield impact in his Belah type country. Mark was keen to determine the cause of low yield performance of his West Chamberlain paddock and to remedy the cause. Together with Rural Solutions SA Mark has been experimenting on his farm in order to help understand what is driving the production in his paddock.

West Chamberlain paddock is a 137 ha parcel of undulating Belah-type country incorporating rises and heavy flats. Surface texture over most of the paddock is sandy loam but soil depth and sub soil textures vary from light sandy clay loam to medium clay increasing the soil holding capacity of the soils. However, estimated unavailable water level increase as constraints to plant growth such as sodicity, salinity, high pH and boron begin to appear in the sub soils in the lower mid-slopes and increase in the flats.

From 2008 we had the following information about the paddock:

- EM38 soil data
- Soil physical and chemical tests from six areas in paddock (0-10, 20-40, 40-60 and 60-80 cm fractions)
- Paddock zone map developed from "Your Soils Potential" model.

In 2010 we produced

- Wheat yield map of paddock
- Yield analysis of treatments by paddock zone

About the trial:

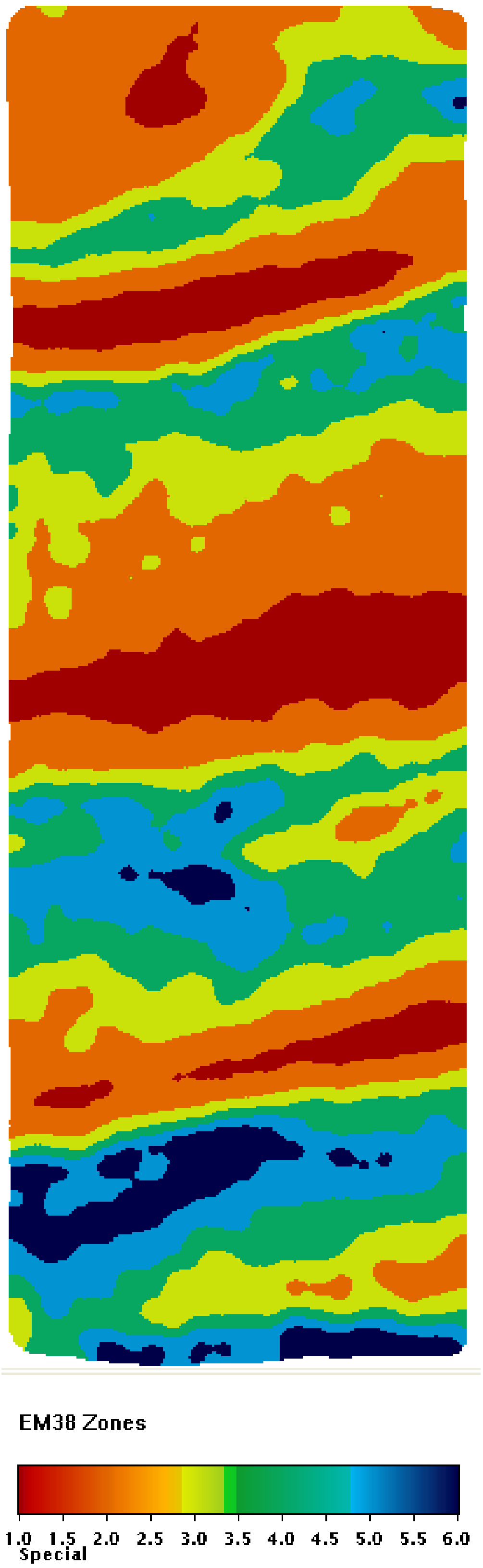
In 2010 Mark Stoeckel designed a replicated trial to test a range of fertiliser treatments at Paringa in the SA Northern Mallee. All treatments except 3 (late sow) were sown on 8th May 2010 as a 50' seeder strip down the length of the paddock. Trial was harvested with yield monitoring on 23rd December - one 42' header width was harvested per seeder strip. Grain samples were collected from three zones during harvest (Rises, Mid-slopes and Flats) and with assistance from Viterra were analysed for protein, test weight, screenings and moisture.

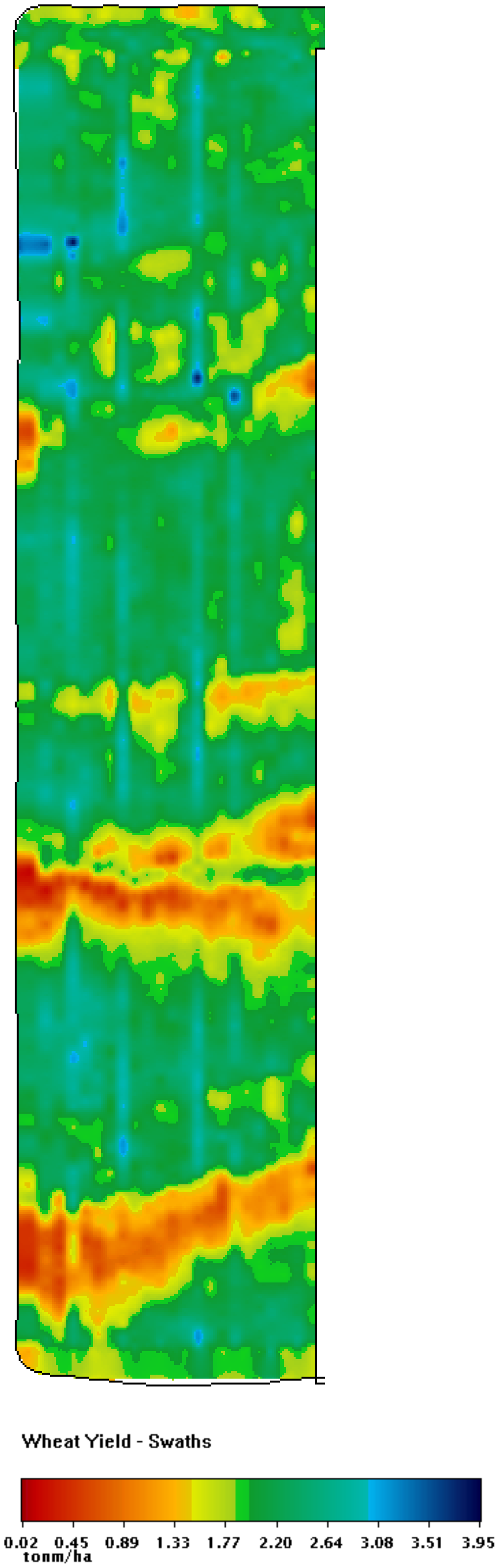
Table 1 Trial treatments and layout of nine treatments and up to three reps. Treatments were sown North to South on 8th May 2010. Dates are shown for post treatments (post Urea and late sowing).

Seeder Run	Rep	Trt #	Trt name	Seed	seed rate (kg/ha)	Fert type	Fert rate (kg/ha)	Dates
1	1	2	low seed	Gladius Zn	42	DAP	45	
2	1	5	control	Gladius Zn	45	DAP	45	
3	1	6	late sow	Gladius Zn	45	DAP	45	3-Jun
4	1	8	high fert	Gladius Zn	45	DAP	60	
5	2	2	low seed	Gladius Zn	42	DAP	45	
6	1	3	no fert	Gladius Zn	45	DAP	0	
7	1	7	post urea	Gladius Zn	45	DAP	45	90kg 14 jul
8	1	4	low fert	Gladius Zn	45	DAP	30	
9	1	1	no zinc	Gladius	45	DAP	45	
10	2	5	control	Gladius Zn	45	DAP	45	
11	2	1	no zinc	Gladius	45	DAP	45	
12	2	8	high fert	Gladius Zn	45	DAP	60	
13	2	7	post urea	Gladius Zn	45	DAP	45	90kg 14 jul
14	2	3	no fert	Gladius Zn	45	DAP	0	
15	2	4	low fert	Gladius Zn	45	DAP	30	
16	2	6	late sow	Gladius Zn	45	DAP	45	3-Jun
17	3	5	control	Gladius Zn	45	DAP	45	
18	3	2	low seed	Gladius Zn	42	DAP	45	
19	1	9	'oliar coppe	Gladius Zn	45	DAP	45	2 lt
20	3	1	no zinc	Gladius	45	DAP	45	

Fig 1. Your Soils Potential zones on West Chamberlain paddock, developed from EM38 and soil analyses, Paringa

Fig. 2. Yield swath map of trial area in West Chamberlain paddock.





Assessments: Grain Yield

Results:

Grain yield was recorded continuously during harvest and logged against GPS position. From the resultant yield map it was possible to isolate treatment strips and zones within these strips and determine the yield for individual strips and therefore treatments, and also where these treatments intersect with the paddock zones. Trail was analysed using a General Linear Model in order to handle the unequal number of replications in the trial. The letters show the statistical groupings for the treatments and zones. There were strong significant statistical differences between treatments and zones.

Table 2 Grain yield for each treatment by paddock zone. In later tables zones are grouped together as sand rise, midslope and flat.

Yield t/ha	Zones							
	Sand rise		Mid slopes		Flats			
Name	1	2	3	4	5	6	mean	
Control	1.45	1.68	1.70	1.50	1.08	0.93	1.49	b
Copper	1.40	1.70	1.70	1.50	1.10	1.30	1.51	c
High Fert	1.70	1.76	1.85	1.56	1.10	0.90	1.59	b
Late sow	1.60	1.90	2.03	1.91	1.55	1.30	1.81	a
Low fert	1.30	1.65	1.64	1.56	1.15	0.90	1.47	c
Low seed	1.54	1.75	1.80	1.57	1.08	1.00	1.59	b
No fert	1.32	1.60	1.63	1.56	1.05	1.07	1.46	c
No zinc	1.43	1.64	1.66	1.50	1.03	0.95	1.47	b
Post Urea	2.18	2.10	2.10	1.80	1.24	1.17	1.89	a
Mean	1.54	1.75	1.79	1.60	1.14	1.04	1.58	
	b	a	a	b	c	d		
		Trt	Zones					
Sig. (P ≤ 0.05)		0.0000	0.0000					
LSD (5%)		0.080	0.0978					
CV %		9.9						

Table 3 Yield expressed as percent of Control. Zones have been combined into 3 zones

Name	Rise	Mid slope	Flat	Mean
Control	100	100	100	100
Copper	98	101	110	102
High Fert	108	107	98	107
Late sow	113	124	140	121
Low fert	96	100	102	99
Low seed	106	106	101	107
No fert	95	100	101	98
No zinc	97	98	97	98
Post Urea	131	123	116	127
LSD				5

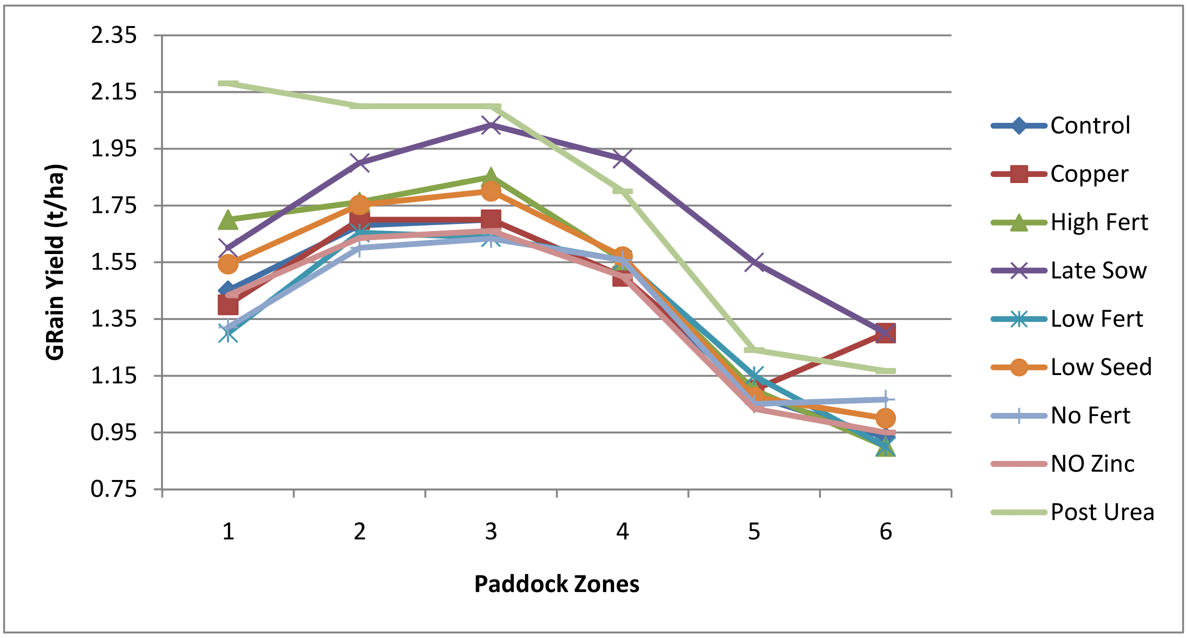


Figure 1 Grain yield for treatment by paddock zones.

Discussion

It can readily be seen in Table 2 that while there were strong treatment effects the effect of the paddock zones on grain yield was also very strong. This is also apparent in a number of other precision ag. trials we have analysed, and growers would know and understand that various parts of a paddock respond differently in different seasons. Because of the limitations of machinery and technology up to this point growers have largely had to treat paddocks as one unit in the one operation. Other options were to fence the hills off and treat them differently, or sow rye on the hills and another crop in the flat. The options were generally expensive and time consuming.

The Sand rises are generally lower in nutrient, lighter in soil texture, but have no soil constraints. They are generally responsive to nutrient inputs. The Mid-slopes are higher in nutrient than the rises and again have low levels of soil constraints. The Flats are heavier textured with often high to very high a nutrient levels, however they often have constraints limiting root growth or prevent roots accessing the nutrients, such as boron, high pH, salts, sodicity, or physical layers such as class 2 calcrete

Variable rate combined with defined and well understood paddock zones can, as this trial shows, reap significant benefits in grain and gross margin. Peter Treloar, from his precision agriculture work in the Mallee made the following conclusions regarding farming to paddock zones in this way:

- Is not about trying to even up the yields across the paddock,
- It's about recognising and understanding the variations in yield potential.
- And applying the appropriate inputs to best allow that potential to be reached.
- It's not always about applying more fertiliser, but rather redistributing inputs into the areas of greatest potential return.

Table 4 below shows the large gross margins between paddock zones e.g. Control Rise ($323.95 return per ha) compared with Control Flat ($187.70 return per ha) a difference of $137.25. In this paddock the flats are quite unresponsive to P and we see that if we applied no fertiliser to the Flat we improved the GM to $221.67 return per ha. This is an advantage of $33.97 per ha.

This trial also shows that the flats are consistently lower yielding than the rises and mid-slopes despite the amount of growing season rainfall. In the drought year of 2009 (162mm growing season rainfall) the flats yielded on 68% of the rises and mid-slopes.

In Table 6 I have constructed a scenario which shows variable rate fertiliser against a flat rate fertiliser application extended over the whole paddock. In order to construct this table a variable rate prescription is devised and the yield results of the 2010 trial are used. If the variable rate prescription results are applied over the whole West Chamberlain paddock then variable rate would grow 19.394 t more grain than Flat Rate, using 1.864 t more fertiliser. Simple Gross Margin per ha of variable rate over flat rate is $29.72.

This scenario in Table 6 demonstrates the result of redistributing the inputs between the various paddock zones – targeting those areas responsive to increased fertiliser and reducing inputs in the unresponsive areas – usually the zones with lower unavailable water capacity.

In 2010 there were strong treatment effects – the best being Urea applied post sowing and the late sowing. Conventional wisdom and practice would suspect that late sowing is not a real option every year. Most growers would understand the yield penalties for sowing much later than the optimum seeding time in the Northern Mallee are considerable. For the past four years (2006 -2009) because of the droughts and low yields the best gross margins have been achieved with zero fertiliser application.

Late sowing and zero fertiliser are not broad recommendations that I would make. This trial clearly shows the advantages of making strategic nutrient inputs based on a good understanding of the paddock.

Post Urea application, despite the risk of volatilisation, from this and the 2009 trial shows very promising results in wet and dry seasons.

Take Home Message:
Variable rate fertiliser application has a real and profitable place in the Mallee when combined with good paddock science.

The precision technology gives the ability to examine the yield data for many effects including other possible influencing factors such as elevation, slope aspect or orientation to the sun, and probably many others.

Table 4 Yield, water use efficiency, grain quality and simple gross margins for treatment by combined zone. Grain price is as at 1 December, Cash, Port Adelaide. All grain was shot and therefore paid as Feed1 price.

Financial Analysis -Yield and Quality

Treatment	**Zone**	DAP kg/ha	Urea kg/ha	**Yield t/ha**	**% Control**	**Strip Yield**	**WUE kg/mm**	**Protein**	**Scrn**	**TW**	**Pay Grade**	**farm gate $/tonne**	**$/ha Return**	**$/ha Fert cost**	**$/ha GM**
Low seed	Rise	45		1.703	106	1.587	10.4	9.0	0.4	72.4	Feed1	210.00	357.70	33.75	323.95
Low seed	Mid slope	45		1.695	106		10.3	10.3	0.5	72.6	Feed1	210.00	356.05	33.75	322.30
Low seed	Flat	45		1.055	101		6.4	11.7	1.1	72.2	Feed1	210.00	221.45	33.75	187.70
Control	Rise	45		1.614	100	1.489	9.8	9.2	0.4	72.2	Feed1	210.00	339.00	33.75	305.25
Control	Mid slope	45		1.600	100		9.8	10.5	0.6	73.2	Feed1	210.00	336.00	33.75	302.25
Control	Flat	45		1.046	100		6.4	11.9	0.9	72.4	Feed1	210.00	219.69	33.75	185.94
Late sow	Rise	45		1.821	113	1.807	11.1	8.4	0.8	72.4	Feed1	210.00	382.42	33.75	348.67
Late sow	Mid slope	45		1.981	124		12.1	9.4	0.8	74.0	Feed1	210.00	416.06	33.75	382.31
Late sow	Flat	45		1.467	140		8.9	10.9	0.9	74.8	Feed1	210.00	308.00	33.75	274.25
High fert	Rise	60		1.744	108	1.593	10.6	9.4	0.5	72.4	Feed1	210.00	366.33	45.00	321.33
High fert	Mid slope	60		1.713	107		10.5	10.5	0.6	73.8	Feed1	210.00	359.80	45.00	314.80
High fert	Flat	60		1.025	98		6.3	11.1	1.0	72.8	Feed1	210.00	215.25	45.00	170.25
No fert	Rise	0		1.526	95	1.457	9.3	8.8	0.6	72.4	Feed1	210.00	320.53	0.00	320.53
No fert	Mid slope	0		1.600	100		9.8	8.9	0.5	73.0	Feed1	210.00	336.00	0.00	336.00
No fert	Flat	0		1.056	101		6.4	10.6	0.9	73.4	Feed1	210.00	221.67	0.00	221.67
Post Urea	Rise	45	90	2.121	131	1.890	12.9	10.2	0.6	73.2	Feed1	210.00	445.42	78.75	366.67
Post Urea	Mid slope	45	90	1.960	123		12.0	10.2	0.5	73.0	Feed1	210.00	411.60	78.75	332.85
Post Urea	Flat	45	90	1.213	116		7.4	11.7	1.0	75.2	Feed1	210.00	254.63	78.75	175.88
Low fert	Rise	30		1.556	96	1.467	9.5	8.6	0.7	72.4	Feed1	210.00	326.67	22.50	304.17
Low fert	Mid slope	30		1.600	100		9.8	8.7	0.6	72.6	Feed1	210.00	336.00	22.50	313.50
Low fert	Flat	30		1.067	102		6.5	11.3	1.0	73.0	Feed1	210.00	224.00	22.50	201.50
No zinc	Rise	45		1.565	97	1.466	9.6	8.9	0.5	72.6	Feed1	210.00	328.73	29.75	298.98
No zinc	Mid slope	45		1.573	98		9.6	8.6	0.5	72.2	Feed1	210.00	330.27	29.75	300.52
No zinc	Flat	45		1.018	97		6.2	10.3	0.7	73.0	Feed1	210.00	213.82	29.75	184.07
Copper	Rise	45		1.588	98	1.514	9.7	8.8	0.5	72.4	Feed1	210.00	333.38	35.75	297.63
Copper	Mid slope	45		1.611	101		9.8	10.3	0.8	73.4	Feed1	210.00	338.33	35.75	302.58
Copper	Flat	45		1.150	110		7.0	12.1	1.1	72.2	Feed1	210.00	241.50	35.75	205.75
Mean				1.580			9.6	10.0	0.7	72.9				Av.	281.53
Lsd (0.05)	(P = 0.0004)				7	0.1112								Max	382.31

Table 5 Fertiliser cost inputs

Fertiliser Product	$/t	rate	$/kg	$/kg $/ha
DAP	750.00	variable	0.75	0.75
Urea	500.00	90.00		0.50
Zn				4
Cu				2

Table 6 Comparison of financial benefit of Variable rate versus Flat rate if the 2010 results were applied over the whole paddock.

Paddock West Chamberlain

Zones created with Your Soils Potential on 2008 EM 38 map

		Yield		Fertiliser Rate (kg/ha)			Total Fertiliser used (t)			Total Grain Grown (t)		Gross Income $		Gross Margins $/ha	
				Flat	Variable		Flat	Variable							
Zone	**Total Area**	**Flat**	**Variable**	**DAP**	**DAP**	**Urea**	**DAP**	**DAP**	**Urea**	**Flat**	**Variable**	**Flat**	**Variable**	**Flat**	**Variable**
Sandhill	16.0	1.614	2.121	45	45	90	0.7	0.7	1.4	25.8	33.9	5422.23	7124.94	338.91	445.33
Mid slope	97.8	1.600	1.713	45	60	0	4.4	5.9	0	156.5	167.5	32856.83	35176.47	335.97	359.69
Flat	23.2	1.046	1.056	45	0	0	1.0	0.0	0	24.2	24.5	5088.56	5138.00	219.63	221.76
	137.0						6.2	6.6	1.4	**206.5**	**225.9**	43367.62	47439.42		

Comparison Variable Rate - Flat Rate		
Difference in Grain	19.394	tonne
Difference in Fertiliser	1.864	tonne
Income over 137 ha	$4,071.80	
GM $/ha	$29.72	

Simple Gross Margin per ha = $29.72

If the results are applied over the whole paddock VR would grow 19.394 t more grain than Flat Rate using 1.864 t more fertiliser

Who was involved?

Mark and Sue Stoeckel, Growers, Bunyip Reach
Peter Treloar, Precision Ag services and Vision Ag.
Richard Saunders, Rural Solutions SA, Trials Coordinator
Michael Moodie, Agronomist, Sustainable Farming Inc.
Mike Mooney, Manager, Mallee Sustainable Farming Inc.

Grower/Regional feedback:

Mark is still concerned that despite the excellent growing season rainfall in season 2010 his water use efficiencies are still relatively low, and this paddock compared to other paddocks responded poorly in yield.

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