

Improved P prescription maps – beyond replacement P

Sam Trengove, Stuart Sherriff,
Jordan Bruce & Sean Mason



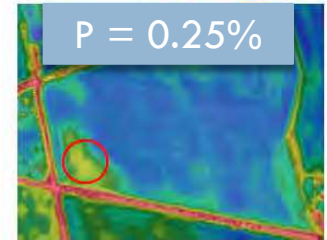
Trengove Consulting tissue test results

- Data from 2011 – 2019: 104 paired samples
 - ▣ 62% of pairs had low P in the Lower vigour sample
 - ▣ 35% of pairs had low Mg in the lower vigour sample
 - ▣ 13% of pairs had low S in the Lower vigour sample
 - ▣ 13% of pairs had low K in the Lower vigour sample
 - ▣ 7% of pairs had low Zn in the Lower vigour sample

Tissue test results

Farmer: Dennis & Robert Dall
 Date sampled: 25/07/2019
 Paddock: No. 16
 Crop & variety: Trojan
 Location in paddock: Lower vigour
 Lab ID No: 110481887
 Crop stage: GS31

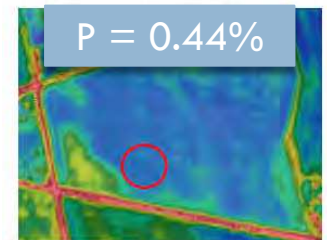
	Result (ppm)	% of optimum	Comments
Sulphur (%)	12.26	120	OK
Phosphorus (%)	0.25	83	Marginal
Potassium (%)	3.67	147	OK
Zinc (ppm)	41.0	228	OK
Iron (ppm)	95	380	OK
Manganese (ppm)	59	295	OK
Copper (ppm)	9.8	327	OK
Calcium (%)	0.34	170	OK
Magnesium (%)	0.13	108	OK
		% of toxic level	
Boron (ppm)	2.6		OK
Sodium (%)	0.02	10	OK



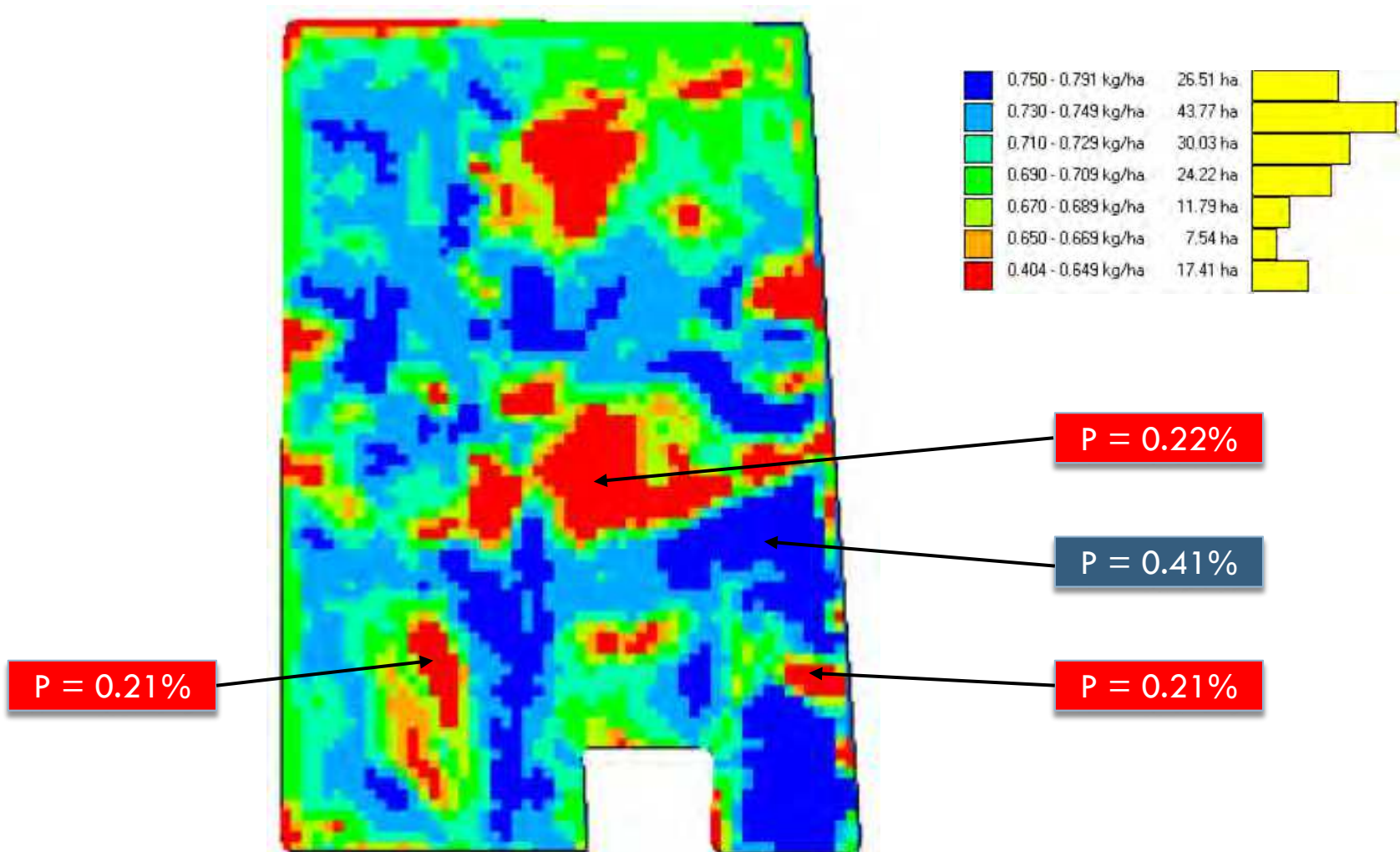
Tissue test results

Farmer: Dennis & Robert Dall
 Date sampled: 25/07/2019
 Paddock: No. 16
 Crop & variety: Trojan
 Location in paddock: Higher vigour
 Lab ID No: 110481888
 Crop stage: GS31

	Result (ppm)	% of optimum	Comments
Sulphur (%)	0.34	113	OK
Phosphorus (%)	0.44	147	OK
Potassium (%)	3.87	155	OK
Zinc (ppm)	23.0	128	OK
Iron (ppm)	120	480	OK
Manganese (ppm)	80	300	OK
Copper (ppm)	8.7	290	OK
Calcium (%)	0.34	170	OK
Magnesium (%)	0.19	158	OK
		% of toxic level	
Boron (ppm)	3.7		OK
Sodium (%)	0.04	20	OK



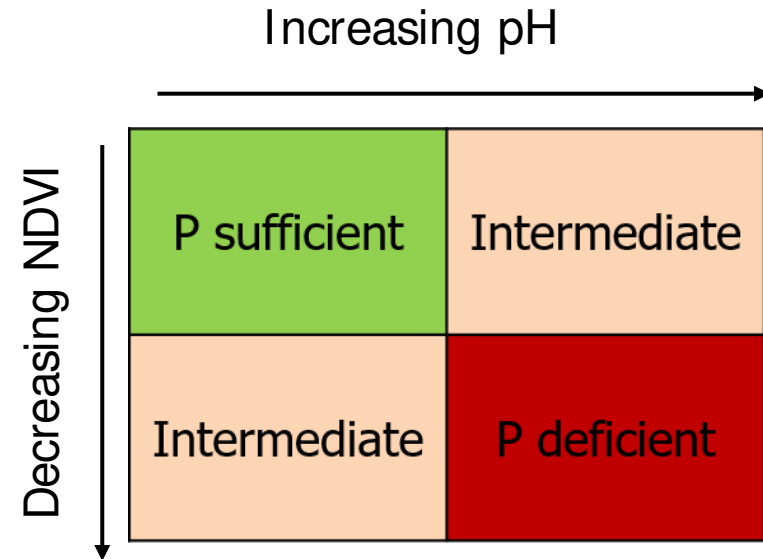
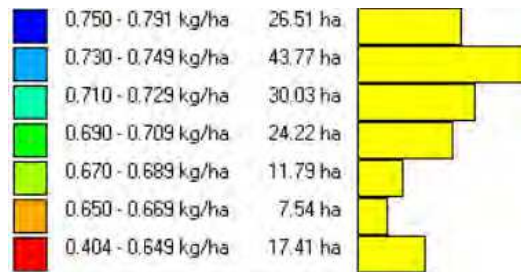
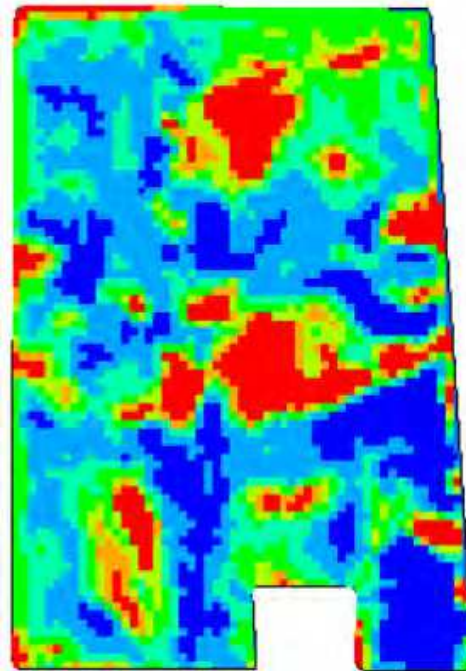
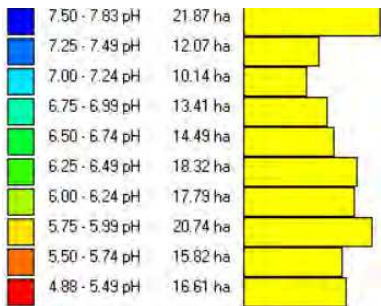
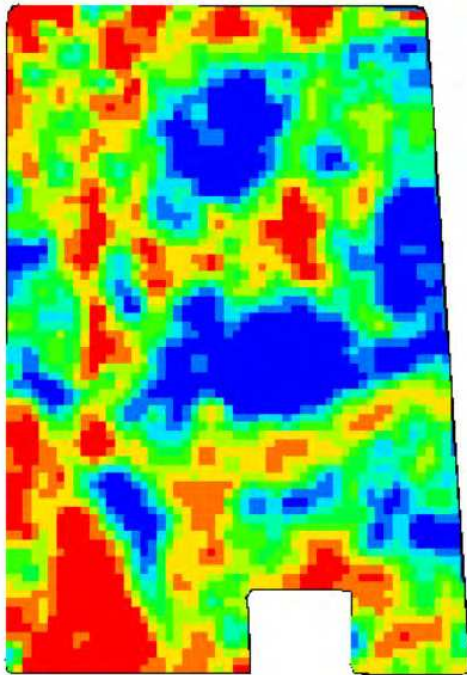
Ground truthing satellite NDVI with tissue testing – Plant P content



Soil pH mapping for improved decision making

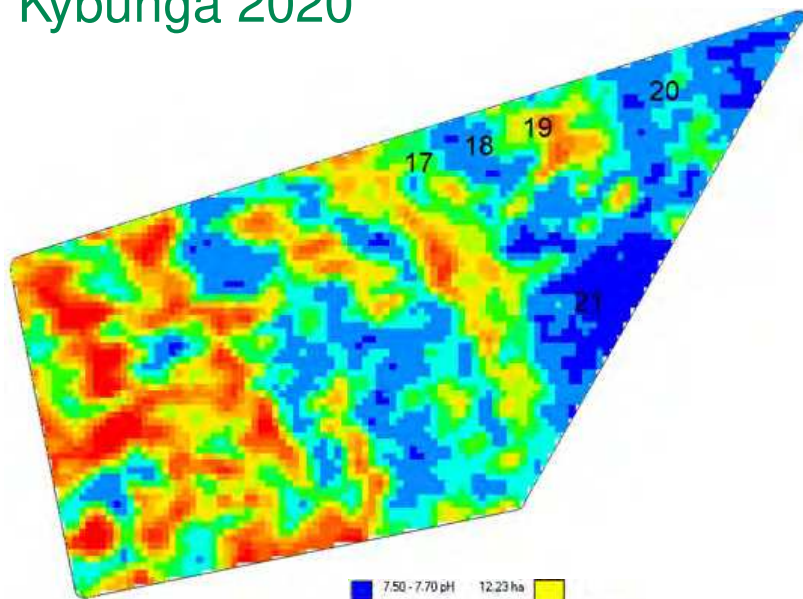


Soil pH Vs Satellite NDVI

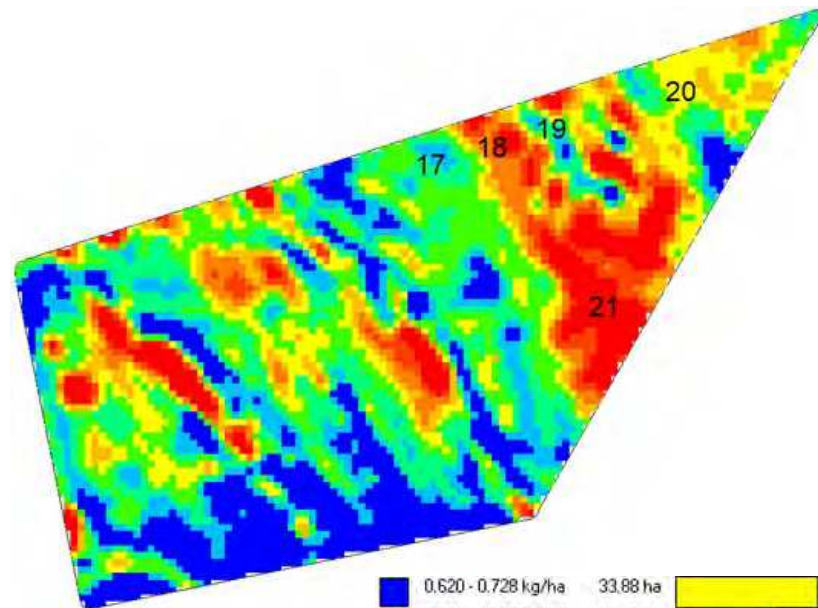


SOIL PH AND NDVI

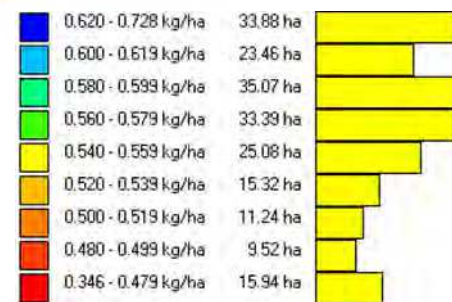
Kybunga 2020



Soil pH

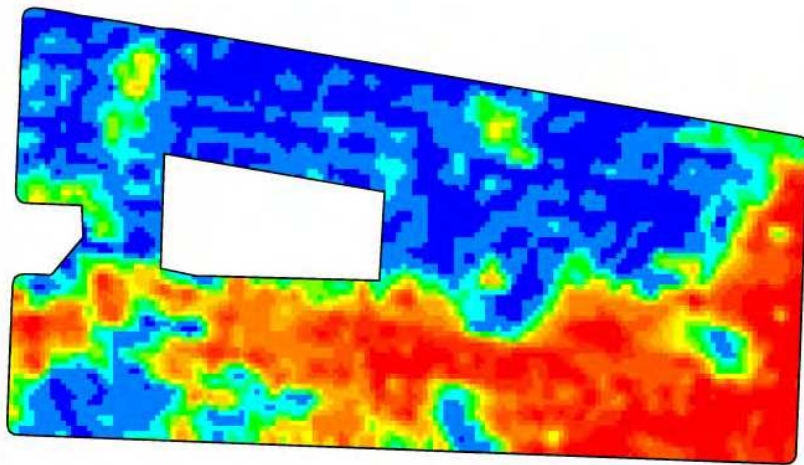


NDVI 2019

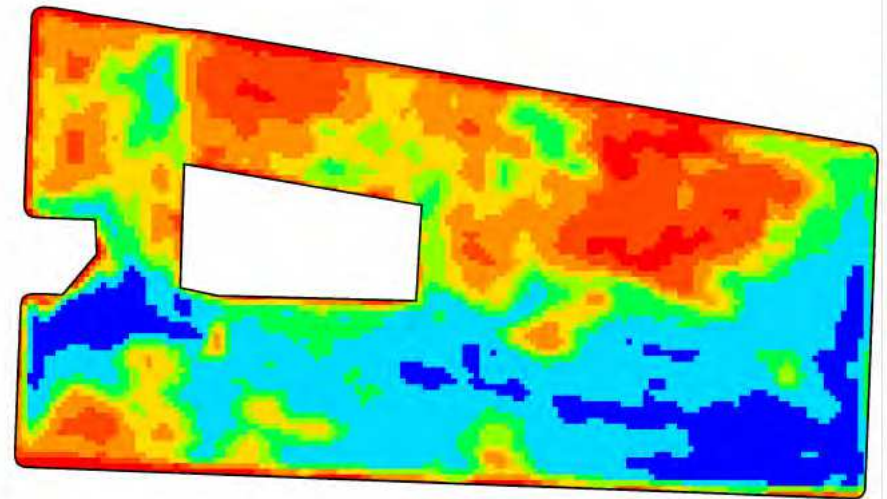


SOIL PH AND NDVI

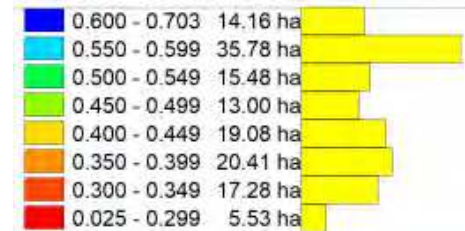
Brinkworth 2020



Soil pH

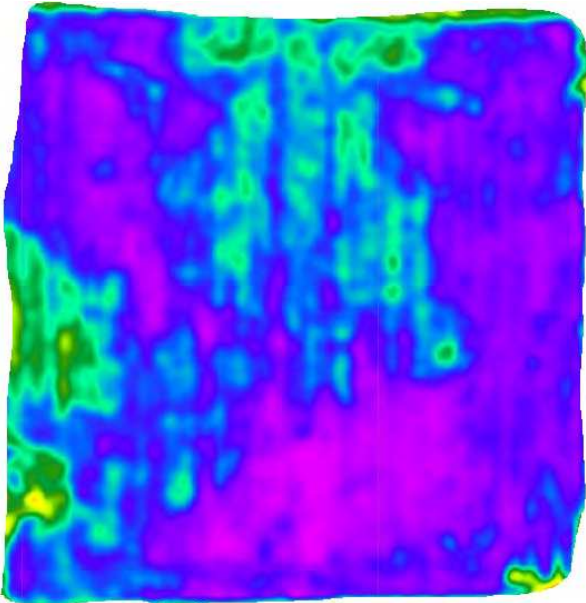
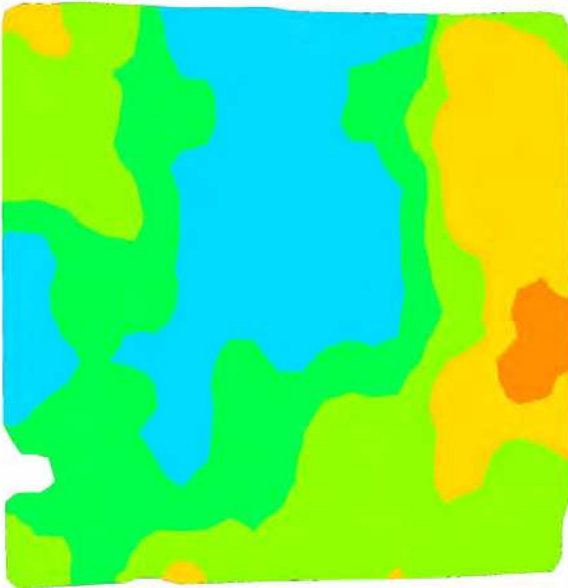


NDVI 2019



SOIL PH AND NDVI

Yeelanna/Brooker 2020

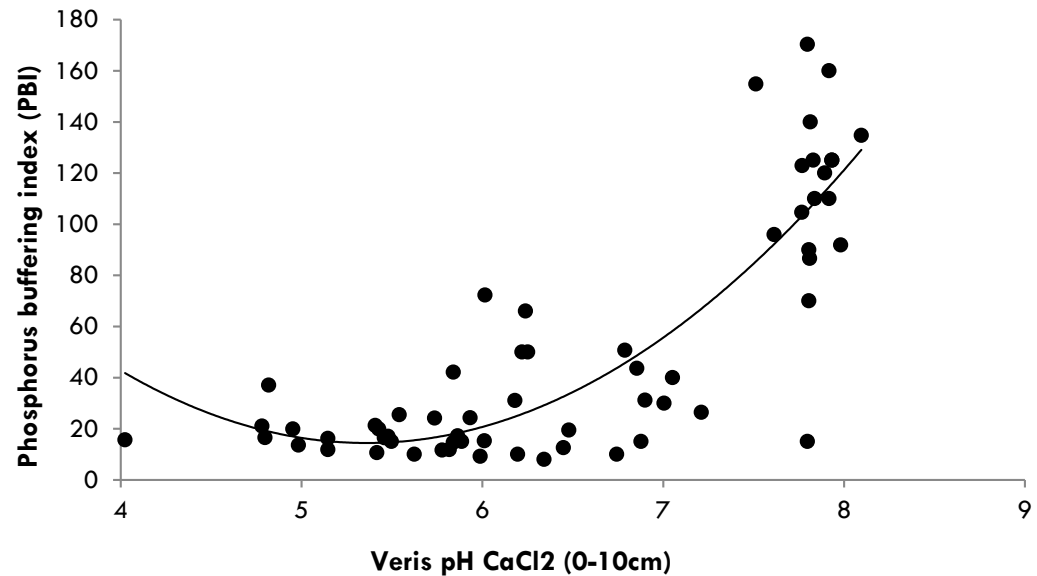
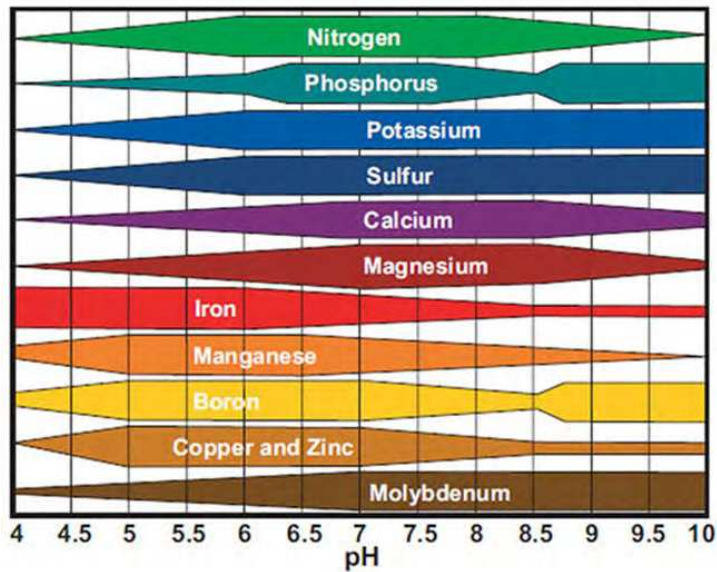


Soil pH

8.00 - 8.06	0.00 ha	
7.50 - 7.99	18.96 ha	
7.00 - 7.49	18.56 ha	
6.50 - 6.99	18.75 ha	
6.00 - 6.49	10.49 ha	
5.50 - 5.99	1.41 ha	
5.00 - 5.49	0.00 ha	
Below 5.00	0.00 ha	

NDVI 2020

Soil pH and nutrient availability



Relationship between pH CaCl₂ and phosphorus buffering index for a Yorke Peninsula farm ($y = 15.3x^2 - 164.3x + 454.6$, $R^2 = 0.721$).

Caveat* Not all high pH soils have high PBI, i.e. soils with low carbonate, some low pH soils do have high PBI i.e. soils with high Al and Fe,

Trengove Consulting P Agronomy 2019 – 2021

Improved Phosphorus prescription maps - beyond replacement P

Four paddocks with four trials = 16 trials

- Actually delivered 21 trials across 5 paddocks
 - 2019: Bute and Koolunga
 - 2020: Bute, Brinkworth and Kybunga

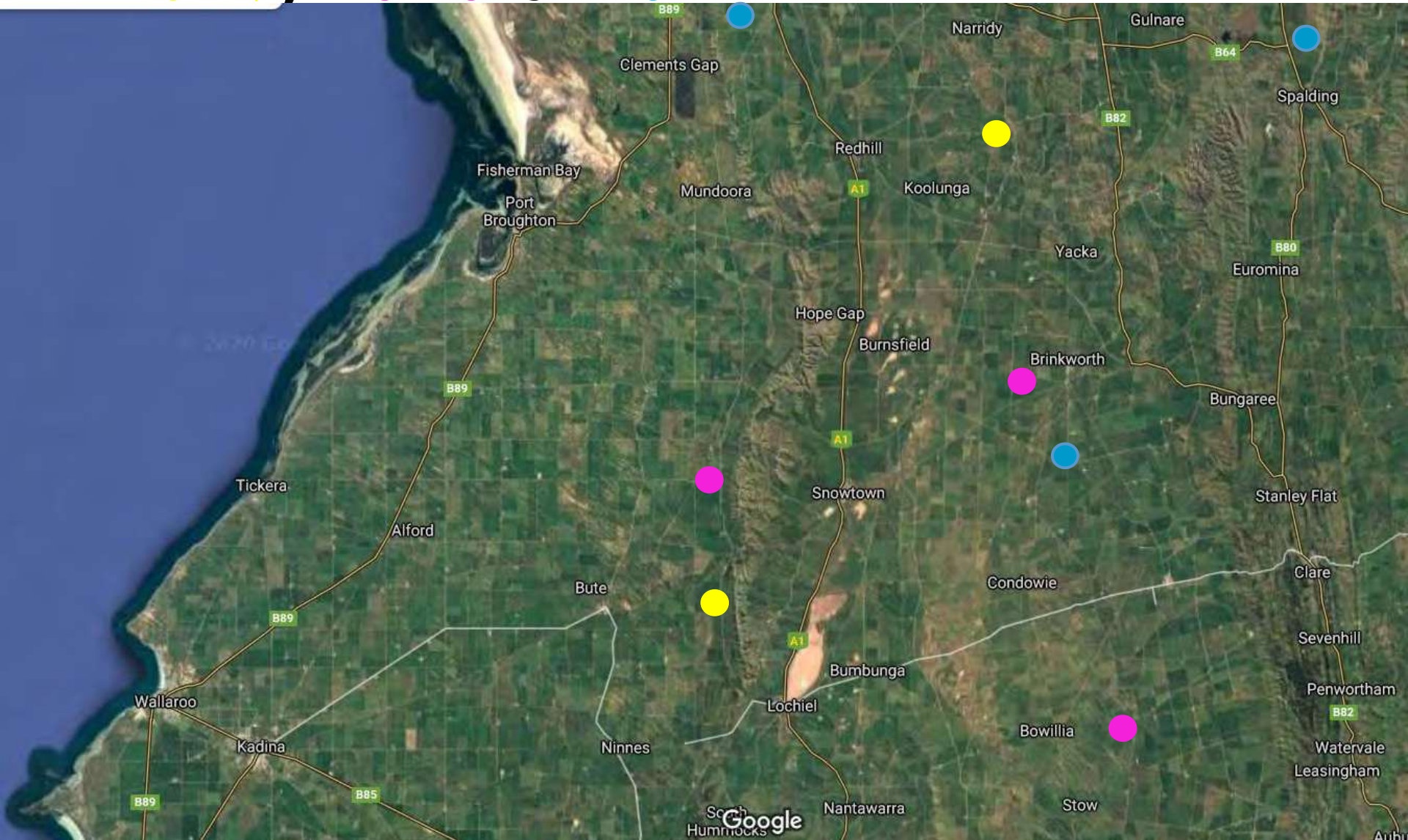
Sites selected using available data layers including

- Veris pH
- Satellite NDVI/SVI
- Grain yield

Treatments include P rates 0, 5, 10, 20, 30 and 50kg/ha + Biosolids or Chicken litter

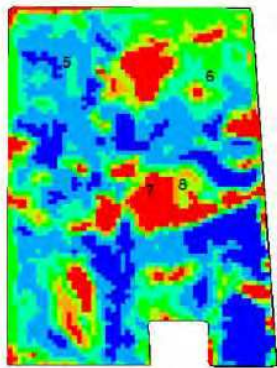


Trial paddocks – 2019, 2020 & 2021

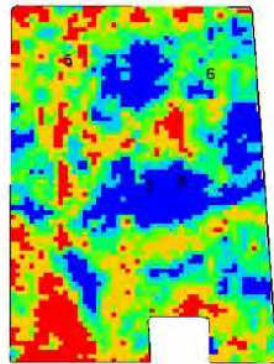


Bute trial sites 2019

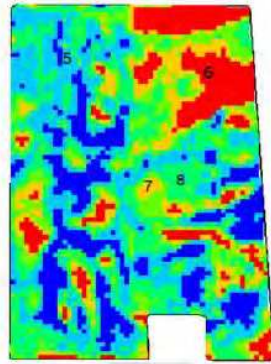
Site	Soil pH	NDVI	Predicted P response	DGT P		Colwell P		PBI	
				$\mu\text{g/L}$		mg/Kg			
5	Low	Moderate/high	Low	103	High	27	Marginal	20	Low
6	Neutral	Moderate	Moderate	106	High	63	High	50	Low
7	High	Low	High	22	Low	20	Low	71	Low/Moderate
8	High	Low	High	38	Low	19	Low	51	Low



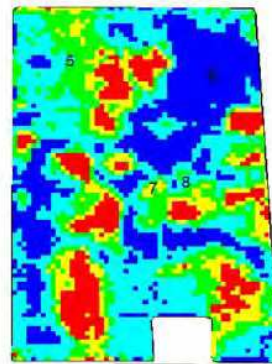
2018 Satellite NDVI



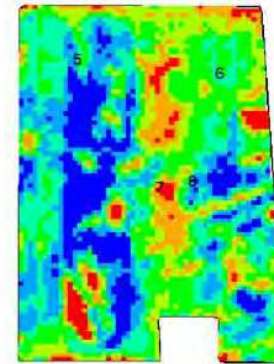
Soil pH



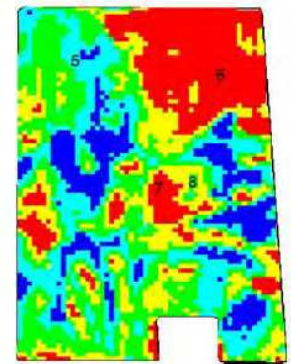
2015 wheat yield



2016 wheat yield



2017 lentil yield



2018 wheat yield



Matching P rates with soil characteristics

□ Koolunga 2019



Site 1: PBI 126 (high pH)

DGT P 12, Colwell 24

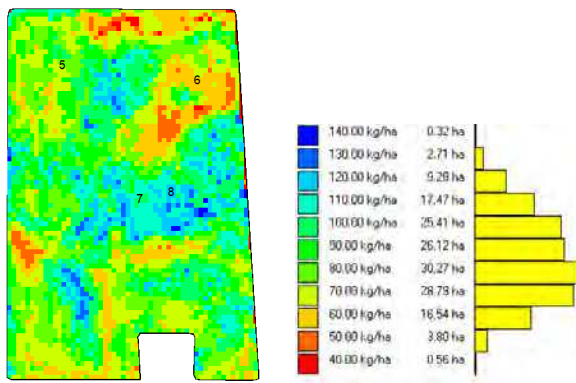
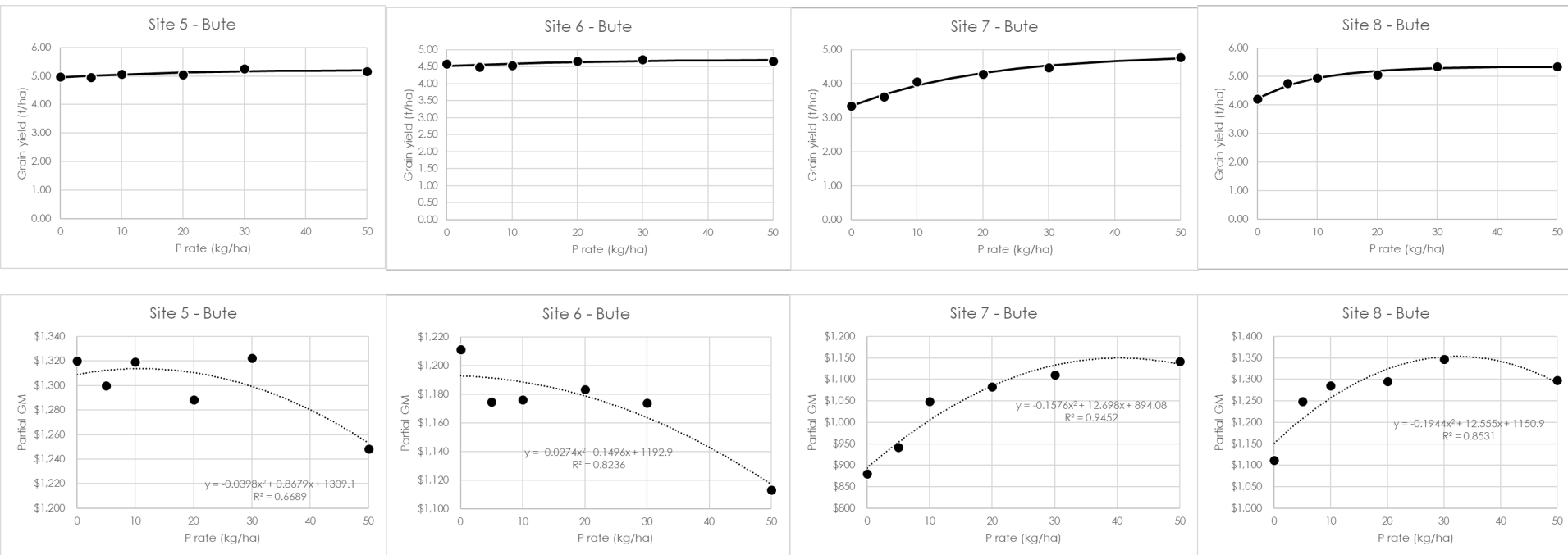
Site 2: PBI 141 (high pH)

DGT P 21, Colwell 35

Site 3: PBI 51 (low pH)

DGT P 56, Colwell 33

Yield and gross margin responses



ROI	Site 5	Site 6	Site 7	Site 8
Max PGM	11	0	40.1	32
0.5:1	0	0	36.1	28.8
1:1	0	0	32.2	25.6
1.5:1	0	0	28.2	
2:1	0	0	24.2	19.2

How do we extend this further?

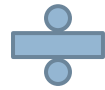


Combine multiple data layers into a single P response index



i.e. the $pHnNDVI = pH/NDVI$ calibrated to P content

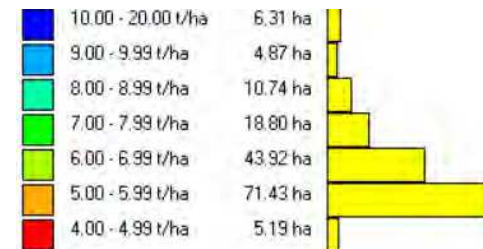
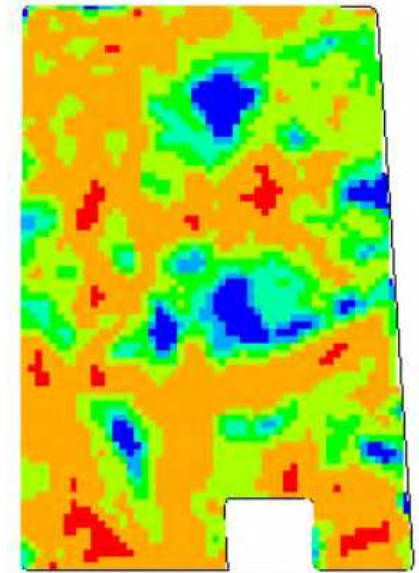
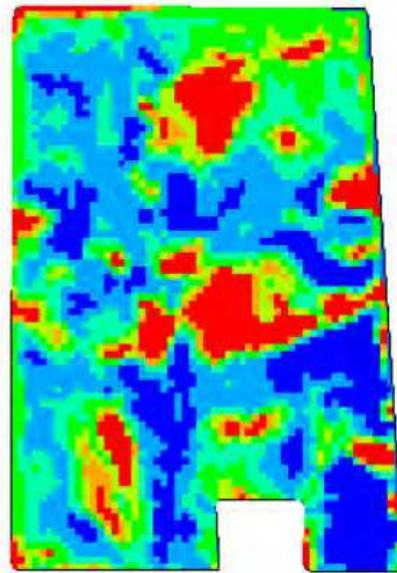
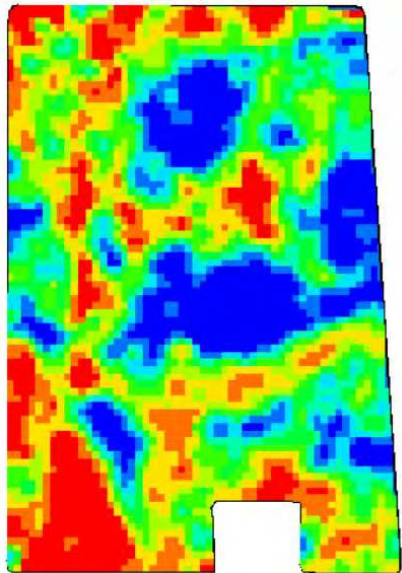
Soil pH



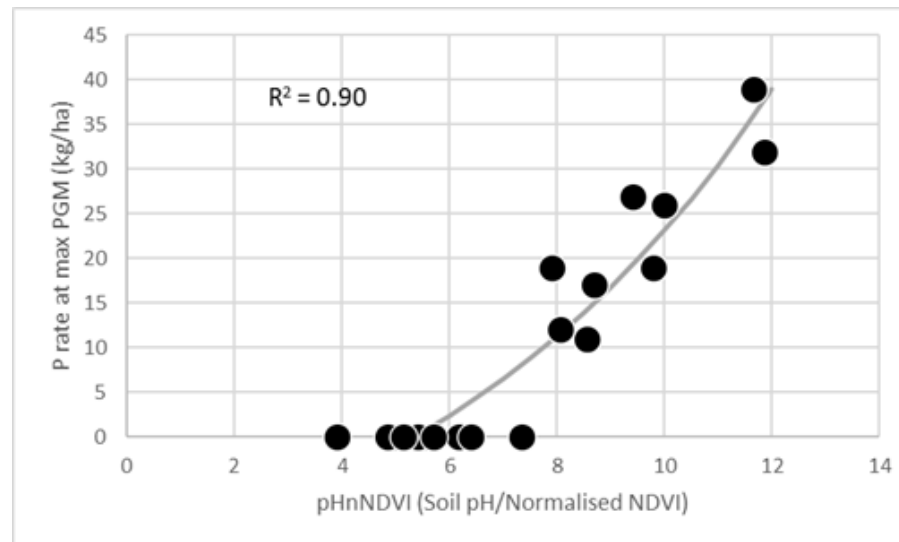
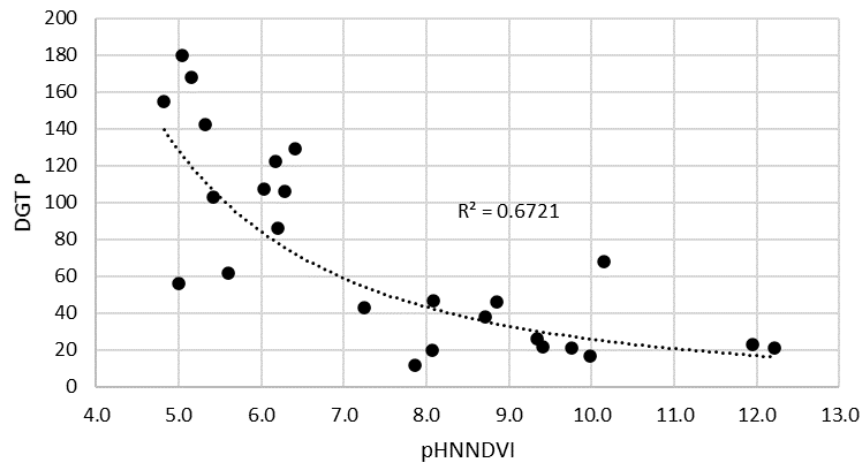
Satellite NDVI



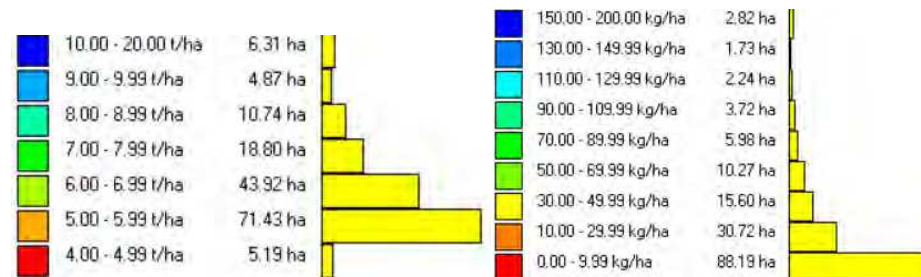
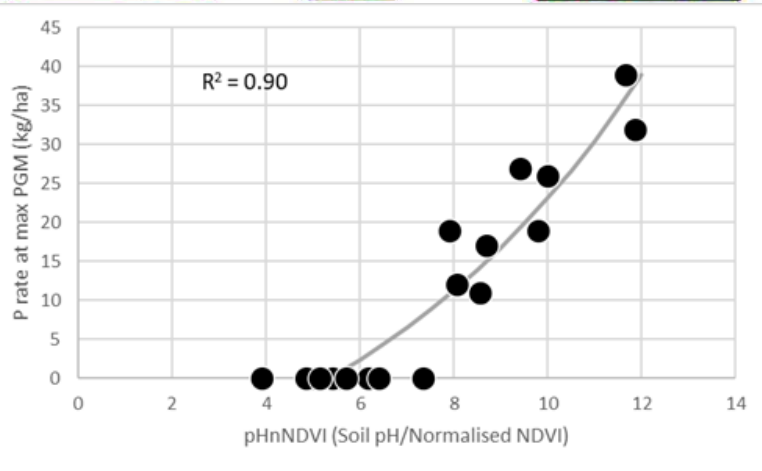
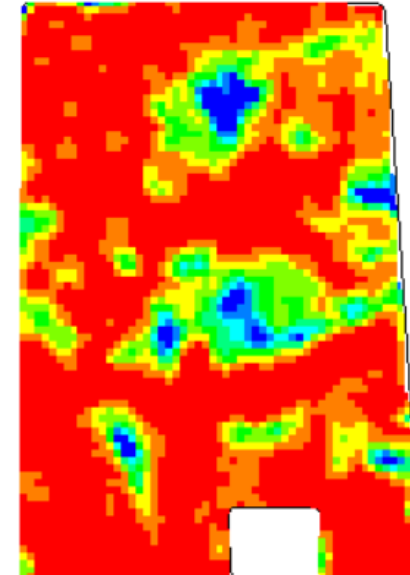
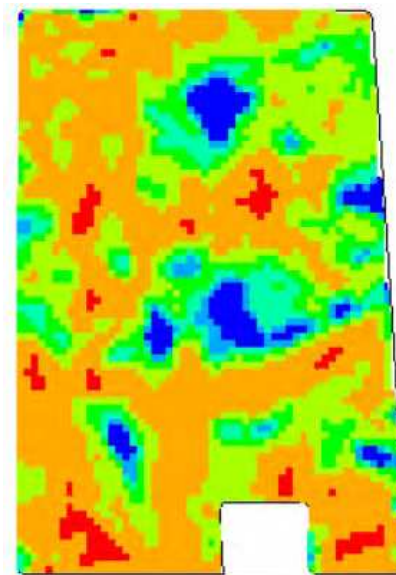
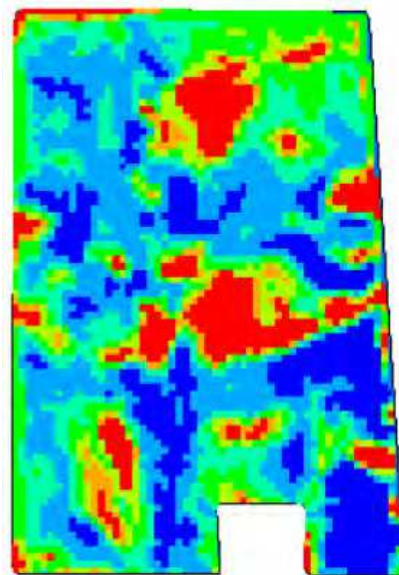
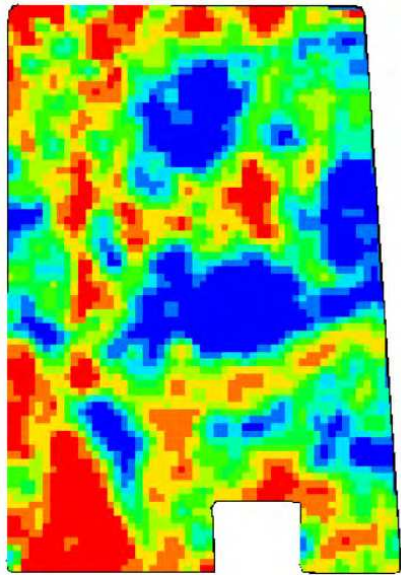
pHnNDVI



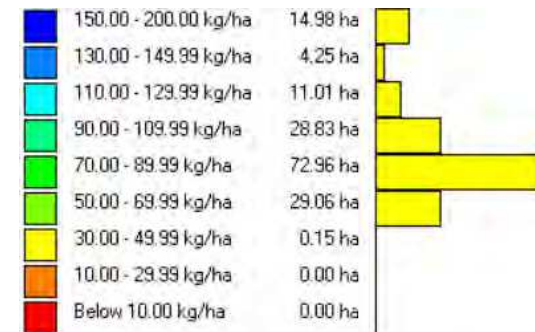
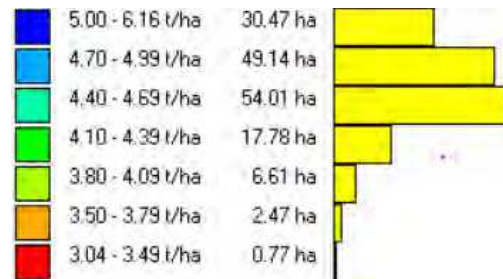
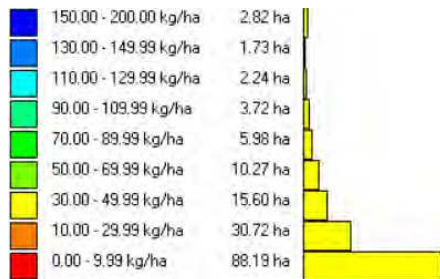
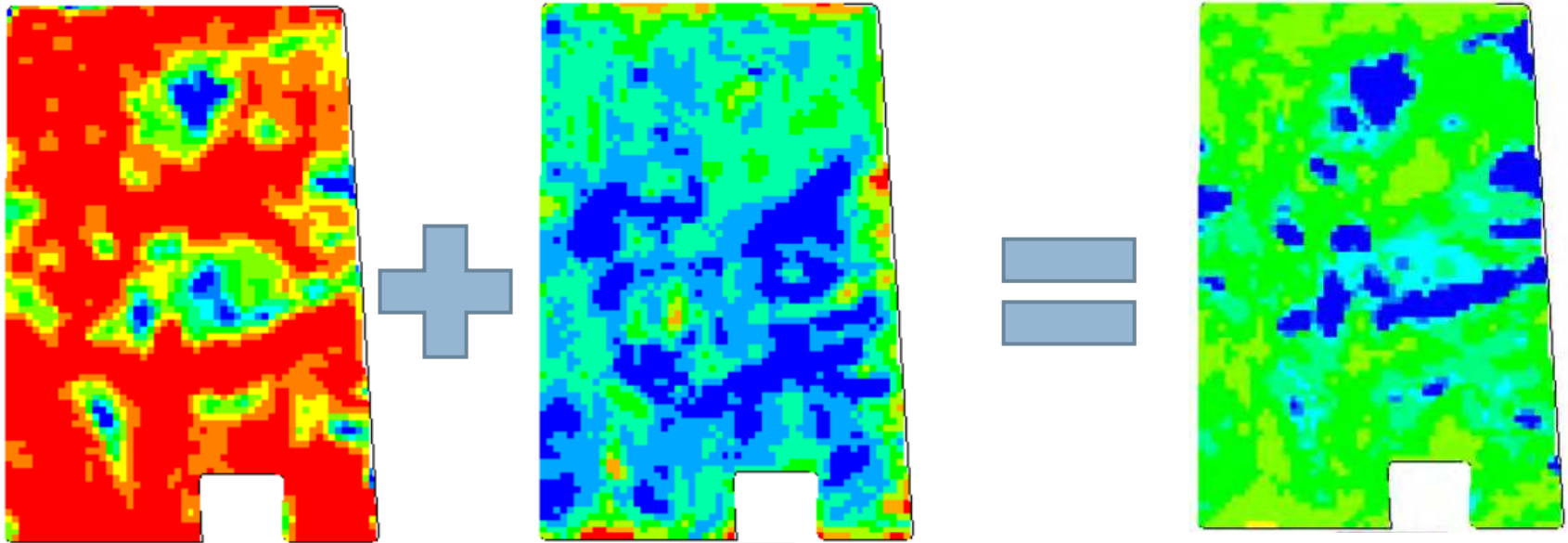
Relationship of 'pHnNDVI' with key P response measures



Soil pH \oplus Satellite NDVI \equiv pHnNDVI \rightarrow P Rate



Use grain yield and P replacement to set minimum rate



Economic sensitivity analysis

P rate to optimise economic return

Decile 1 Grain prices: Wheat (APW1) - \$214t, Barley (F1) - \$165

MAP (\$/t)	pHNNDVI					Soil DGT P				
	4	6	8	10	12	> 150	100	50	30	< 20
\$500	0	3	11	19	28	0	4	16	28	40
\$750	0	1	7	13	19	0	3	12	21	30
\$1,000	0	1	5	10	14	0	2	9	16	24
\$1,250	0	0	4	7	10	0	1	7	12	18
\$1,500	0	0	3	5	7	0	1	5	9	13

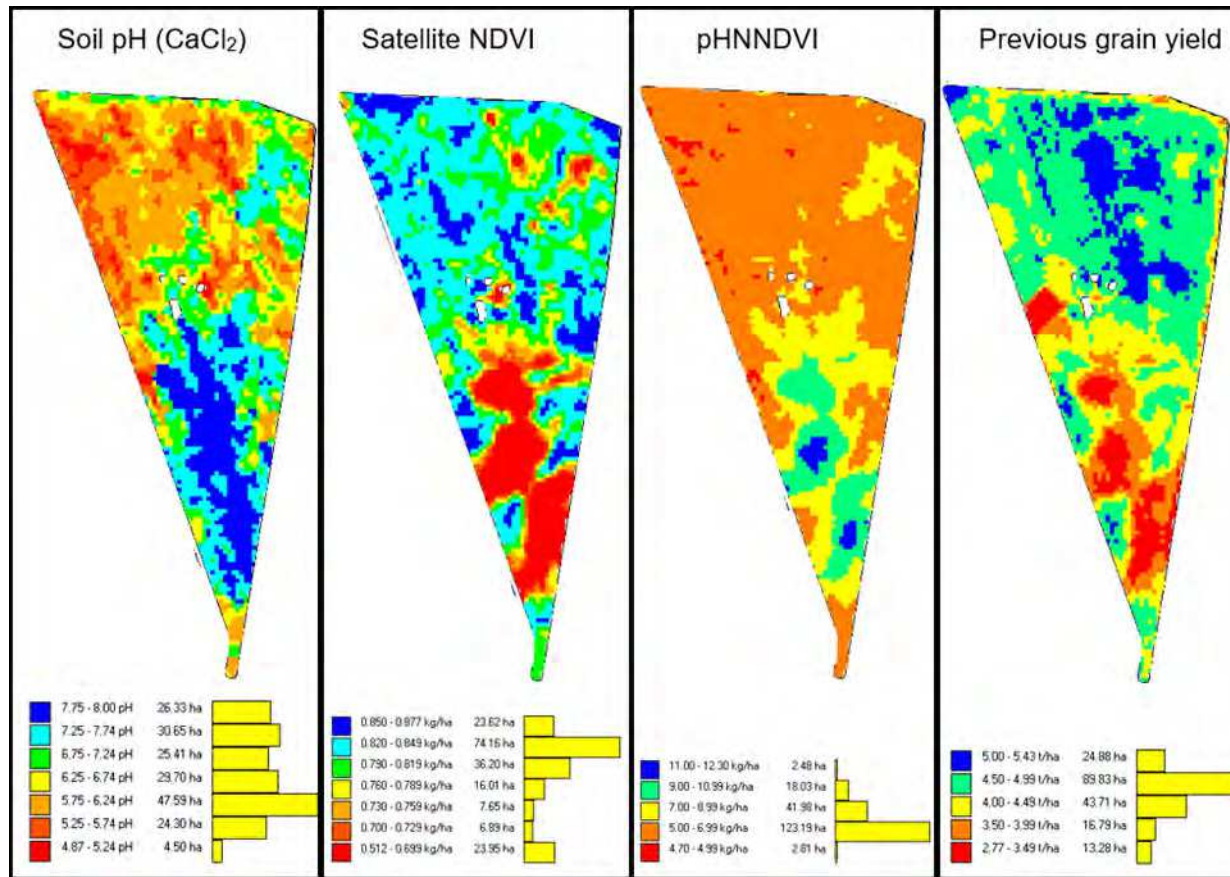
Decile 5 Grain prices: Wheat (APW1) - \$275t, Barley (F1) - \$230

MAP (\$/t)	pHNNDVI					Soil DGT P				
	4	6	8	10	12	> 150	100	50	30	< 20
\$500	0	5	16	26	36	0	6	20	34	47
\$750	0	2	10	18	25	0	4	15	26	38
\$1,000	0	1	7	13	19	0	3	12	21	31
\$1,250	0	1	6	10	15	0	2	10	18	25
\$1,500	0	1	4	8	12	0	2	8	14	21

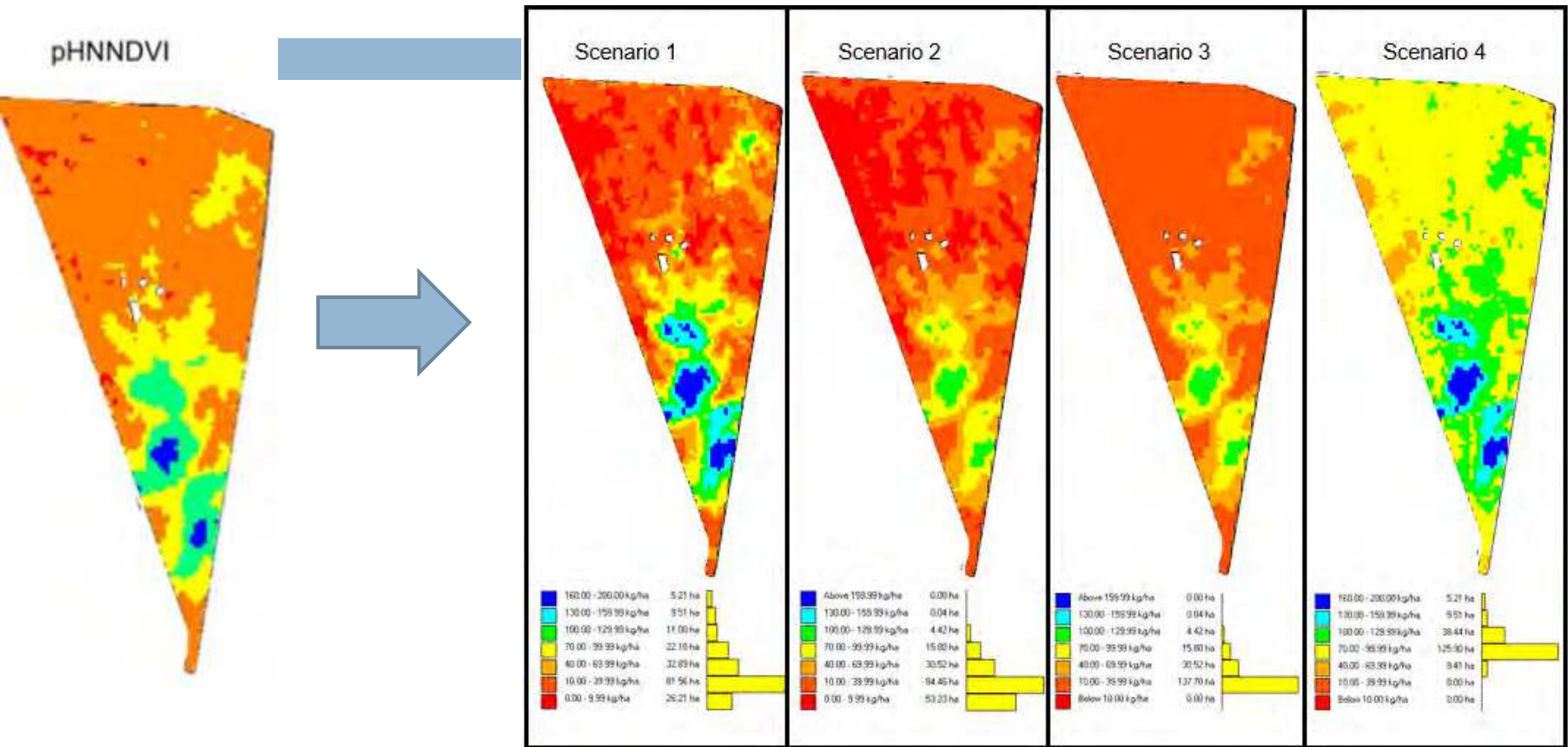
Decile 9 Grain prices: Wheat (APW1) - \$332t, Barley (F1) - \$293

MAP (\$/t)	pHNNDVI					Soil DGT P				
	4	6	8	10	12	> 150	100	50	30	< 20
\$500	0	8	20	31	42	0	9	23	37	51
\$750	0	3	12	21	31	0	5	18	31	44
\$1,000	0	2	9	16	24	0	3	14	25	36
\$1,250	0	1	7	13	19	0	3	12	22	31
\$1,500	0	1	6	11	16	0	2	10	18	26

Case Study – Crystal Brook



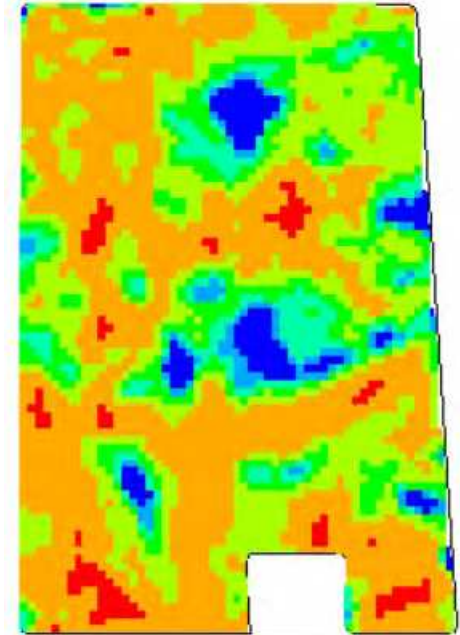
Case Study – scenario sensitivity



Scenario	Grain Price	MAP Fert Price (\$/t)	Min MAP fert rate (kg/ha)	MAP fert rate range (kg/ha)	Ave MAP fert rate calculated (kg/ha)
1	Decile 9	750	0	0-200	44
2	Decile 9	1500	0	0-130	24
3	Decile 9	1500	20	20-130	32
4	Decile 9	750	Replacement from previous yield	50-200	90

Next steps

- SAGIT funded project TC221 – field trials planned for 2021-2023
 - ▣ Further validation of P response prediction based on spatial data.
 - ▣ Testing in a broader range of production environments and soil types.
 - ▣ Determining best practice long term management of high P response sites.

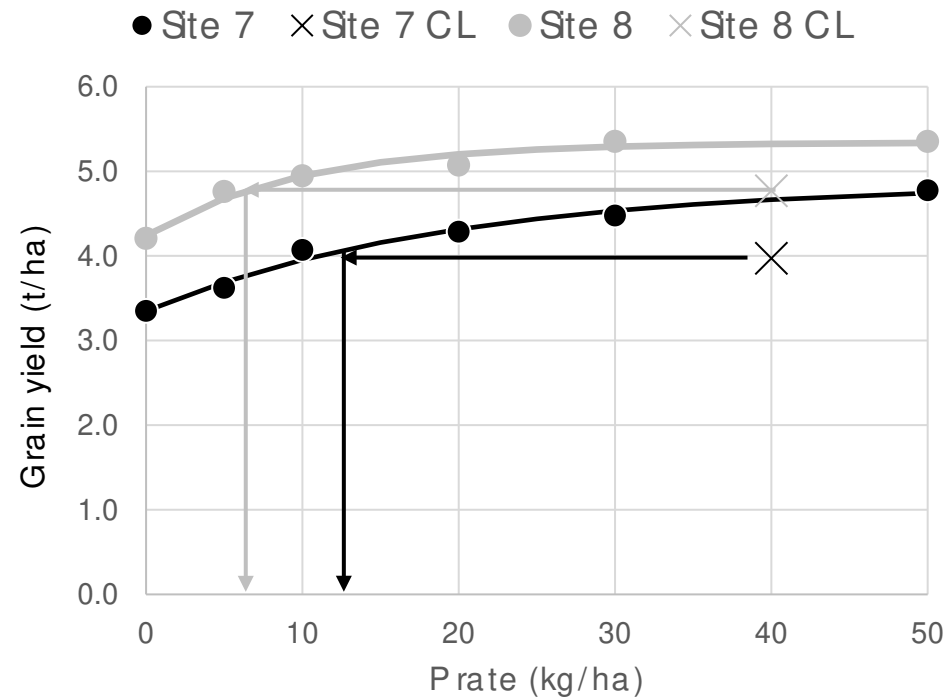
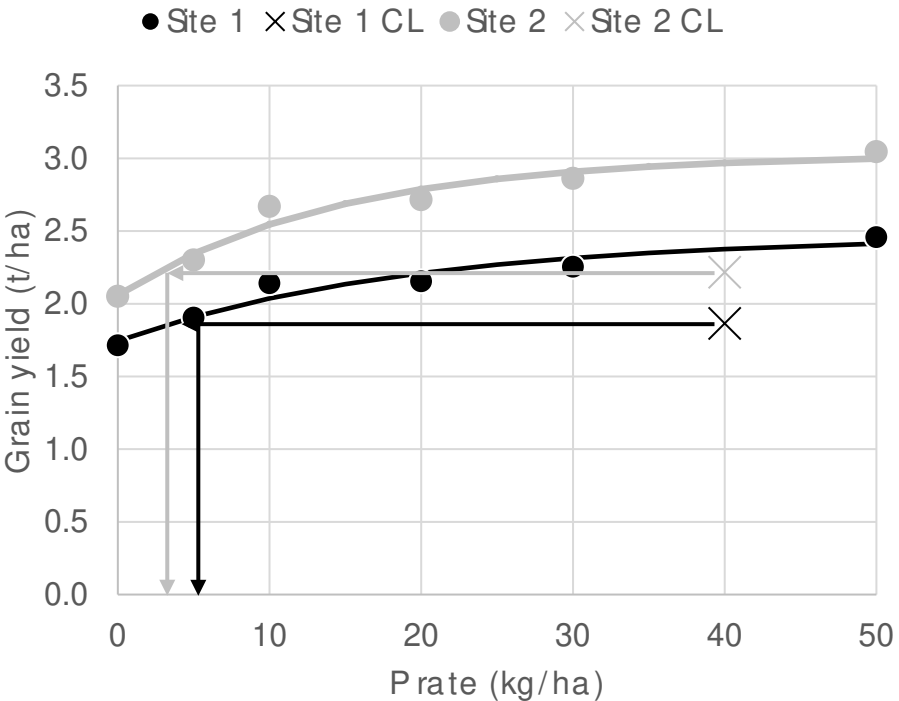


Take Home Messages

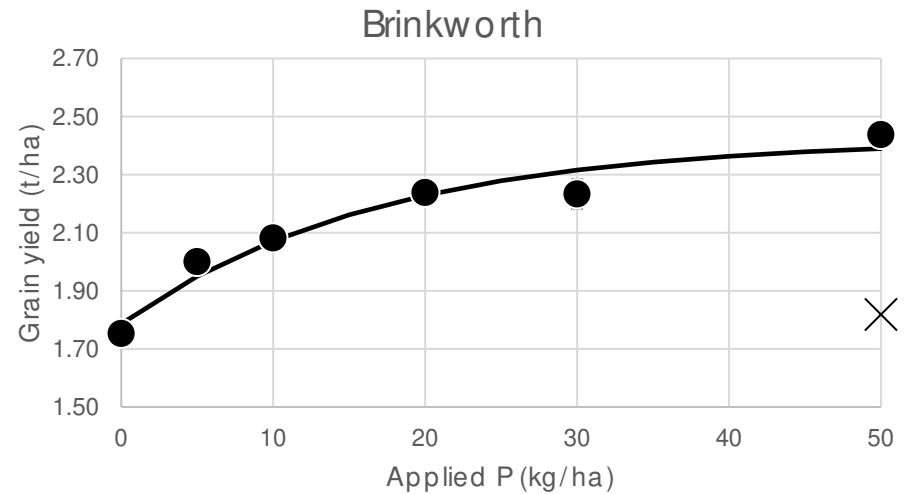
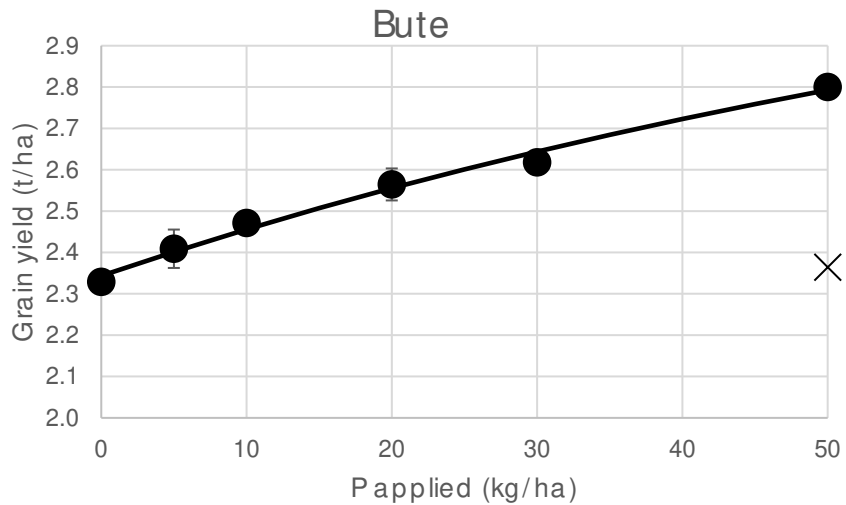
- Wide range in optimum P rates measured within the same paddock
- Readily available spatial data layers are showing good ability for predicting P responses
- Improved prescription maps, beyond replacement P, can be produced for fertiliser application



Chicken Litter 2019 – 5t/ha @ 0.8%P

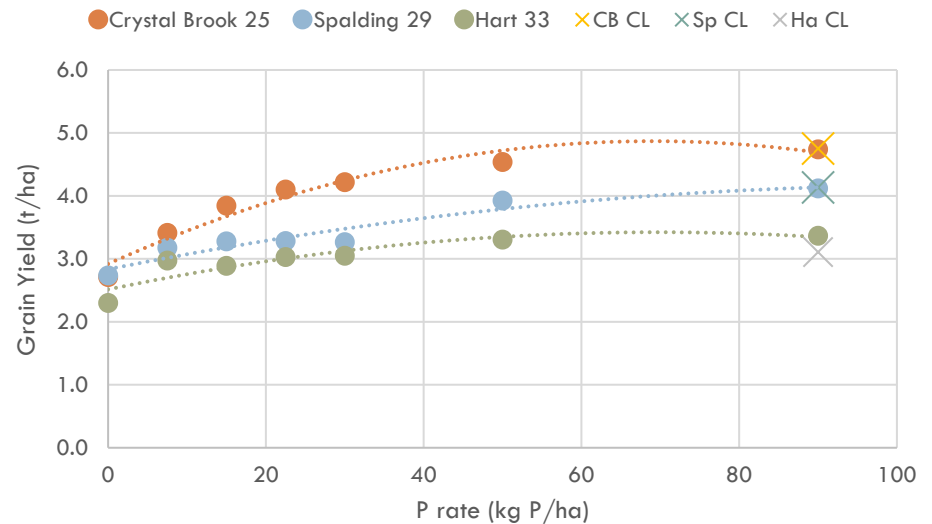


Biosolids 2020 – 5t/ha @ 1% P



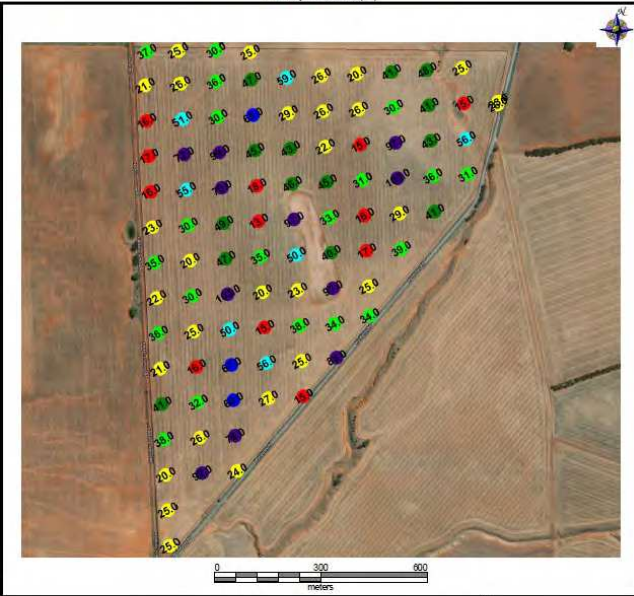
Chicken Litter 2021 – 6.25t/ha

- 2021 trials
 - ▣ Chicken litter P content = 1.2%
 - ▣ Chicken litter applied at 6.25t/ha = 75kg P/ha
 - ▣ Chicken litter applied with 15kg P/ha starter MAP = total of 90kg P/ha

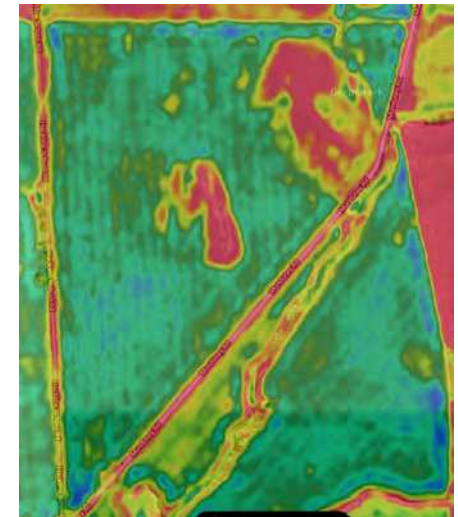
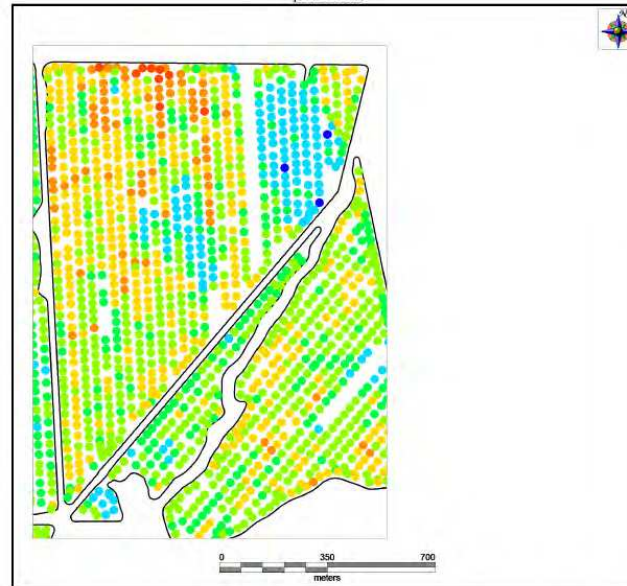


Alternative mapping techniques

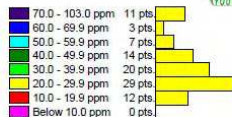
Mundunney Road Triangle: Soil Test
Phosphorous (P)



Longmire pH 2019
pH CaCl2



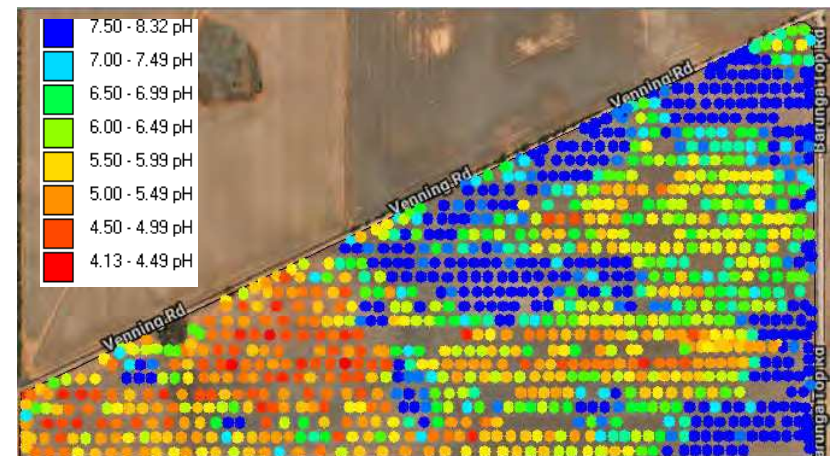
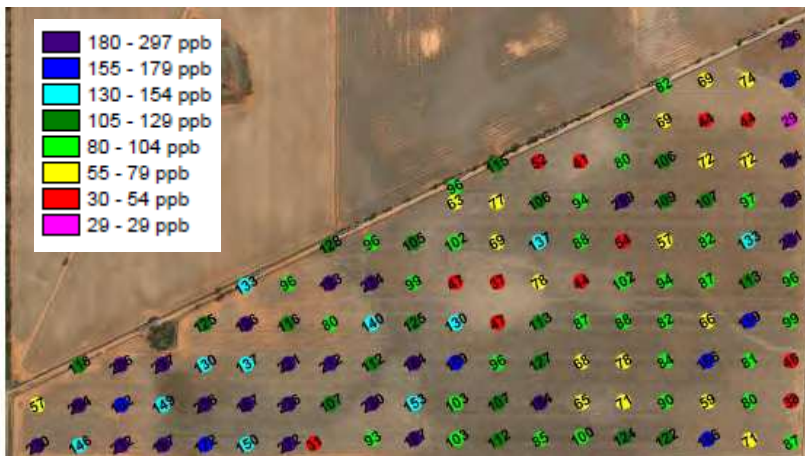
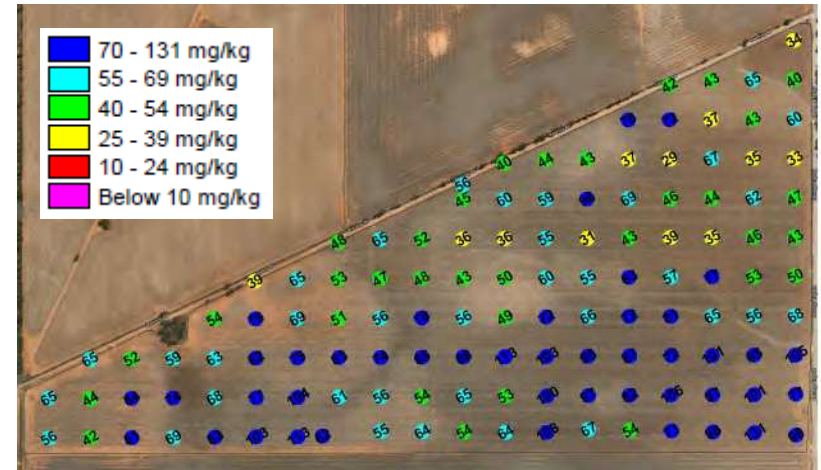
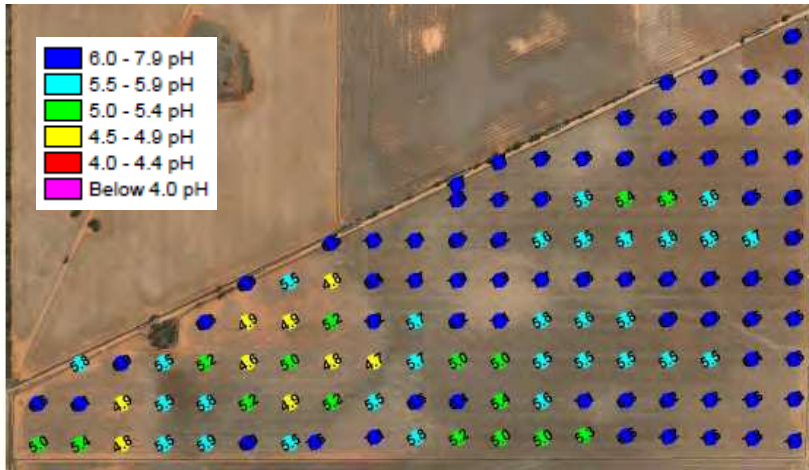
Client: < Unassigned Client >
Paddock: Mundunney Road Triangle
Name: triangle p k 2020
Type: Soil Test
Date: 11/02/2020



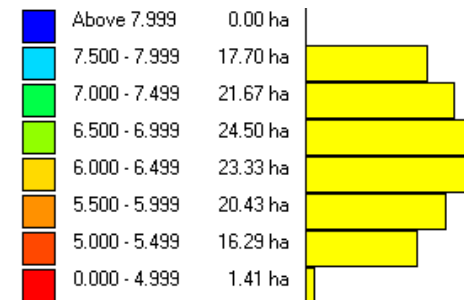
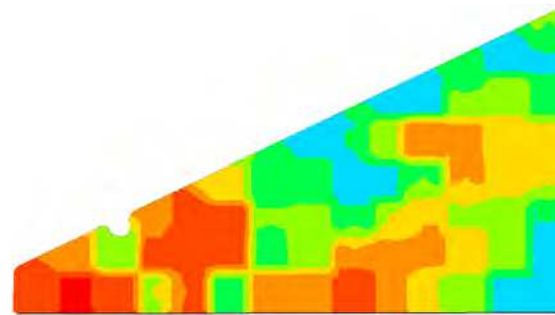
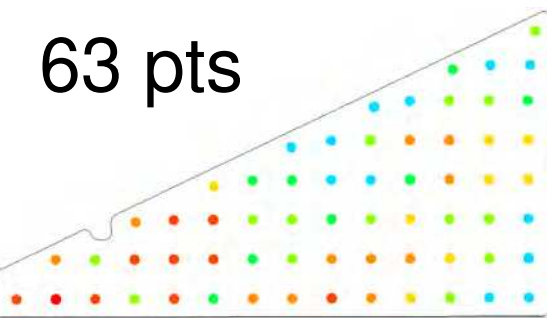
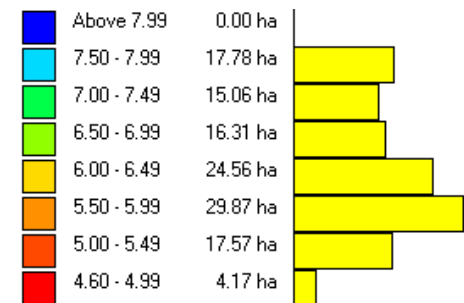
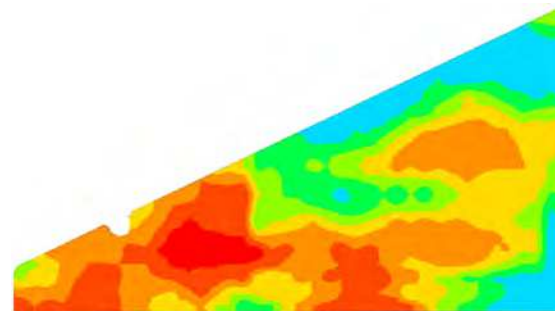
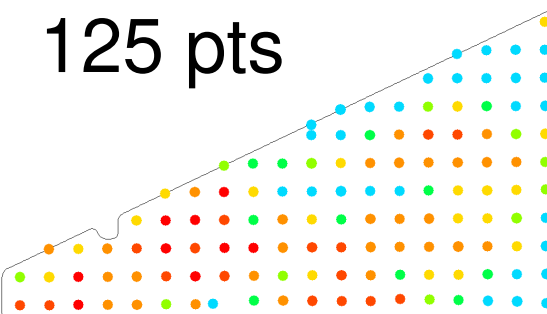
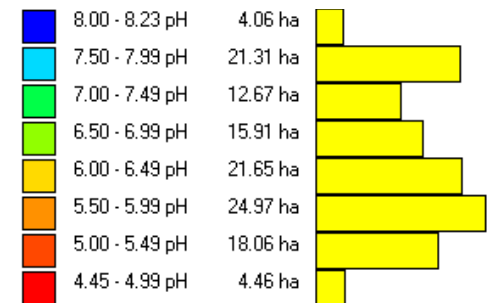
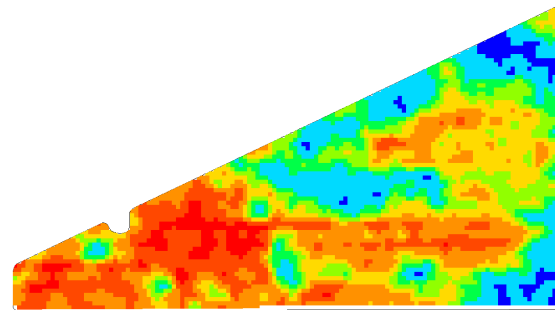
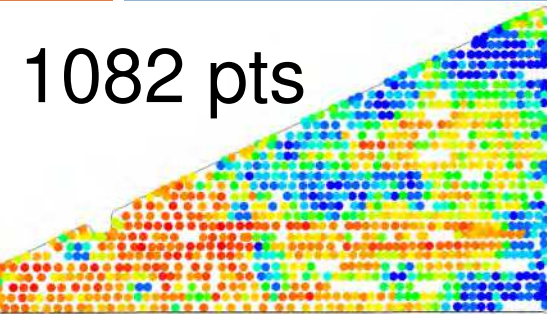
Client: Longmire, Darren
Farm: Longmire
Paddock: Longmire pH 2019
Name: pH CaCl2
Date: 27/05/2019
Min: 4.493
Max: 8.365
Avg: 6.127



Alternative mapping techniques

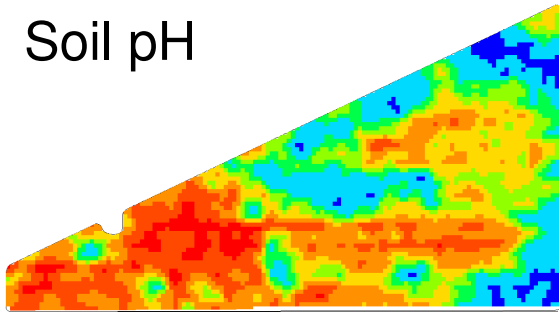


Sampling strategy: Veris, 1ha, 2ha

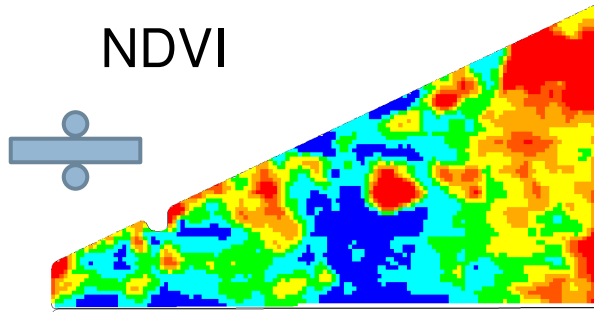


Predicting spatial P response

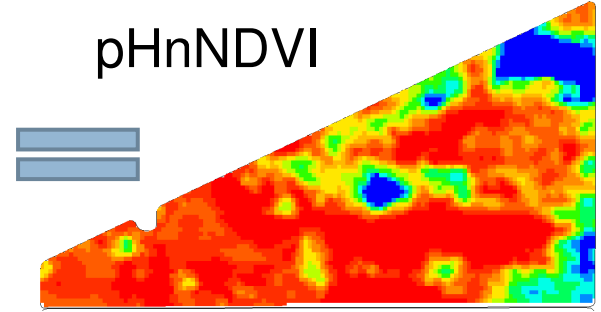
Soil pH



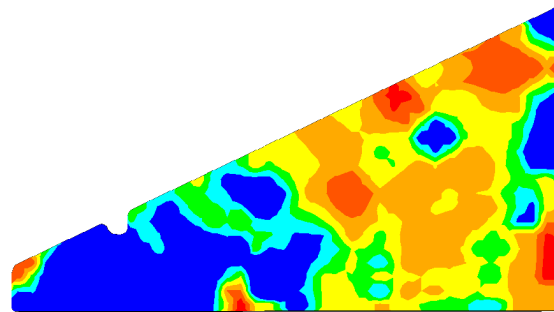
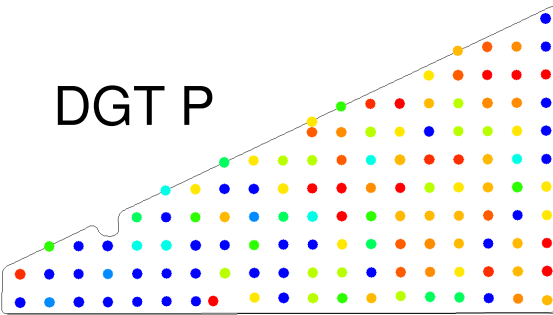
NDVI



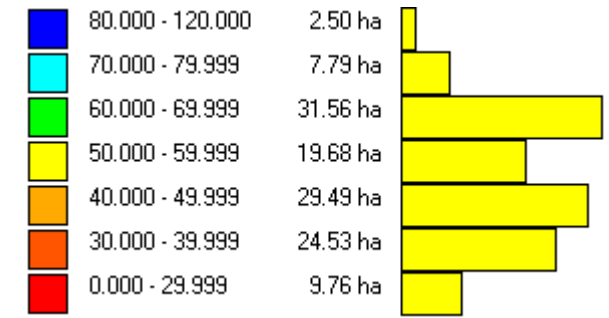
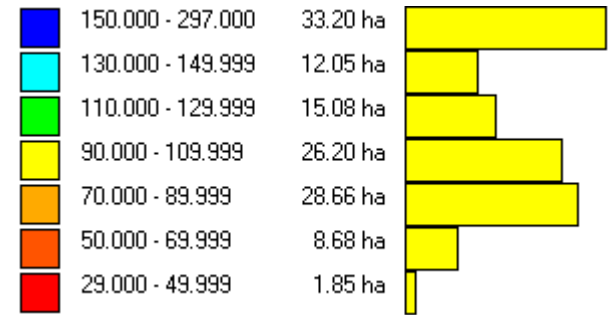
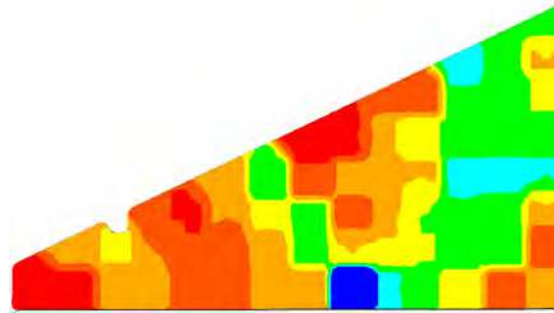
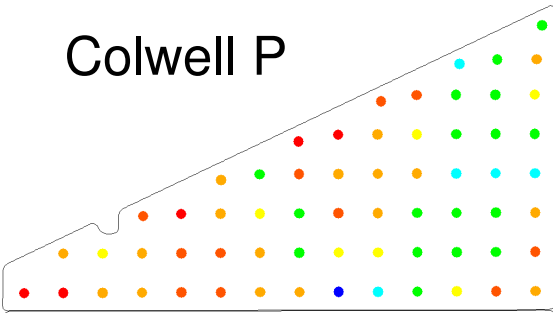
pHnNDVI



DGT P

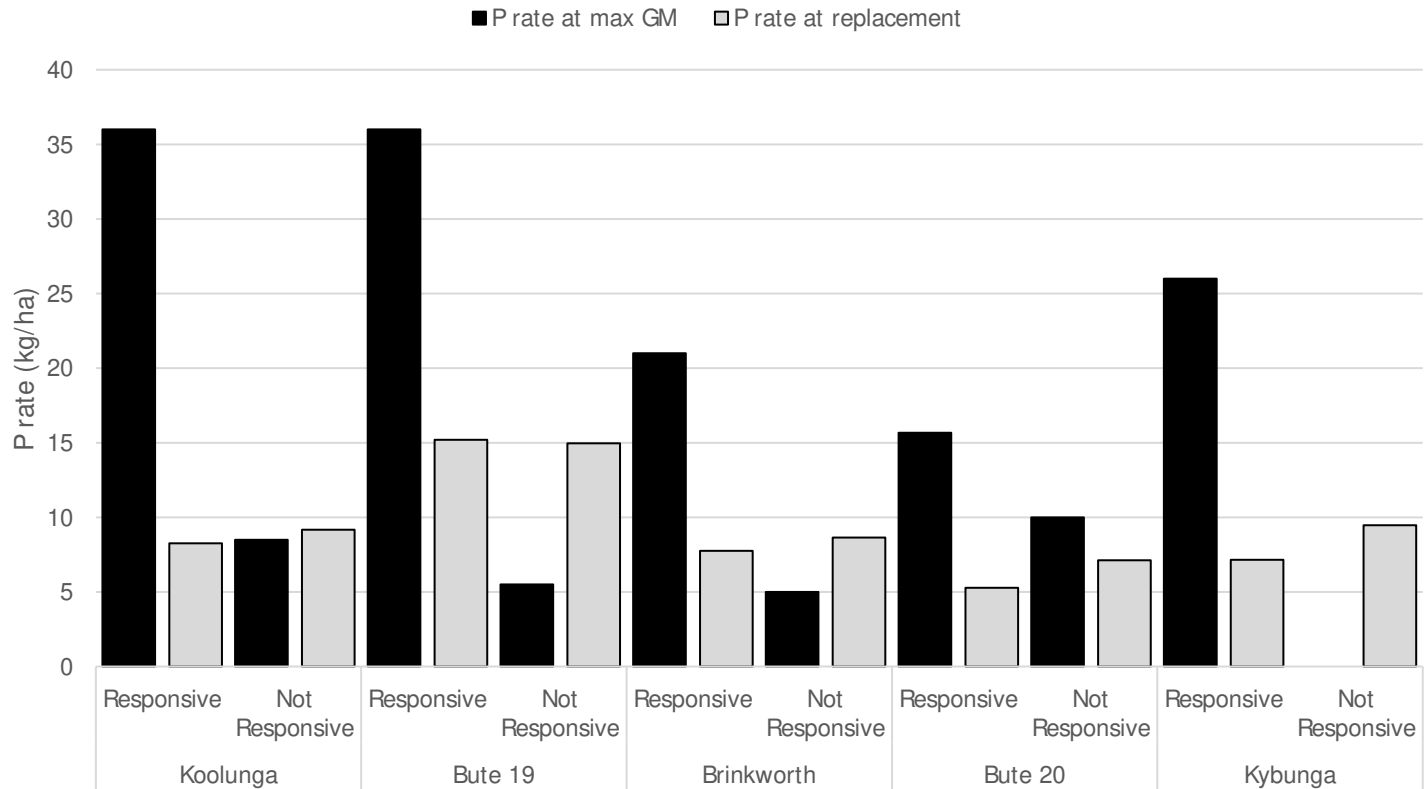


Colwell P



MATCHING P RATES WITH SOIL CHARACTERISTICS

Phosphorus rates – PGM vs Replacement



Soil pH stratification

Yorke Peninsula

Sample ID	994	999	992	1001	1004	993	1003	1000	995	998	997	991	996
Veris pH	4.7	4.93	5.14	5.15	5.21	5.92	6.31	6.59	6.95	7.05	8.02	8.07	8.07
Depth													
0-5cm	5.7	5.4	6.2	5.4	5.2	6.1	5.9	6.6	6.3	6.3	7.4	7.5	7.5
5-10cm	4.9	5.0	5.2	5.0	4.5	5.0	6.3	6.1	6.6	7.1	7.6	7.7	7.7
10-15cm	4.4	5.6	4.3	4.3	4.9	5.1	7.3	6.1	7.2	7.5	7.7	7.8	7.7
15-20cm	4.9	4.9	4.8	4.6	4.7	5.7	7.6	6.3	7.8	7.7	7.6	7.7	7.7
Ave 0-10cm	5.3	5.2	5.7	5.2	4.9	5.6	6.1	6.4	6.5	6.7	7.5	7.6	7.6
Ave 0-20cm	5.0	5.2	5.1	4.8	4.8	5.5	6.8	6.3	7.0	7.2	7.6	7.7	7.7

Mid North

Sample ID	26	27	28	29
Veris pH	4.6	5.99	6.5	6.25
Depth				
0-5cm	5.6	5.6	6.4	6.2
5-10cm	4.6	4.7	6.4	6
10-15cm	4.4	4.6	7	6.7
Ave 0-10cm	5.1	5.2	6.4	6.1
Ave 0-15cm	4.9	5.0	6.6	6.3

Lime incorporation –

Ripping

Ripping + inclusion plates

Spading, Plozza

Deep cultivation/disc