Practising precision II: Making precision pay

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Abstract

PIP (Precision in Practice) is an innovative new approach to identify and treat management zones. PIP is a two phase process -Phase 1 enables farmers to accurately and cost effectively identify zones within paddocks or management units that are statistically different. This is addressed in Practising precision I. This paper addresses PIP Phase 2 **-** the agronomic and farm system implications of this tool to determine the optimal allocation of resources in the production system, so that both the soil resource and farm profit improve. Using the zone and landscape information developed by PIP Phase 1, in conjunction with the experience of the land manager and their agronomist, PIP Phase 2 supports the development of a soil sampling plan by zone. Understanding that soil chemistry may not be the only issue, laboratory results are examined in the context the soil and landscape findings and where appropriate ameliorants, seed and fertilizer requirements can be accurately entered into controller maps for variable rate application.
The case study below demonstrates the potential for savings to be made.

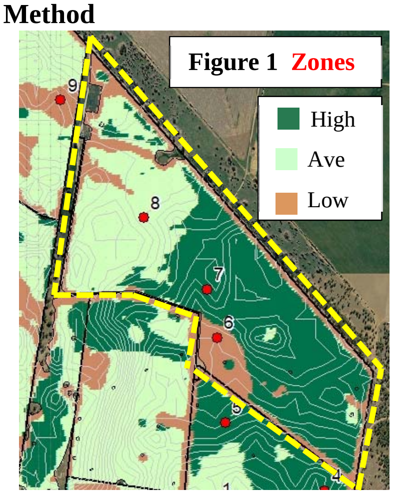
Key Words

precision, zones, variable rate, soil, cost benefit, decision making

Introduction

The quality and reliability of data being used to make decisions in farming systems is of serious concern particularly where soil and 'precision' products are concerned. This situation has led to a collaboration between Terrabyte and 3D-Ag with the subsequent development of an 'outcomes based' precision platform called Precision in Practise or PIP. PIP Phase 1 (PIP 1) produces a scientifically based platform of zones within a paddock or management unit using a base of satellite imagery and spatial statistics, as described in the paper Practising Precision 1.
In PIP Phase 2 (PIP 2) the land manager has some solid background information provided by PIP 1 from which can be devised a plan of actions to expand the evidence base for decision making. Guided by PIP 1 soil and landscape assessment, more comprehensive soil testing can be targeted by zone to identify the barriers to production, which are seldom captured by the standard 0-10 cm sampling alone. Selective sampling to depth can potentially uncover constraints which can be hostile to root growth and therefore limiting the volume of soil plants have to retrieve water and nutrients.
With a greater understanding of the environment into which a crop is being sown, the grower can: make better informed choices regarding crop type and/or variety; and use more appropriate levels of inputs as matched to a more realistic yield outcome. Where variable rate machinery is available, more targeted inputs of seed, fertiliser or soil amendments can be used to manipulate the growing environment to increase the growth potential accordingly.

Method



The following is presented as a brief case study of a cropping farm.

The farm concerned is north-west of Wagga Wagga adjacent to the Murrumbidgee River. A 120 ha paddock highlighted in Figure 1 shows the zoning result from PIP 1. The zone designation High relates to higher performing and so on.

PIP 1 also revealed this paddock to be 128.8 ha in total, of which 123 ha is arable.

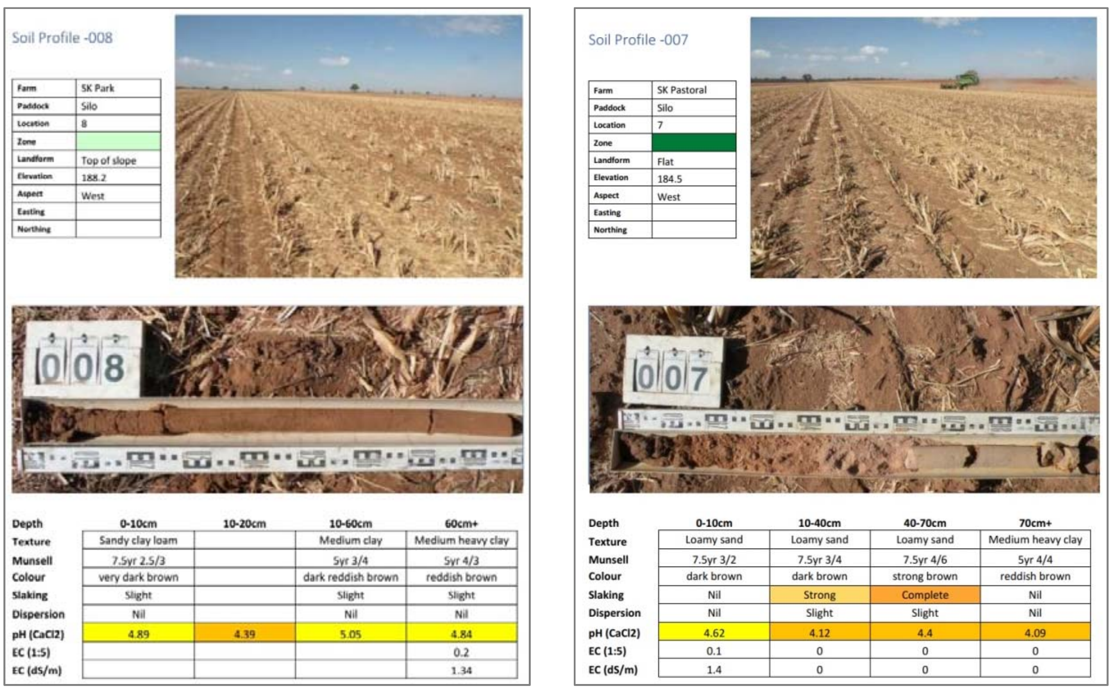
The issues identified from PIP 1 warranting further investigation included:

- The presence of an apparent 'acid throttle' below the surface 0-10 cm

- Soil clay and organic matter content, as impacts water holding capacity and growth potential

The grower chose to carry out further soil testing to depth, nominating the two larger zones within the subject paddock (Fig. 1) to undergo analysis on soil samples from 0-10cm, 10-20cm, 20-40cm, 40-60cm and 60+ cm with a transect of 30 cores per zone composited and sub-sampled for 0-10 and 10-20 cm (Eds Peverill et. al. 1999) and 15 cores per zone composited for samples to depth (Conyers pers. comm.)

The paddock concerned is adjacent to a roadway which has created issues with water movement across the northern section within the average zone. The soil and landscape assessment (Figures 2 and 3) showed a difference in the depth of sand, a potential acidity issue (despite the paddock having been limed) and a soil stability issue in the area of the paddock that is currently performing better. From a physical point of view the core extracted from the Average zone clearly shows more structure than its counterpart from the 'better performing' high zone?


Soil Profile -008

Farm	SK Park
Paddock	Silo
Location	8
Zone	
Landform	Top of slope
Elevation	188.2
Aspect	West
Easting	
Northing	

Depth	0-10cm	10-20cm	10-60cm	60cm+
Texture	Sandy clay loam		Medium clay	Medium heavy clay
Munsell	7.5yr 2.5/3		5yr 3/4	5yr 4/3
Colour	very dark brown		dark reddish brown	reddish brown
Slaking	Slight		Slight	Slight
Dispersion	Nil		Nil	Nil
pH (CaCl2)	4.89	4.39	5.05	4.84
EC (1:5)				0.2
EC (dS/m)				1.34

Soil Profile -007

Farm	SK Pastoral
Paddock	Silo
Location	7
Zone	
Landform	Flat
Elevation	184.5
Aspect	West
Easting	
Northing	

Depth	0-10cm	10-40cm	40-70cm	70cm+
Texture	Loamy sand	Loamy sand	Loamy sand	Medium heavy clay
Munsell	7.5yr 3/2	7.5yr 3/4	7.5yr 4/6	5yr 4/4
Colour	dark brown	dark brown	strong brown	reddish brown
Slaking	Nil	Strong	Complete	Nil
Dispersion	Nil	Slight	Slight	Nil
pH (CaCl2)	4.62	4.12	4.4	4.09
EC (1:5)	0.1	0	0	0
EC (dS/m)	1.4	0	0	0

Figures 2a. and 2b. An example of the results from the soil and landscape assessment for the subject paddock

Table 1. The zone soil test results from PIP 2

SK Pastoral			Zone soil tests						Date	2019	
Test code	E13	0-10 & 10-20	E26	20-40 etc							
		Average	Subject pdk				High	Subject pdk			
Sample ID		5A	5B	5C	5D	5E	6A	6B	6C	6D	6E
Depth To		0-10	10-20	20-40	40-60	60-100	0-10	10-20	20-40	40-60	60-100
Colour		Brown	Red	Brown	Orange /Yellow	Orange /Yellow	Brown	Brown	Brown	Brown	Brown
Texture		Clay Loam	Clay Loam	Clay	Clay	Clay	Sandy Loam	Sand	Sand	Clay	Clay
OC	%	0.99	0.48				0.88	0.24			
pH (CaCl2)		5.1	4.7	5.8	6.8	8.1	5	4.3	4.6	6.5	6.4
EC (1:5 H2O)	dS/m	0.12	0.05	0.06	0.23	0.51	0.09	0.03	0.03	0.06	0.07
N	mg/kg	34	7.8				35	7			
P	mg/kg	61	16				50	21			
PBI		52	51				29	34			
K	mg/kg	290	150	200	450	530	180	110	72	160	330
S	mg/kg	8.1	4.9	3.2	20	47	5.3	2.6	2.2	2.3	6.9
Al	%	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	19	5.4	<1.0	<1.0
Ca	%	72	66	47	29	40	81	55	66	51	45
Mg	%	13	22	36	51	41	7.4	12	16	38	43
Ca:Mg		5.7	2.9	1.3	0.6	1	11	4.6	4.1	1.4	1.1
K	%	13	7.9	7.7	5.1	4.5	11	12	9.3	5.4	4.9
Na	%	2.1	3.9	8.5	15	14	0.9	3.1	3.3	5.8	6.9
CEC	Meq/100g	5.74	4.84	6.71	22.5	29.8	4.2	2.36	1.97	7.48	17
Cu	mg/kg	0.4	0.38				0.19	0.21			
Fe	mg/kg	120	65				130	75			
Mn	mg/kg	24	17				12	15			
Zn	mg/kg	0.3	0.14				0.24	0.09			
Bo	mg/kg	0.65	0.5	0.76	2.5	3.7	0.36	0.19	0.2	0.44	1

The soil testing by zone revealed some interesting points…

- there is a sub-surface acidity issue

Interestingly however it is the High zone where this is more defined and is associated with elevated Aluminium.

Exchangeable Sodium Potential (ESP) levels are also elevated in the sub-surface in both zones.

What this reveals is a need for as deep as possible incorporation of lime to address the acidity developing at 10-20 cm and to mop up the Aluminium.

More difficult to address is the deeper structural issues. Trials investigating the deep incorporation of organic matter conducted by Tavakkoli et.al. (2019) look promising and may provide a useful option here if the cost benefit is favourable. The only other option is 'biocultivation' via a strong deep rooting crop such as safflowers.

All this information should however also be indicating to the trained observer that this paddock has more than a chemistry issue. Looking at the physical soil cores and the test results, without the zoning information, it would appear that the average zone has the 'better' soil. Therefore the question becomes why isn't it being expressed in performance? This is where knowledge of the paddock becomes important. Addressing the issue of water movement may be the key to unlocking more potential in the average zone or at least a portion of it.

With the information to hand the grower decided the drainage issue was a priority. Creating a roll through water course to carry excess water to an existing drain to the west is now part of the plan, with an estimated cost of around $5,000.

The targeted lime application for the subject paddock was to be a 'blanket rate' of 2.0 t/ha (a total of around 250 tonnes). The zoning information allows the potential for the lime to now be allocated on the basis of the zones developed, thus the Low zone will be targeted to receive no lime, the Average zone 1.0 t/ha and the High zone 2.0 t/ha. A variable rate map file is prepared for the variable rate spreader. Once applied, the lime will be worked in to 20 cm to facilitate addressing the acid throttle at 10-20 cm.

Preliminary estimates of the savings in lime for this one paddock are around 96 tonnes
i.e. $65 x 96 t or $6,240

Taking the same approach to the other planned inputs of animal manure and MAP fertiliser Table 2 shows the full extent of potential savings comes to $110.09 per hectare. In cost benefit terms it is a return on investment (ROI) of $87.66 per hectare.

Table 2. A cost benefit calculation of the planned variable rate inputs v 'blanket' application

Subject Pdk	ha	Lime		Animal manure		MAP		
		Rate t/ha	Amount	Rate t/ha	Amount	Rate kg/ha	Amount	
'Blanket rate'	123	2	246	4	492	60	7380	
Cost $		**$65**	**$15,990**	**$70**	**$34,440**	**$0.70**	**$5,166**	
By zone								
High	56	2	112	2.5	140	60	3360	
Average	38	1	38	3	114	40	1520	
Low [a]	15	0	0	10	150	30	450	
Low [b]	14	0	0	0	0	30	420	
			150		404		5750	
Cost $			**$9,750**		**$28,280**		**$4,025**	
Saving			**$6,240**		**$6,160**		**$1,141**	
Low [a] relates to the two sandhills in the paddock						**Total saved**	**$13,541**	
Low [b] relates to the paddocks edges and watercourses							**$110.09**	**/ha**
			Cost of PIP 1 & 2 inclusive of lab costs				**$22.43**	**/ha**
						ROI	**$87.66**	**/ha**

While this set of results are very encouraging it is unlikely that all situations will make the decision-making process so easy.

Targeted inputs may not necessarily decrease the grower's costs overall, initially at least, but they should give the best opportunity for a return on the investment. In this case however, a positive cost benefit is indicated with significant savings shown. At harvest yield maps will be produced to gauge any flow on benefits. It is envisaged increased yields are likely in the longer term, through areas within zones transitioning toward better performance (low to average and average to high) further improving the potential for profit.

Conclusion

The PIP process has been shown to have merit. Investing in understanding the soil and landscape in which our food and fibre is grown is a crucial part of sustaining productivity and providing opportunities for management to build resilience against increasing volatility of seasonal conditions and shifting policies.

References

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