Nitrogen Removal Maps Collected from Australian Paddocks during the 2015 and 2016 Grain Harvest.

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Introduction:

Protein is made up of approximately 17.5% Nitrogen. When grains, pulses, oil seeds and other crops are grown, Nitrogen is removed from the soil and ends up in the plant tissue and seeds as Protein. This simple relationship can be used to generate a Nitrogen Removal Map (NRM) based on protein and yield maps collected using an on combine NIR analyser and a yield monitor. The NRM can then be used to generate a Variable Nitrogen Rate map showing the amount of Nitrogen that must be added back to the soil as fertilizer in order to sustain the available Nitrogen in the paddock for the next crop.

An On Combine NIR Analyser is the tool needed to quantify the Protein in the seeds and thereby the amount of Nitrogen removed from the soil through the seeds. This article looks at Protein, Yield and Nitrogen Removal Maps collected from Australian farms during the 2015 and 2016 harvests

Description:

More than 100 farmers in Australia, USA, Canada and the UK have now installed the CropScan 3000H On Combine Analyser into their combine harvesters. Three growers were asked to provide protein, yield and GPS data from a single paddock off their farms. The growers were selected from South Australia and Victoria. The protein data was collected by the CropScan 3000H at a frequency of approximately 11 seconds per reading or approximately every 50 meters. The GPS coordinates were taken from the combine's GPS receiver and added into the Protein data file. The Yield data was collected a much higher frequency, i.e. 1- 2 seconds. By aligning the Protein and Yield data at each GPS coordinate, a file was generated that contained Protein, Yield and GPS coordinates. Farmworks was used to import these files and generate Protein and Yield maps.

The following computation was applied in Farmworks to each of the aligned data points in order to generate the Nitrogen Removed value for each data point.

N removed (kg N/ha) = Yield (kg/ha) x Protein (%) x 0.00175

e.g. N Removed = 4340kg x 14.5 x 0.00175
= 110.2 kg/ha

The Nitrogen Removal Map was generated by plotting the N Removed at each GPS coordinate.

Case Study 1: Figures 1 and 2 show a Protein map and a Yield map off the Tintara Pastoral property of Ashley and Louise Wakefield, Urana, York Peninsula in South Australia. The Wakefields run a John Deere S970 Combine with the Greenstar GPS and Yield Monitor. The Protein map shows protein readings at approximately every 50 meters across the paddock. Figure 3 shows the Nitrogen Removal Map for the Wakefield's 221A paddock where they grew hard wheat in 2015.

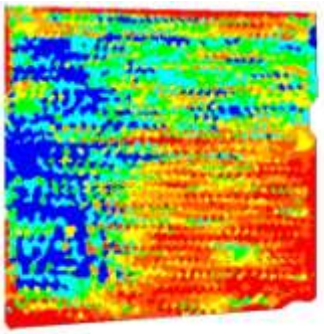

Figure 1. Protein Map

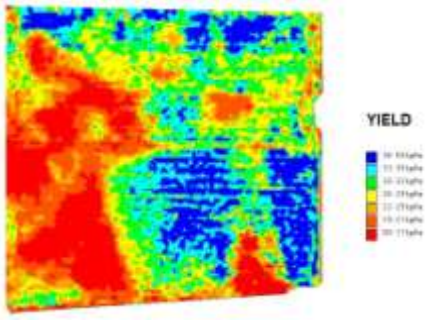

Figure 2. Yield Map

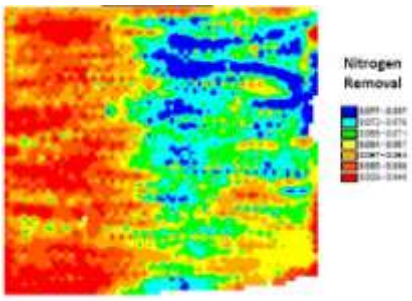

Figure 3. Nitrogen Removal Map

The Protein and Yield maps support the Dilution Theory that yield and protein are inversely related, however there are areas within this paddock where the Dilution Theory does not hold. In the bottom right hand corner of the Yield map there is a red section where the yield is low and in the Protein map the same area is also red indicating low protein. This suggests that this area is suffering from a nutrient deficiency. Additional Nitrogen could increase both the yield and protein content in this area.

The Nitrogen Removal Map shows that in the top right hand corner of the paddock, there is more Nitrogen removed than elsewhere in the paddock. The left hand side of the paddock shows a very consistent pattern that would suggest a higher N application rate would increase the protein content but reduce the yield. The right hand side of the paddock shows considerable variation in N removed and suggests that a Variable Nitrogen Rate (VNR) application would be beneficial.

Mr. Wakefield assessed the cost savings of applying Urea based on the NRM against a blanket rate across the entire paddock. Table 1 shows the cost analysis based on Urea at $437/tonne and applying Urea using VNR versus blanket application rates of 40, 56, 60, 70 and 80 kg per hectare. Note that previously Mr. Wakefield had applied 56kg/hectare across this paddock. Based on this data, it can be seen that Mr. Wakefield could reduce his Urea costs by 13% = $1562 for this paddock. However if he used a higher blanket rate of Urea to increase protein and/or yield then the cost savings would be even greater.

Table 1. Cost Analysis of VNR vs Blanket Fertilizer Application

	Cost of Urea using VRF	Cost of Urea at 40kg/H	Cost of Urea at 56kg/H	Cost of Urea at 60kg/H	Cost of Urea at 70kg/H	Cost of Urea at 80kg/H
Cost	$10,632	$8,710	$12,194	$13,065	$15,243	$17,420
Savings		-$1,922	$1,562	2433	4611	6789
Savings/H		-10.4	8.4	13.2	24.9	36.7
% Savings		-22	13	19	30	39

Case Study 2: The next case study was taken from the farm of Thomas Schmucker, Kimba, Eyre Peninsula in South Australia. Mr Schmucker runs a CASE IH 7160 combine fitted with GPS receiver, Yield Monitor and CropScan 3000H. The paddock is called Longdam and covers approximately 280 hectares. Figures 4, 5 and 6 show the Protein, Yield and Nitrogen Removal maps for this paddock where he grew hard wheat in 2016.

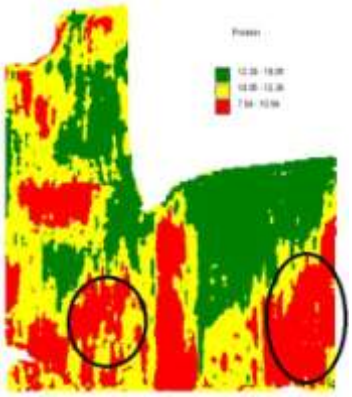

Figure 4. Protein Map

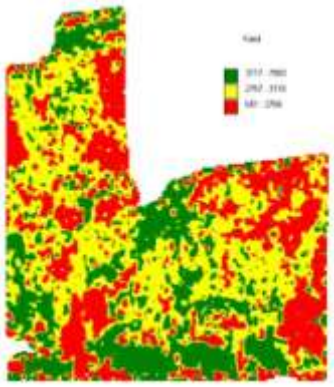

Figure 5. Yield Map

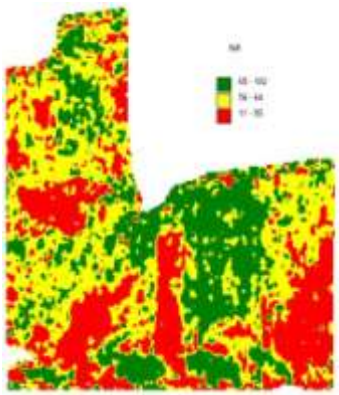

Figure 6. Nitrogen Removal Map

The Longdam paddock exhibits gradual undulation and the soil types vary from gray clay to sandy clay to sand from top to bottom. This paddock was originally four paddocks that were separated by fences. In general the high yield zones correspond to low protein and vice versa, however there are two areas where the yield and protein are low, ie, lower left hand corner and right side bottom. These two areas could potentially be targeted for additional N fertilizer.

Mr Schmucker advised that they plant legumes as a rotation crop in order to replenish the Nitrogen in the soil, however the specific legume does not grow evenly across the paddock especially in the sandy soil types. As such the Nitrogen availability across the paddock is not consistent.

The Nitrogen Removal Map could be used to develop a Variable Nitrogen Rate prescription in order to even out the protein and yield across this paddock. Table 2 shows the Urea cost analysis of using a variable Nitrogen rate application versus a blanket rate of 60, 80, 100 and 120kg/Ha.

Table 2. Urea Cost Analysis

	VRF	60kg/Ha	80kg/Ha	100kg/Ha	120kg/Ha
Urea Cost $	36511	36365	41214	60608	72730
Savings $		-146	4703	24098	36219
Savings $/Ha		-0.6	17.8	91.3	137.2
% Savings		0%	11%	40%	50%

Case Study 3: The third case study is for a farm in the Malley region of Victoria. Mr Leeton Ryan operates a mixed farm at Winnambool and grows wheat, barley and some pulses. The CropScan 3000H was fitted to CASE IH 8240 combine purchased through Sunrise Ag in Ouyen, Victoria.

Figures 7, 8 and 9 shows the Protein, Yield and Nitrogen Removal maps for Mr Ryan's Elertons paddock where he grew wheat in 2016. Mr. Ryan's agronomist, Michael Ayres, Injecta, Adelaide, SA, has commented on the Elertons' maps.

“Farmers traditionally have always obviously concentrated on the "timing of management" for planting and the productivity of their crops. Now they need to "manage the timing" to further add value to the uptake and availability of Nitrogen and other nutrients as they relate to soil performance. The zones in the Ellertons paddock are defined by the sodic soils, dispersive clay layers and higher rising ground (sandy soil). The high yield zones in this particular paddock are located in the higher rising sandy soils whereas the high protein zones are in the more sodic soil management zones.

The Yield map correlates directly to soil performance and the Protein map is a very good proxy for plant performance. The Nitrogen data is what makes everything else fit together, ie, productivity and performance. The on combine protein analyser is a tool of exceptional value whose true value is only just starting to be well enough understood"

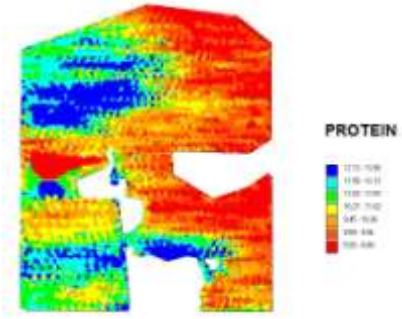

Figure 7. Protein Map

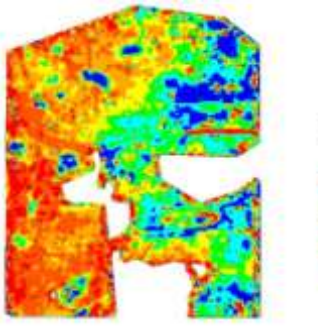

Figure 8. Yield Map

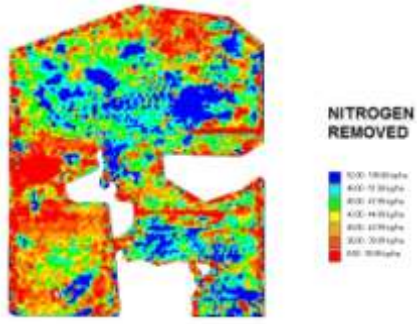

Figure 9. Nitrogen Removal Map

Commentary:

Protein mapping is now a reality. As with any new technology there are anomalies and glitches but during the 2016 harvest, 100 + farmers used the CropScan 3000H On Combine Analyser to measure protein in their paddocks. The majority of the users have used the protein data to blend grain in the paddock in order to optimize payments based on protein premiums, or they have segregated their grain into on farm storage facilities based on the Bin Average Protein data generated by the CropScan 3000H. There have been many examples where farmers have increased their revenues by using the CropScan 3000H for in paddock blending and on farm segregation.

There have also been several farmers who have used the Protein mapping as a Precision Ag tool and have also benefitted from increasing yield, receiving higher premiums for protein and reducing Nitrogen fertilizer costs.

Mr. Matt Hill, Coolinup, WA, operates 4 x New Holland CR9090 combines fitted with on board yield monitors and CropScan 3000H Grain Analysers installed by Staines Esperance WA. Mr Hill has made the following comments regarding the use of the protein data from the CropScan 3000H and other PA inputs to increase productivity across his farms.

“I have been able to combine the yield and EMI maps collected over many years, and now protein maps to develop zones across the farm. We have been able to look closely at the yield response curves to optimise VNR application across the paddocks. The increase in yield and protein in certain zones across the farm have resulted in a significant return on investment for the PA equipment and services. By going to Variable Nitrogen Rate applications we have been able to increase the tonnage, to jump to higher protein grades and also to reduce our input costs. “

The missing piece of the Precision Agriculture puzzle… Protein Mapping, is now available using the CropScan 3000H On Combine Analyser… an Australian designed and manufactured product.