How to Profit from Real-time Protein Mapping:

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Introduction:
Near Infrared analyzers have been used by grain growers for more than 20 years to measure the protein, moisture and oil in their crops. Where farmers have invested in on farm storage, the importance of having a NIR analyzer to measure the grain quality and to segregate crops into silos, sheds, bags or bunkers is even greater. The next generation of NIR analyzers has been developed whereby the protein, moisture and oil data can be collected in real-time as the grains are stripped in the field. On combine NIR analyzers provide real-time protein data that allows farmers to blend and segregate their grain while in the field. With this real-time information, farmers can generate thousands of dollars more in payments across their fields. As well, the protein data can be combined with yield data collected from the field to generate Nitrogen Removal Maps and Variable Rate Fertilization applications which can assist farmer in optimizing productivity and profitability. This paper provides several examples of how farmers have increased their profits by using the CropScan 3000H On Combine Analyzer.

Description:
The CropScan 3000H On Combine Analyzer has been installed in more than 100 combines around the world. The system consists of three parts: Remote Sampling Head, NIR Spectrometer and Touch Screen PC. The schematic below, figure 1. illustrates how the system is connected. The Remote Sampling Head is mounted to the clean grain elevator. The NIR spectrometer and Touch Screen PC are located inside the cabin. The GPS receiver fitted to the combine is connected by a RS232 cable to the Touch Screen PC. A proximity sensor is located on the out loading auger and connected to the NIR spectrometer so that the system knows when the bin is being out loaded. Figure 2 shows the Remote Sampling Head mounted to a CASE combine. The Sampling Head can be mounted to any combine brand or model.
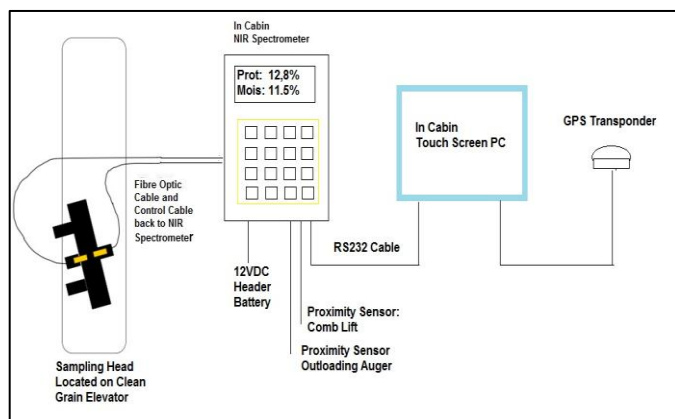

Figure 1. Schematic of how the CropScan 3000H components are connected.

As grain passes up the clean grain elevator, a portion falls into the Remote Sampling Head where a set of flaps traps the grain in the flow cell. NIR light passes through the sample of grain and a fiber optic cable carries the light back to the NIR Spectrometer. Within the NIR spectral region, protein, moisture, oil and starch absorb energy. The more energy absorbed at the appropriate frequencies for protein, moisture, oil and starch, the higher the concentration. The NIR Spectrometer generates what is referred to as the NIR spectra for each sample of grain. The spectra are sent to the PC where calibration models are applied for protein and moisture in wheat and barley, protein, oil and moisture in canola, and protein, oil, moisture and starch in corn and soybeans.

The Touch Screen PC is the control centre for the CropScan 3000H. The software displays the protein, moisture and oil data in the form of tables, trend plots, field maps and Bin Averages. The data is stored in the PC and the Bin Average data is sent to the internet where it can be viewed from a Smart Phone, tablet or PC.
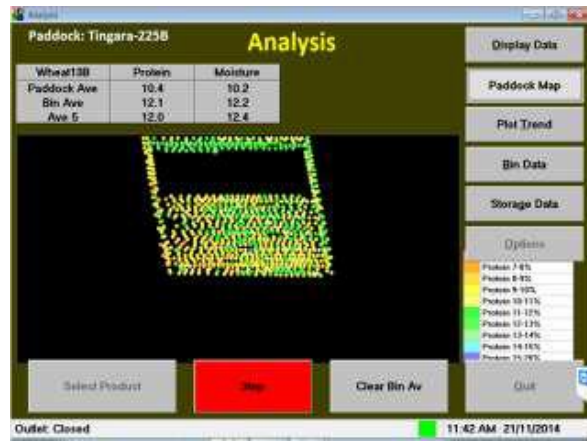
Figure 2. Remote Sampling Head.

Figure 3 shows the screen of the in cabin PC.

As compared to using a bench top NIR analyzer at the storage silos, the CropScan 3000H On Combine Analyzer provides data in the field. Many users have discovered that once they can see the variation that occurs for protein across their fields, they quickly work out how they can selectively strip the grain and blend it either in the combine's bin or into field bins located around the field. Other users have gained significant benefits from using the Protein and Yield Maps to optimize their productivity and profit.

The case studies below provide details on how farmers profited from Real-time Protein Mapping.

Case Study 1: In Field Blending:
Mark and Jordan Hoskinson farm 8000 hectares at Kikora, NSW. They installed a CropScan 3000H into their John Deere combine in 2014. In one large wheat field Jordan quickly realized that there was a 4-5% variation in protein across the field. He started to strip grain from one section of the field where the protein content was up to 15%. As the bin filled he would monitor the Bin Average for protein as displayed on the PC. He would monitor the tonnage in the bin and when it reached 5 tonne, he then stripped grain from another section where the protein was 9-11%, thereby blending
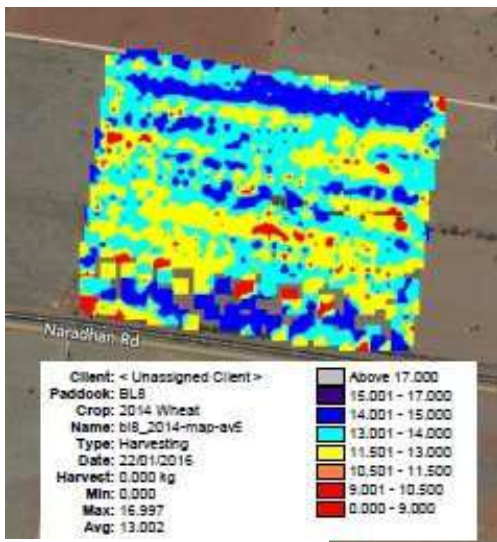
the grain based on protein. He would monitor the Bin Average for the protein as he filled the bin with the lower protein wheat. When the average reached 13.5%, he would go to the field bin and out load the grain. He stripped this field over several days and reported that they trucked every load to the GrainCorp silos at Kikora and had every load accepted as APH1 grade. At that time APH1 was paying $30 per tonne more than APW grade. The Hoskinsons reflected that in previous years this field had produced a mixture of low and high protein grades. Overall, the ability to blend in the fields across their farm had generated an estimated $40,000 in higher payments as compared to previous years. Figure 4 shows the Protein Map for the field mentioned above.

Figure 4. Protein map for wheat

Case Study 2: On Farm Segregation and Storage.
Luke Follett, Pindara, Euston, NSW grows approximately 6000 tonne of wheat. He operates 2 CASE 8130 combines and he installed a CropScan 3000H onto one of his combines in 2014. Luke has 6 x 1000 tonne silos on farm where he segregates his grain into ASW, APW, AHI and AH2 grades. Luke uses the local AgFarm agent to market his wheat to domestic users. The CropScan 3000H software calculates the Bin Average for protein for each bin load and then posts the Bin Average to the internet in real-time. The combine operator uses the Bin Average data to segregate the loads into

specific field bins based on grade. Trucks are filled from the field bins and taken back to the farm's silo complex. The protein, moisture and weight of every truck load that is stored into each silo is received from the internet and stored in the farm's PC.

Fabian Devereaux, AgFarm, has access to Luke's data by signing into the CropNet web site. He can see what is stored in each silo as shown in figure 5 and 6. Fabian can then market the grain in each silo based on the running average with confidence that the protein will meet the buyer's requirements.
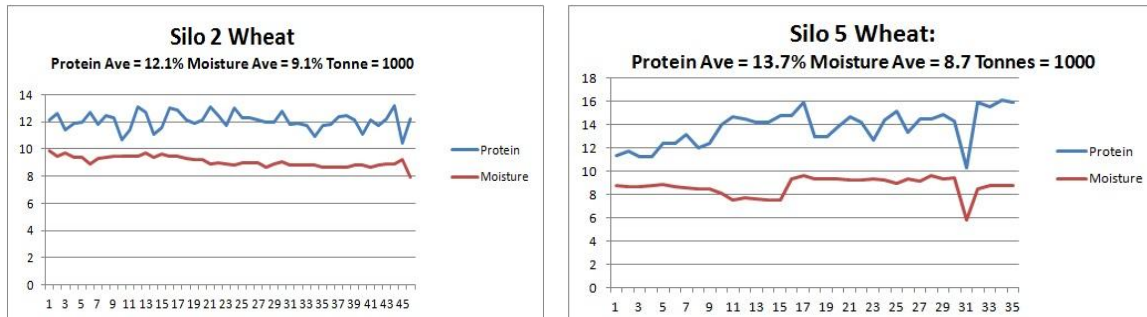

Figure 5 and 6. Plots of protein and moisture of wheat stored in silos 2 and 5.

Luke advised that AgFarm were able to secure an additional $5 per tonne for 1000 tonne of wheat from the buyer in guarantee that the average was 12+% protein. He also commented that all truck deliveries passed inspection by the buyer. Since Euston is over 400km from Melbourne, rejected truck loads have in previous years cost him thousands of dollars in penalties and/or returned loads.

Case Study 3: Optimizing Protein and Yield.
Matt Hill, Coolinup, WA, operates 4 x New Holland CR9090 combines fitted with CropScan 3000H On Combine Analyzers installed by Staines Esperance WA. Mr Hill 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 fields. 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. "

Case Study 4: Agronomic Benefits:
Steve Larocque, Beyond Agronomy, Alberta, Canada, installed a CropScan 3000H to his JD9750 combine in 2016. He provided the following comment;

"The ability to map protein and combine it with yield mapping is where the magic happens. The sensor gives you an average protein and moisture content for each hopper load. In cereals this may help you segregate high versus low protein wheat or malt barley. I've seen some producers do their own on farm blending using a grain cart. This technology would make it that much easier to blend grain when you know what you have.

 "I can see this technology on every combine in the future as it holds great potential to evaluate components of your agronomy program like fertility, fungicides, seeding rates and varieties. It can also be used to segregate grain based on moisture or protein content. It can help avoid heated canola by having accurate moisture readings and improve malt barley selection by blending yourself on farm or storing high protein away from barley that meets spec. I'm really looking forward to

sharing my research findings this year using the CropScan 3000H. It's one of the most useful pieces of technology I've purchased in some time. SL"

Case Study 5: Pushing your fields to their fullest potential... Real-time protein mapping is the Missing Piece of the PA puzzle.
When protein and yield data are available across a field then the following maps can be generated;

- Protein and Yield Maps
- Nitrogen Removal Maps
- Gross Margin Maps
- Diagnostic Maps

However the most powerful information provided by real-time protein maps is the understanding of the variability of the quality of the grain across the field. Most farmers believe that there is little variation in protein across their fields. When the farmer sees Protein maps of their fields, they are amazed. Using the protein and yield data to generate a Nitrogen Removal Map then shows the farmer how the protein/yield balance can be optimised to increase profitability.

Figure 7 shows the Protein, Yield and Nitrogen Removal Maps for a 439 ha wheat field from Beefwood, Croppa Creek, New South Wales. Glen Coughran, Farm Manager for Beefwood, runs 4 Claas Lexion combines of which 2 combines have the CropScan 3000H installed. The yield map shows three zone that can be examined, ie, top, middle and bottom.
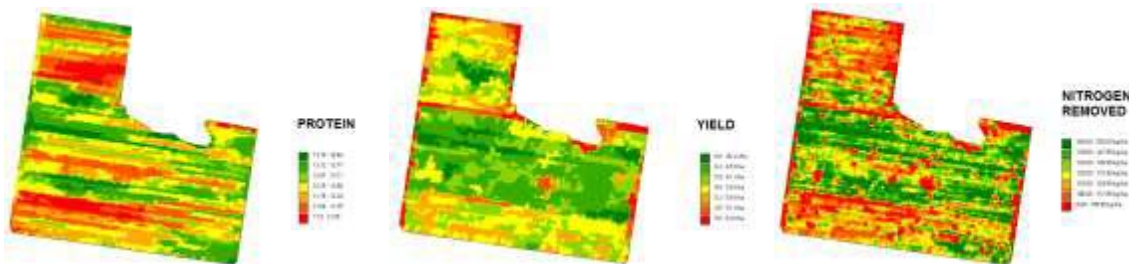

  Figure 7. Protein, Yield and Nitrogen Removal maps of a 439 ha field in north NSW.

In the middle zone, the protein and yield are both high, where as the top and the bottom zones, the protein and the yield are lower than in the middle zone. The maps suggest that the top and bottom zones could realize an increase in protein and yield by applying more Nitrogen. However it could also be that too much Nitrogen is being used in the middle zone, since the protein average is well above the 13.5% target. By reducing the Nitrogen applied in the middle zone and increasing the Nitrogen applied to the top and bottom zones, they may be able to balance the protein and yield across the field. Assuming that the yield can be increased by 0.6 tonne /ha in the top and middle zones to bring it in line with the yield for the middle zone, then it would increase the revenue for this field by an estimated $40324.

The potential increase in revenues from a field by using the combined Protein and Yield maps to generate Nitrogen Removal Maps which then leads to Variable Rate Nitrogen Fertilization application is one of the biggest benefits of Real-time Protein mapping. Beefwood produces more than 20,000 tonne of mixed grains each year. VNR has the potential to increase profitability by at least 10-20%.

Conclusion:
Farming is about converting water into grain. When there is sufficient water available, then the farmer's task is to optimize the yield and to get the best price for the grain. Variable Rate Fertilization applications can help to achieve the optimum yield across fields, and real-time protein data can help blend and segregate to achieve the best pricing for the grain.