

# Nitrogen Measurement in the Field.



## How much are you leaving In your paddocks?

“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. “

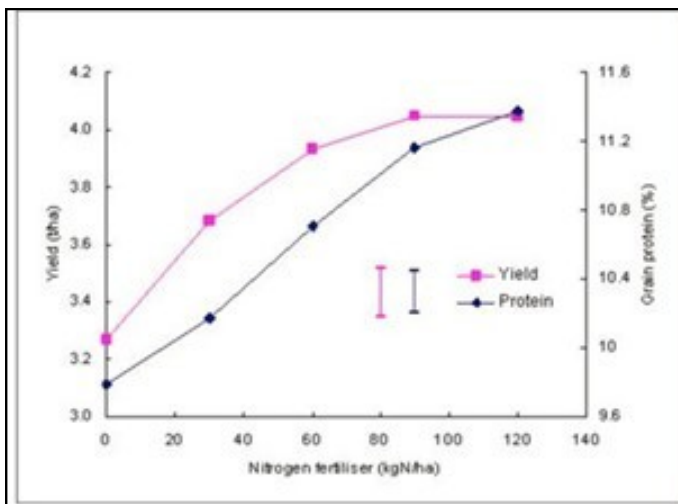
Michael Ayres, Injecta, SA,

The CropScan 3000H On Combine Analysers measure Protein and therefore Nitrogen in your grain in real-time.

Understanding the Protein/Nitrogen/Yield Balance will enable you to optimise the yield and get the best price for your grain.

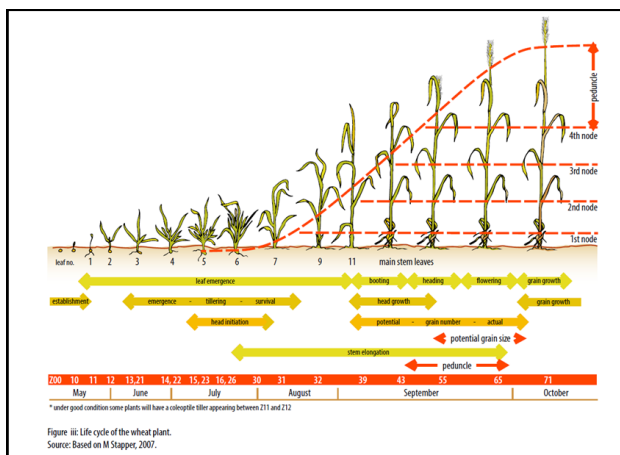
## What is the Protein/Nitrogen/Yield Balance?

The optimum protein level for growing wheat or barley is between 11 and 12% as shown in the diagram below. At this protein level, the yield should be approximately 4 tonne per hectare if there is sufficient Nitrogen and moisture in the soil and there are no micro nutrient deficiencies. The objective should be to achieve the highest yield at the highest protein premium.



Nitrogen needs to be available at both the tillering stage and the reproductive stage in order to achieve optimum yield at the correct protein level.

Nitrogen is required in the early stages of plant development i.e. emergence and tillering.



There needs to be sufficient nitrogen to produce enough tillers to ensure that the crop is set up to reach the optimum or target yield. Once the plant has reached the growth stage, DC30, the head size has been determined and the plant has finished tillering, then the potential yield has been set, but not realised.

Head size is determined at the 5-6 leaf stage, before you can see it. Nitrogen is required in all growth stages to ensure that the heads are fully developed. If there is not enough Nitrogen in the soil during tiller production, head formation or flowering then the plant will adjust yield potential in line with the available Nitrogen. If there is sufficient Nitrogen in the soil then the heads should fill completely, i.e. achieve their full yield potential, and reach their optimum protein levels.

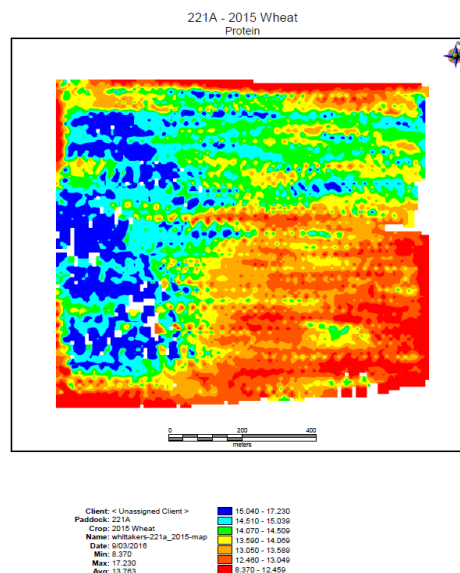
Water is the No. 1 driver of final yield and Nitrogen is the second most important factor. If you have sufficient water in the soil but not enough Nitrogen then the yield will be limited. Adding more Nitrogen to a field where there are low tiller numbers and therefore low head numbers, will not recover the yield potential. The added Nitrogen will only be used by the plant to produce protein.

### Protein in seeds is directly related to Nitrogen:

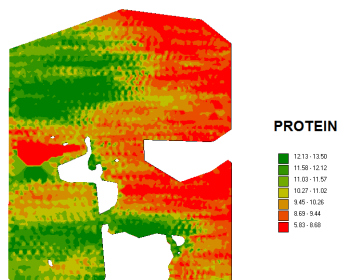
Nitrogen makes up 17.5% by weight of all protein molecules, i.e.  $\text{Nitrogen\%} = \text{Protein\%} \times 0.0175$  (Wheat grains. Other seeds have slightly different conversion factors).

As such for every tonne of wheat grains stripped from the field, 17.5kg of Nitrogen is removed from the soil.

The CropScan 3000H On Combine Analyser measures protein in grains and oil seeds in real-time as they are stripped in the field. Protein data can be converted to Nitrogen data by using the above formula. A Protein/Nitrogen Map shows how much Nitrogen has been taken from the soil in the form of protein in the seeds across the paddock. A Protein/Nitrogen Map shows how the plant has performed and explains if the full yield and price potential have been achieved.

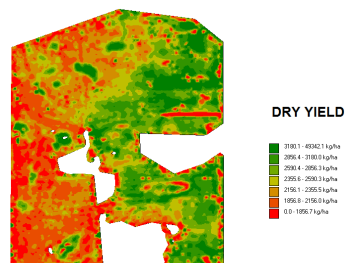


A Protein map can be converted into a Nitrogen map by multiplying the Protein recorded at each GPS coordinate by 0.175.

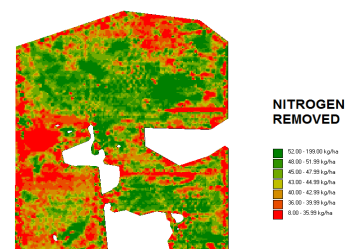


A Nitrogen Removal map can be generated using the following formula.

$$\text{Nitrogen Removed} = \text{Yield (tonne/ha)} \times \text{Nitrogen\%}$$



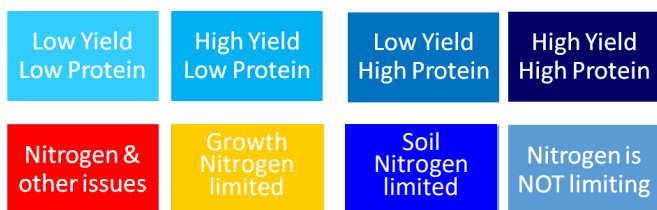
Nitrogen Removal maps or Nitrogen Replacement maps shows how much Nitrogen has been removed from the field and therefore the minimum that needs to be replaced to replenish the Nitrogen into the soil.



However additional Nitrogen should be applied since not all the Nitrogen removed from the soil ends up as protein in the seeds. Some Nitrogen is required for stem and leaf development. Approximately 5kg of Nitrogen fertilizer per hectare should be added to the Nitrogen removed in the seeds.

### How to Use Protein/Nitrogen Maps to Diagnose Plant Performance.

Yield maps only tell part of the story of plant development. Protein maps provide the Missing Piece of the PA Puzzle. The following scenarios describe how Protein and Yield are related and how Nitrogen impacts plant performance.



### Low Yield and Low Protein:

The yield has been limited by insufficient Nitrogen in the soil at leaf emergence and then in the growth phase. Other nutrient deficiencies may also be impacting the yield.

### High Yield and Low Protein:

There was sufficient Nitrogen available for the early growth stage but not enough to produce protein.

### Low Yield and High Protein:

There was insufficient Nitrogen available to support tiller development and therefore there were not enough heads produced to reach the potential yield. However there was sufficient Nitrogen available in the reproductive and grain filling stages to achieve high protein. This Nitrogen was probably applied late in the growth cycle, ie, top dressing of urea, or was deep in the soil profile and accessed late as the roots grew down to the deeper soil.

### High Yield and High Protein:

There was sufficient Nitrogen available for development of tillers and through the entire plant development to achieve the optimum performance, ie, "Sweet Spot".

### Correlation Maps based on Protein and Yield Show the Farmer if he has Left Money in the Field?

A Correlation Map of Protein to Yield shows 3 zones :

#### Zone 1: Positive Correlation: Blue Zones

High Yield/High Protein means the optimum revenues.

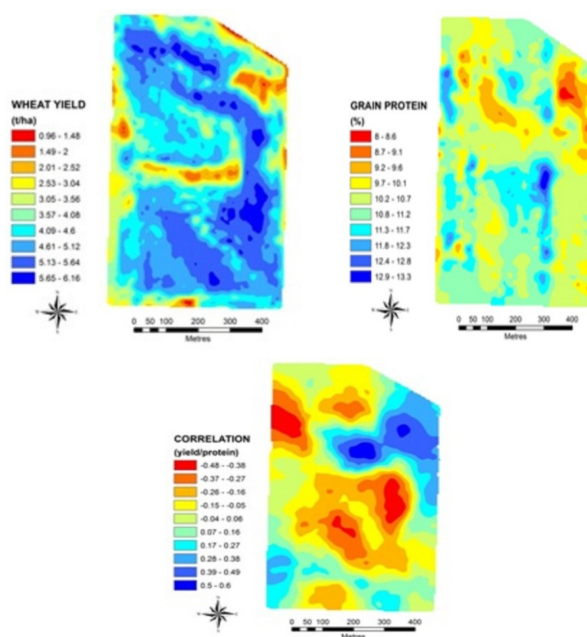
#### Zone 2: Negative Correlation: Red Zones

High Yield/Low Protein means good revenues but money was left in the field.

Low Yield/High Protein means low revenues and definitely left money in the field.

#### Zone 3: Zero Correlation: Yellow Zones

Mixture of Yield and Protein data that shows no correlation, means least revenues and definitely left money in the field.





Correlation Map shows ;

1. Zones where improvements can be made by applying Nitrogen fertilizer
2. Zone where you cannot improve revenues
3. Zones where the problem is most likely not related to Nitrogen fertilization, ie, soil, other nutrients, pH or water.

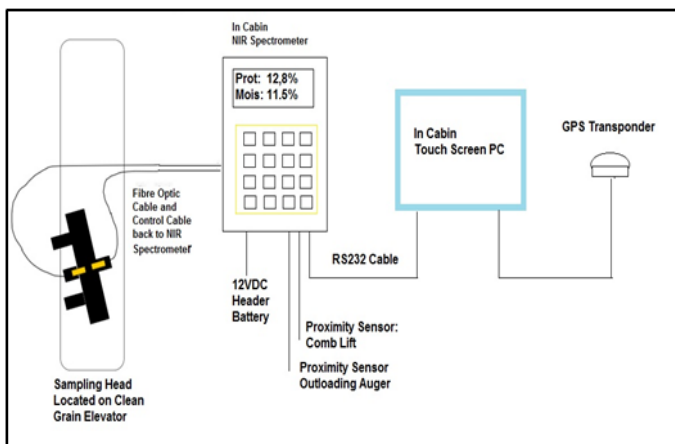
The Negative Correlation zones can be assessed to calculate the lost revenue potential:

Lost revenues = (Optimum Yield – Actual Yield) X \$/tonne for APW X Zone area (ha)

Protein maps show where in the paddock the plant has not achieved its full potential. If the Protein is not between 11 and 12% then the plant has not reached its optimum yield potential and the farmer is not getting the best price for his crop.

### Description of the CropScan 3000H

The CropScan 3000H On Combine Analyser 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 illustrates how the system is connected.

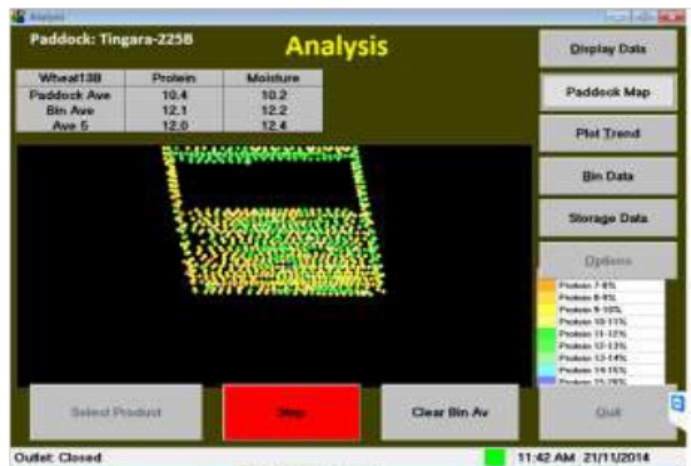


The Remote Sampling Head is mounted to the clean grain elevator. The NIR spectrometer and Touch Screen PC are located inside the cabin. The GPS receiver fitted to the combine is connected by a RS232 cable to the Touch Screen PC. A proximity sensor is located on the out loading auger and connected to the NIR spectrometer so that the system knows when the bin is being out loaded.

The adjacent figure shows the Remote Sampling Head mounted to a CASE combine. The Sampling Head can



be mounted to any combine brand or model. 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.



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