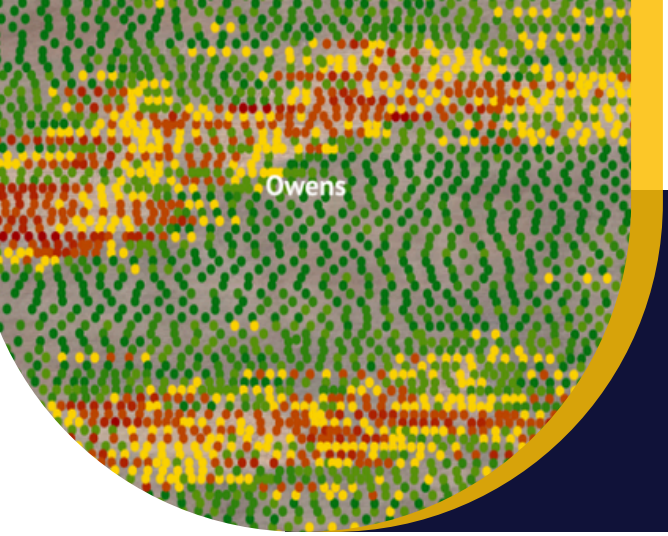

CropScanAg

CASE STUDY - 28

CropScan 3300H
On Combine Grain Analyser

FIELD PERFORMANCE ASSESMENT

OBJECTIVES

The CropScan3300H On Combine Grain Analysers were installed to two New Holland CR 9.9 Combine harvesters on a farm in Northern Alberta. The farmer was interested in producing Protein maps as a way to refine management zones in the fields to further improve their current Nitrogen Management Strategies. Their current VRA strategy is focused on yield mapping and soil testing. Zones are developed from these data layers and variable rate Nitrogen is applied each year.

The Protein, Yield and applied Nitrogen data have been collated to simplify the interpretation of harvest data for the grower and their agronomist. Protein has been a key missing piece of the data layers required to validate and report on fertilizer performance and farming practices. Whenever a new approach or practice is applied to a field, the Yield and Protein need to be recorded and reported. This gives an independent score of the new practice.

Farm revenue is currently based on the quality and quantity of the grain marketed. In the future, additional metrics will be required for reporting including Nitrogen Use Efficiency and Emissions Intensity score to ensure market access.

This case study is designed to explain how to:

1. Interpret and apply Protein Maps from one season to another.
2. Create Field Performance Maps based on Protein, Yield and Applied Nitrogen for future sustainability reporting
3. Improve the overall farm profitability, and identify areas where fertilizer rates can be reduced.
4. Provide the grower and their agronomists confidence to utilize Protein Maps in a VR strategy.

Three fields we selected to focus on in this investigation based on size and crop rotation. These fields represent the in field variability and year on year relationship for reporting and scoring.
The 3 fields presented:

1. Across from House
2. Leducs
3. S House

CASE STUDY - 28

FIELD MAPS

FIELD: ACROSS FROM HOUSE- WHEAT>CANOLA

Field ID	Acres	Year	Crop Type	Protein %	Yield bu/ac	N Removed lb/ac	Applied N lb/ac	Soil N Bank lb/ac	Total N lb A/c	Fertilizer NUE %	SoilBank* Fert NUE %
Across from House	44	2022	Wheat	15.3	89	58	25	43	69	227%	84%
Across from House	44	2023	Canola	23	72	70	63	40	103	112%	68%
Leducs	44	2022	Canola	23.2	60	59	80	154	234	74%	25%
Leducs	44	2023	Wheat	15.5	72	47	56	57	112	85%	42%
S House	44	2022	Canola	20.2	61	52	83	85	168	63%	31%
S House	44	2023	Wheat	15.5	43	28	80	85	165	36%	17%

Table 5.1 Nutrient Removal and assesment table.

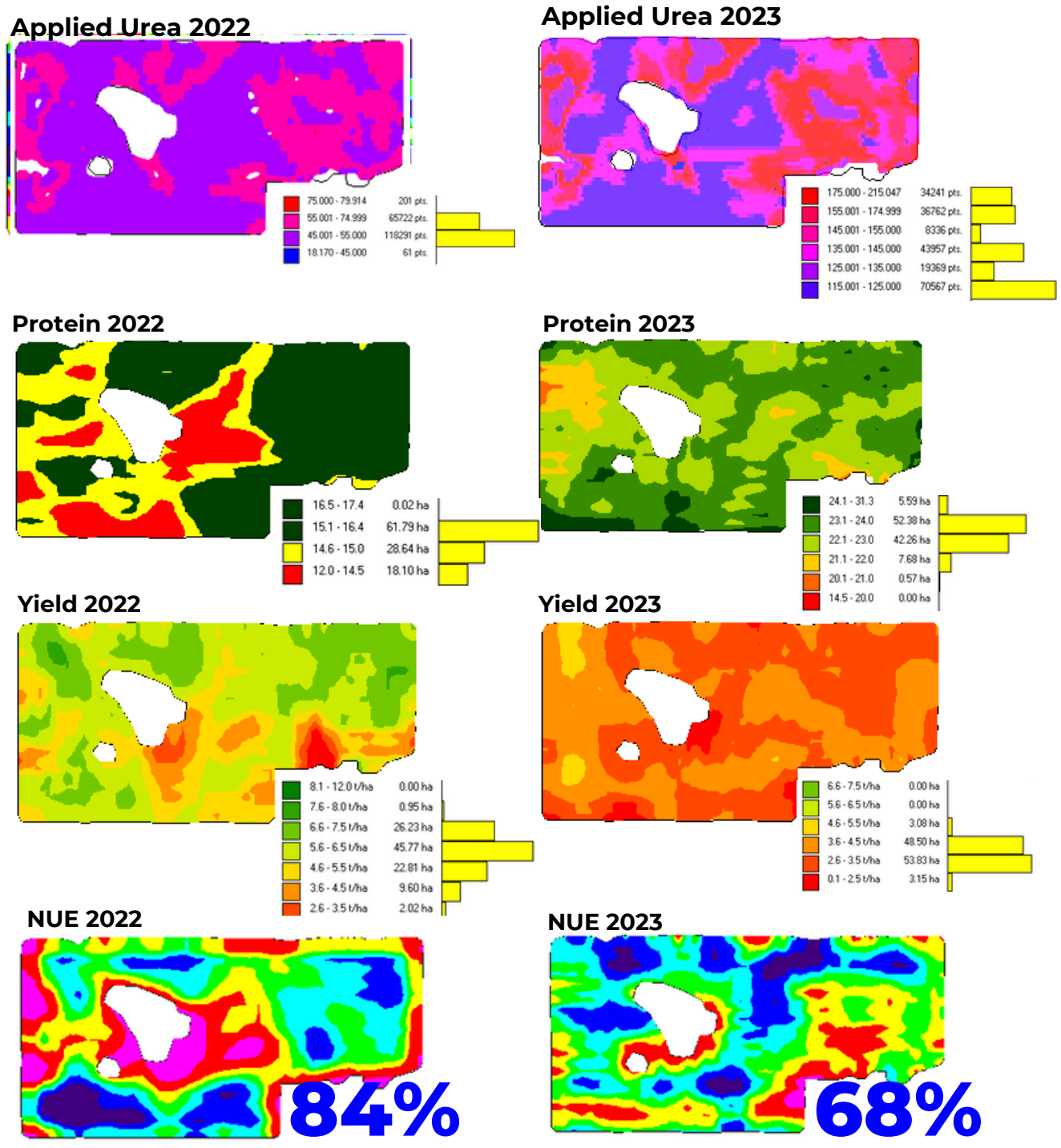

Figure 1.0 Across from House Field Maps

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FIELD MAPS

FIELD: LEDUCS
CANOLA › WHEAT

2022	2023
Applied Urea	Applied Urea
Protein	Protein
Yield	Yield
NUE	NUE

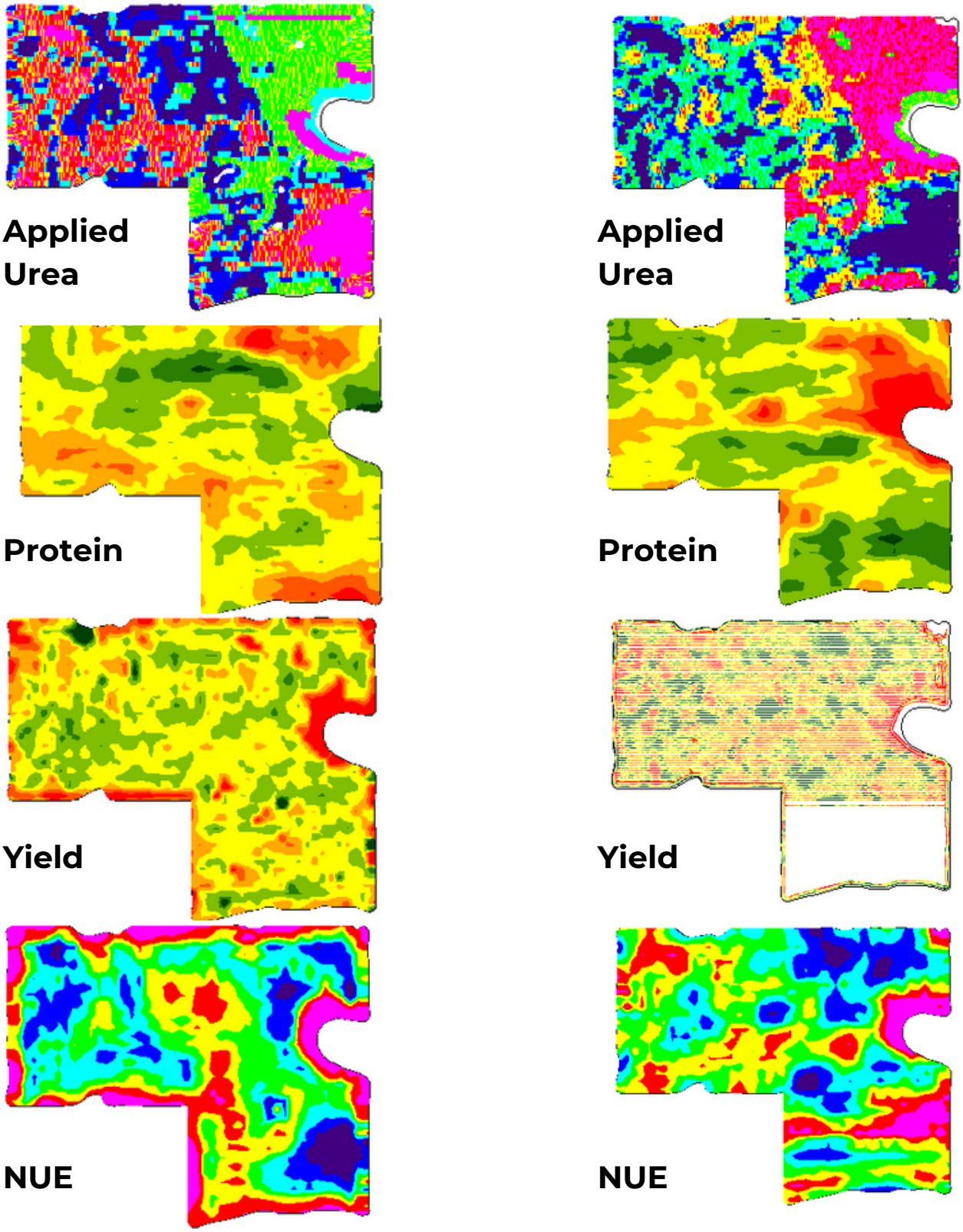

Figure 2.0 Leducs Field Maps

CropScanAg

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FIELD MAPS

FIELD: S HOUSE
CANOLA > WHEAT

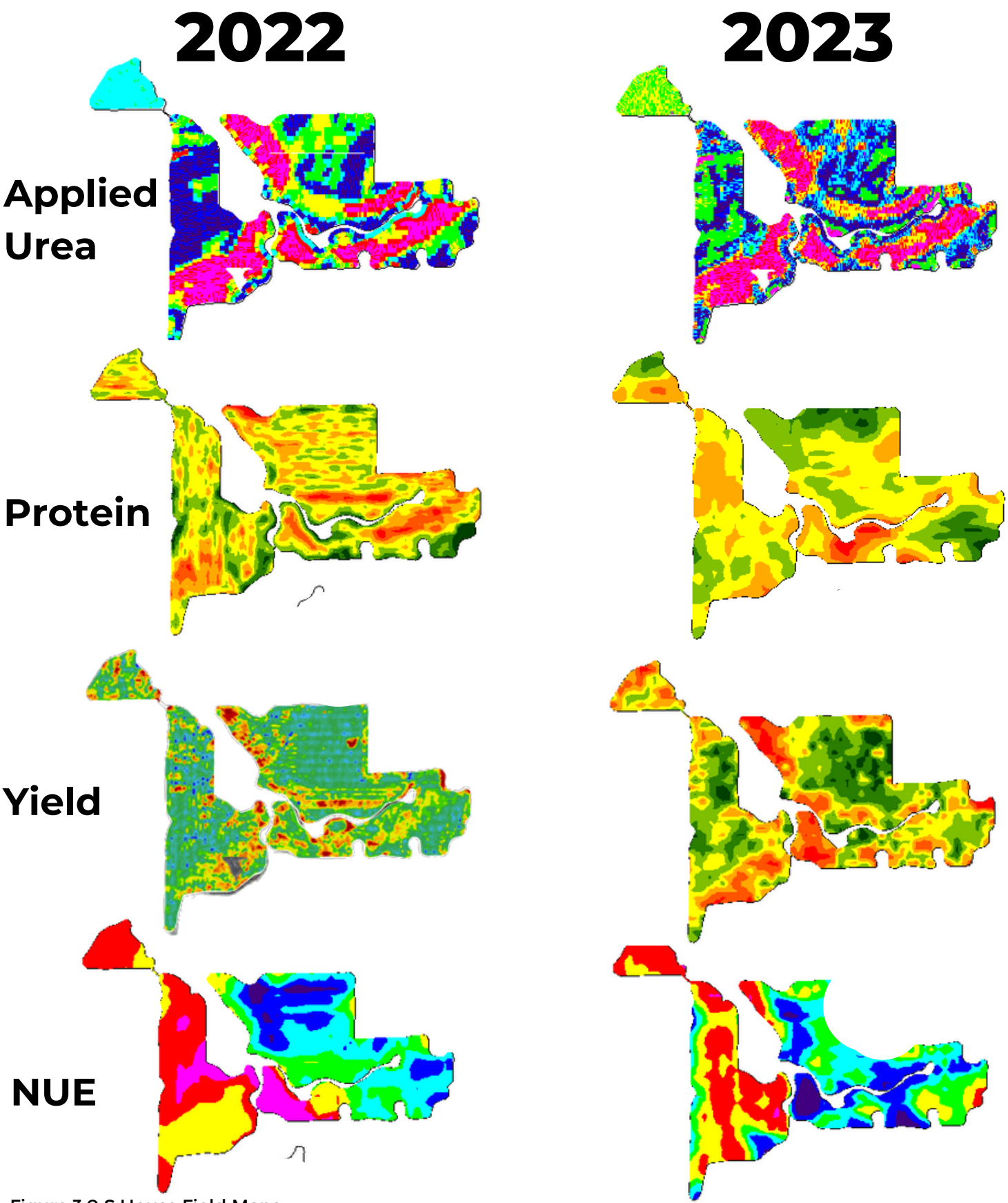

Figure 3.0 S House Field Maps

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FIELD PERFORMANCE

Agronomic Review

The Protein and Yield for each field should be presented in an easy to use format and sharable with growers, advisors and their agronomist. The data for both Protein and Yield highlight the variability across the fields and provide valuable insights for the farmer to improve field management. The yield data provides detail to overall moisture availability and the Protein data indicates the nutrient availability relative to available moisture. Adding other layers of data like soil testing make the system even stronger. By identifying the lower Protein areas (8-12%) of a field the assessment would be there is lower nitrogen levels available in these zones compared to the higher Protein areas (12-16%) which would indicate adequate Nitrogen availability. As with Yield, the higher yielding areas indicate adequate moisture availability to the plant.

Field Performance - A new approach for field assessments

The Field Performance Maps create 4 zones in the field based on their Yield and Protein performance. These maps create a reference to assess the relative performance of a given field in relation to water and nutrient availability. The Field Performance Maps provide insights into where the field has been over or under applied with fertilizer to satisfy the Yield target. By understanding the Protein to Yield relationship in regards to the Nitrogen response curve, the data can then be utilised to identify where the potential exposure points are for excessive emissions or environmental risks from over or under applications of fertilizer. This information can then be utilised in conjunction with as applied data to generate Nitrogen Use Efficiency maps across the landscape.

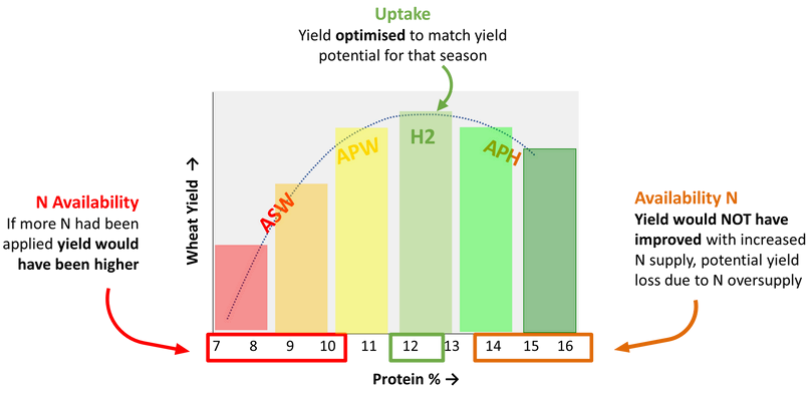
Nitrogen Use Efficiency

Providing growers with a solution to calculate accurate nutrient removals from the Yield and Protein data, allows the data to be linked with the as applied rate to generate the Partial Nutrient Balance Nitrogen Use Efficiency (PNB).

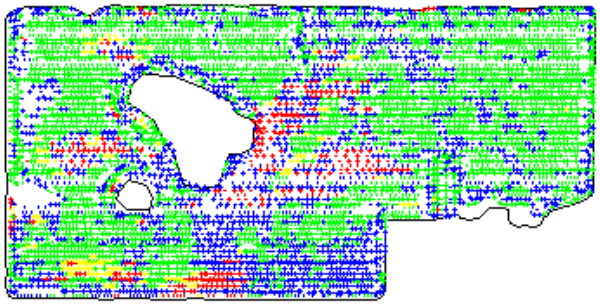
This is a key metric to assess the opportunities within the system to refine the application strategy as it has a direct relationship to the Greenhouse Gas emissions intensity associated with the grain production.

Assessing the data to not only assess the agronomic optimum for Nitrogen applications but also takes into consideration the exposure to Nitrous Oxide emissions intensity once the Nitrogen availability exceeds the maximum yield potential.

1. Agronomic review

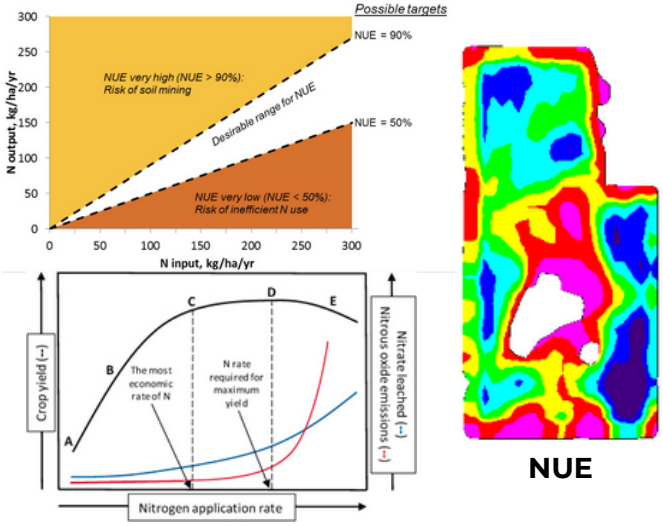


2. Relative Field Performance



- Low Yield / High Protein - Moisture Limited
- High Yield / High Protein - Optimum
- High Yield / Low Protein - N Limited Yield could have been even higher
- Low Yield / Low Protein - N Limited Zone

3. Efficiency/ Environmental Review



NUE

Antille D, Moody P, 2021 Nitrogen use efficiency indicators for the Australian cotton, grains, sugar, dairy and horticulture industries. Environmental and Sustainability Indicators, Vol 10.

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FIELD ASSESSMENT

ASSESMENT

The Field Performance Map analysis has been set to use a Protein target of 14% and a Yield field average target point. Therefore the Field Performance analysis scored the field as follows:

- Blue 32% - indicates Nitrogen was not the limiting factor compared to moisture limitations.
- Green Zone 59% - indicating adequate Nitrogen availability relative to water availability.
- Yellow Zone 3% - indicating Nitrogen was limited in these zones.
- Red Zone 5% - indicating Nitrogen was limited in these zones.

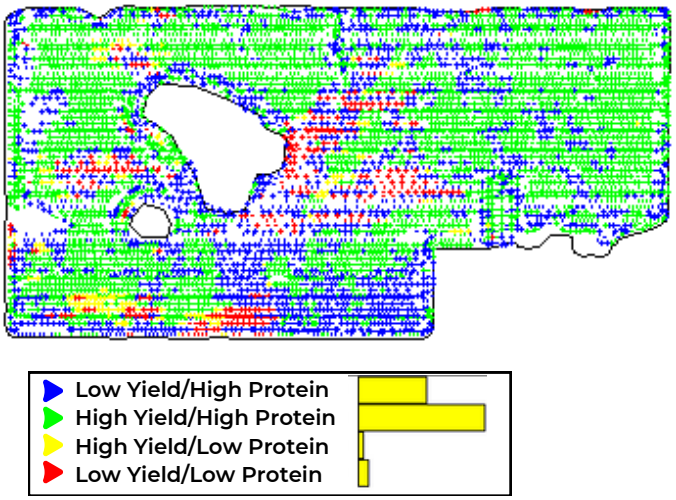

Figure 4.1 Across from House Performance Map

APPROACH

The traditional soil testing and zoning methods can now be enhanced with the collection of 2 years of Protein maps. Additionally N rich Strips or Trial Sites can be added to the variable prescription to monitor Protein/Yield responses as shown in Figure 4.2.

Measure Manage Grow!

1. Choose a management zone system that best reflects the nutrient to be applied.
2. Create the management zone at resolution and capabilities of the implement (Implement Width) and application direction (Heading).
3. Define Nitrogen rates and response required to increase the low Nitrogen soil zones and reduce the high soil Nitrogen zones.
4. Create high to low Nitrogen Rich treatments to test the applied Nitrogen to improve the year to year application response.
5. Conduct year to year soil testing at the High/Low Trial Sites to monitor residual soil Nitrogen levels.
6. Adjust fertilizer rates in relation to residual soil Nitrogen levels and seasonal conditions.

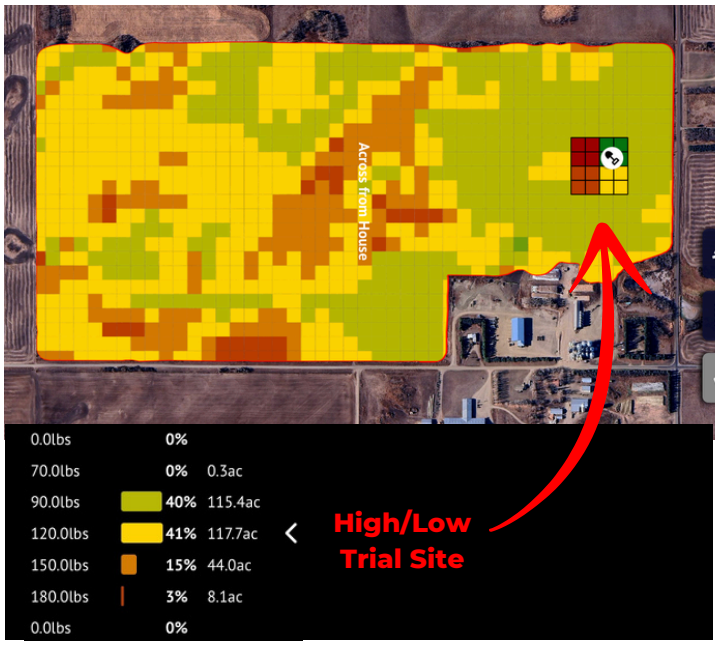

Figure 4.2 Across from House Urea Application Example

CASE STUDY - 28

SUMMARY

The collation of the Field Maps for Applied Nitrogen, Protein, Yield, Nitrogen Use Efficiency and the Performance Maps are tools to report and score the fields to provide a strategy for the subsequent years Nitrogen management plan.

The Protein maps demonstrate a positive relationship towards the applied Nitrogen as shown in the field maps below for Leducs, i.e., the applied Nitrogen is a key driver to produce grain Protein. The Protein sensor enables farmers to identify zones where Nitrogen has been in excess of the optimum Yield potential. Therefore adopting the strategy of reducing 10-30 lbs of nitrogen per acre in the high Protein zones can benefit the farmer in reducing the overall fertilizer budget.

The Nitrogen Use Efficiency has been calculated at 40% for 2022 and 38% for 2023 across the analysed fields as a Partial Nutrient Balance Nitrogen Use Efficiency, taking into account the fertilizer contribution relative to the outputs from the field.

By utilizing the Protein data in combination with Yield, it provides the necessary insights to refine the nutrient management strategy and mitigate the risks of under or over applying fertilizer. The target protein level for this region is approximately 13.5-14%. In both 2022 and 2023 seasons, the protein levels for the wheat were greater than 15%. This indicates the availability of Nitrogen was in excess relative to the yield. In 2023 the rainfall was more marginal and was a driving factor in the elevated protein levels.
This data should provide confidence to the grower and their agronomist to reduce the applied Nitrogen per bushel and to utilize the soil Nitrogen bank to stabilize yields with a target Protein level of approximately 13.5-14%.

If the grower was to reduce Nitrogen by 0.2lbs/bu resulting in a decrease of 10% on average on the last two years fertilizer applications, would still maintaining optimum yield and protein for the season.

By using this strategy across a 2-3 year period of monitoring the high and low Protein zones will enable the grower and their agronomist to establish the correct application rates to achieve the desired Yield and Protein.

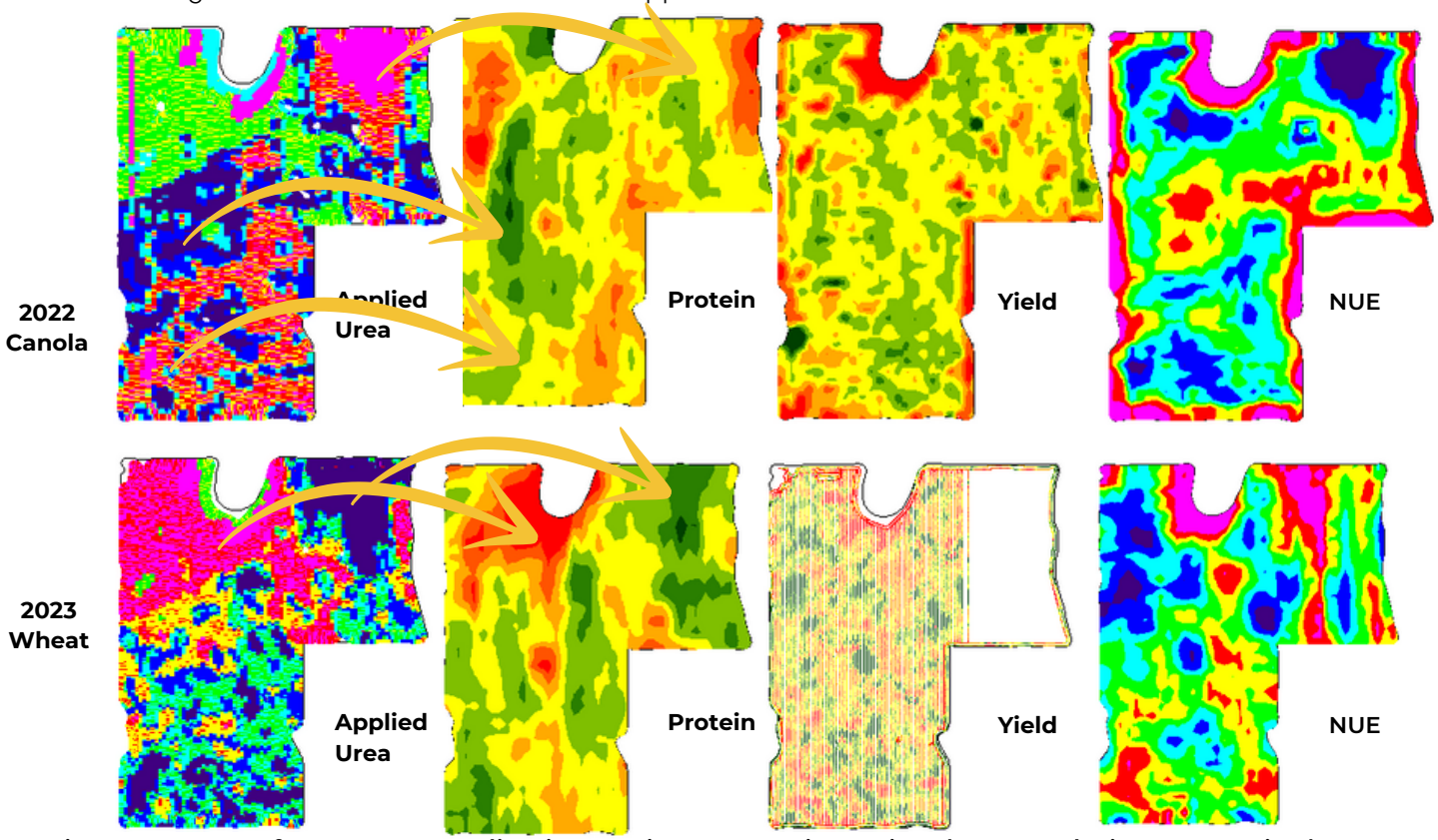

Figure 5.1 Across from House Application Zoning Vs Protein Zoning. (Improved Nitrogen Zoning)

CASE STUDY - 28

SUMMARY

2022	Area Applied (ac)	Applied Rate Urea (lbs)	Applied Total Urea (lbs)	Urea Cost CAD$	Grain Yield (bu/ac)	Nitrogen (lb/bu)
Canola	2948	172	507044	$ 304,227	71	2.4
Wheat	2207	133	293511	$ 176,106	86	1.5
		Total Urea (lbs)	800555	$ 480,333		
2023	**Area Applied (ac)**	**Applied Rate (lbs)**	**Applied Total Urea (lbs)**	**Urea Cost CAD$**	**Grain Yield (bu/ac)**	**Nitrogen (lb/bu)**
Canola	1568	173	271178	$ 162,707	63	2.8
Wheat	3403	156	530928	$ 318,557	54	2.9
		Total Urea (lbs)	802106	$ 481,263		
2024 Senario	**Area Applied (ac)**	**Applied Rate (lbs)**	**Applied Total Urea (lbs)**	**Urea Cost CAD$**	**Grain Yield (bu/ac)**	**Nitrogen (lb/bu)**
Canola	1568	156	244530	$ 146,718	60	2.6
Wheat	3403	123	418616	$ 251,170	70	1.8
		Total Urea (lbs)	663146	$ 397,888		

Table 5.1 2022-2023 Applied Fertilizer table.

Table 5.1 shows the applied fertilizer totals and rates for 2022 to 2023 and a 2024 fertilizer budget scenario.

The grower and their agronomist have indicated they are planning to reduce Nitrogen rates down 0.2lbs/bu across the farm. The data analysis also indicates that low NUE Zones generally align with the low Protein Zones which we would improve the NUE over time. The following benefits in fertilizer costs would be seen if actioned:

1. Cost Reduction of overall Nitrogen Fertilizer of 10-20% (CAD$48K to $96K).
2. Improved Nitrogen Zoning using the Protein Maps - 20-30% improved Nitrogen placement(CAD$87K-$130K).
3. N2O Emission Factor - 1% of applied Nitrogen - Emissions intensity was calculated between 2023 and proposed 2024 strategy which indicates a potential Emissions Intensity decrease of 2.1 CO2e/bu or 197 CO2e/ac.

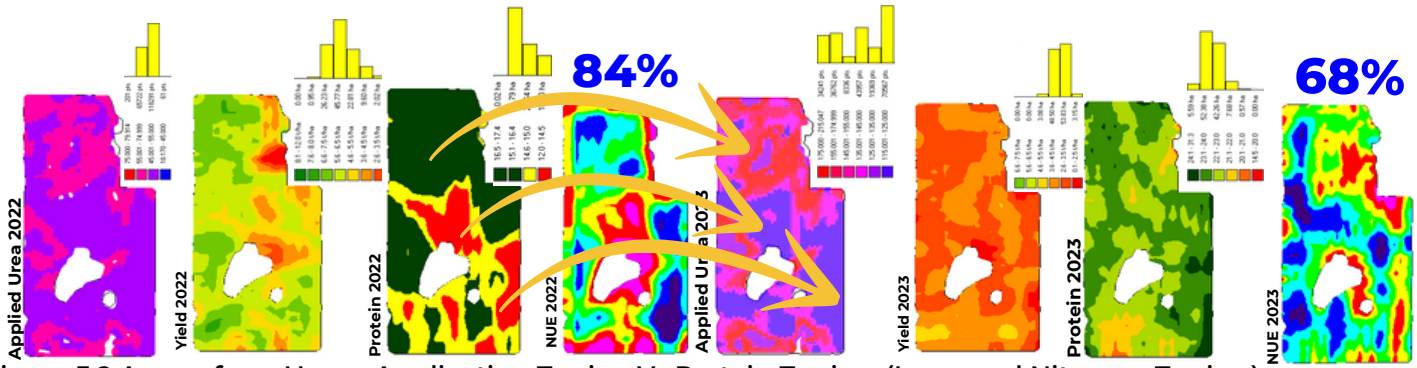

Figure 5.2 Across from House Application Zoning Vs Protein Zoning. (Improved Nitrogen Zoning)

The main goal is to maintaining optimum yield and protein for the season which is now available through Protein and Yield monitoring on a Combine Harvester. The CropScan On Combine Grain Analyzer in conjunction with the Yield monitor can measure year on year grain quality and quantity compared to the fertilizer inputs. If the field performance decreases this will be indicated by the efficiency analysis and the grower can refine the input strategy to maintain and manage the Farm profitability while improving carbon foot print.
Utilizing the data will result in increasing Nitrogen Use Efficiency which in turn has a direct impact on the Emissions Intensity of the grain produced.