Precision Agriculture Advancements for Ontario

Purpose:

Technology is now widely available to vary the rate of crop inputs including seed, liquid or dry fertilizer, pesticides etc. Relative to traditionally applying one average rate across an entire field, these tools allow input rates to be increased in areas where additional economic response may be expected ("missed yield opportunity") and reduced in areas where average rates may be expected to be well beyond economical ("excess input wasted").There have been questions regarding the payback of adopting these technologies, as well as how to decide what rate goes where in a field. With the increasing prevalence of yield monitors on combines, it is becoming easier to conduct field trials which can measure the response to inputs in various regions of a field to measure what variability in response exists across a field. Not only can these input response trials help determine the return on investment for variable rating for a given field during a given year, they can also be used to ground-truth recommendations, management zone delineations and sensory technology which may be used in attempts to predict where areas of higher and lower yield response are expected to occur. This project was developed to assess variability in yield response to the most common crop inputs (nitrogen fertilizer, seed) for corn, soybeans and wheat across a large number of fields throughout Ontario.

Methods:

A total of 25 fields with at least three years of yield map history have been selected from Essex County to the Ottawa Valley. For greatest relevance to Ontario cash crop growers, the crop focus will be corn, soybeans and wheat, while the variable rate investigations will focus on seeding rate and fertility (primarily nitrogen). To evaluate variability in yield response to inputs, multiple rates of seed or fertilizer will be applied in close proximity across different areas of the field (Management zones) to develop input response curves. Where variable rate equipment is available, "rate blocks" will be positioned based on management zones created from yield maps or soil sensing data collections (Figure 1). Where variable rate equipment is not available, strips of different input rates will be installed down the length of the field. Both blocks and strips will be replicated across the field. At the end of the season, yield monitor maps will be collected to determine yields within the rate blocks and strips. These replicated response curves will serve several purposes:

i) Identify what variability in input response exists across a field, and what opportunities exist to vary input rates to maximize economics.
ii) Evaluate how well yield or soil based management zone development can define areas of similar yield response (ie. highly responsive regions, low responsive regions).
iii) Evaluate the ability of soil or aerial sensors to predict response potential in different parts of the field.

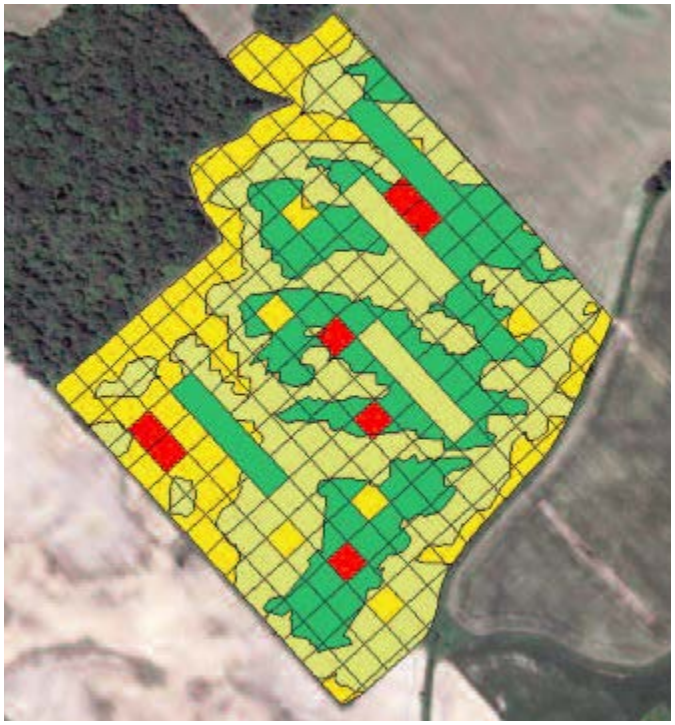

Figure 1. Variable rate population prescription map with population response check blocks (solid coloured squares/strips) across each zone

Results:

The locations and crops for the eighteen project fields investigated with variable rate inputs in 2015 are presented in Table 1. An additional 7 fields are also included in the project but no variable rate investigations could be completed in 2015 due to crop or equipment limitations; trials will be conducted at these fields in 2016 and 2017.

Activities Completed to Date

One-Time Measurements Completed for All Fields:

- RTK-quality elevation surveys – used for developing landform maps (hilltops, depressions, side-slopes etc.) for management zone creation or interpretation of yield data, all fields will have narrow pass (20' max) RTK quality elevation data for high resolution elevation mapping collected by existing operation maps if sufficient, or by project survey equipment.
- Grid soil sampling – basic (nutrient, OM, pH) soil sampling at 6" depth on one acre grid pattern across all fields for field background reference and comparison to management zones delineation, yield maps and crop yield responses across check plots.
- Soil mapping – creation of Electro-Conductivity (EC) or Electro-Magnetic (EM) maps via Veris® or Dual EM® measuring equipment (Figure 2), EC maps are related to soil texture for development of management zones and comparison to yield map data.

Table 1. Field locations, crops and variable rate inputs investigated in 2015.

Location	Crop	Variable Rate Input
Exeter 1	Corn	Nitrogen
Tillsonburg 1	Corn	Population
Tillsonburg 2	Corn	Population
Port Perry 1	Corn	Population
Rodney	Corn	Population
Kent Bridge	Corn	Population
Russell	Corn	Population
Vernon	Corn	Nitrogen
Chesterville	Corn	Nitrogen
Winchester	Corn	Population
Courtland	Corn	Nitrogen
Hensall 1	Corn	Population
Hensall 2	Corn	Nitrogen
Port Perry 2	Soybeans	Population
Exeter 2	Soybeans	Population
Brantford	Soybeans	Population
Wainfleet	Soybeans	Population
New Dundee	Soybeans	Population

Figure 2. Polaris Ranger pulling Dual EM sensor through corn stubble

Annual Measurements for Variable Rate Nitrogen Fields:

- Pre-Sidedress Nitrate Testing (PSNT) – 12" geo-referenced soil sample collection for soil nitrate analysis taken from first to second week of June for background soil nitrate quantities and comparison to nitrogen response between low and high N strips/blocks. Samples taken incrementally down length of zero nitrogen strips or within low-N check blocks
- In-crop aerial imagery – UAV imagery of fields including NDVI for comparison of remote sensing tools with yield response between low and high N strips/blocks.
- Yield monitor data collection – collection of yield monitor data from combines for yield mapping and evaluation of yield responses between low and high N strips/blocks across different management zones.

Annual Measurements for Variable Rate Population Fields:

- Plant Population Counts – mid-season stand counts replicated at multiple locations within each different population strip/block across each management zone for population verification.
- Yield monitor data collection – collection of yield monitor data from combines for yield mapping and development of yield response curve across multiple population rates across different management zones.

Yield Analysis:

Yield monitor data has been collected from grower combines and analysis for yield response to strips or variable rate response check blocks is being completed. Yield responses will be compared for correlation to various field measurements (remote/proximal/soil) or management zones. A representation of the yield analysis output for seeding rate response in a field across three historical yield-based management zones is presented in Table 2.

Table 2. Representation of determining variability in yield response across management zones in a corn field.

Seeding Rate (Seeds/Ac)	Management Zone Based on Historical Yield Index		
	Consistently Below Average	Variable	Consistently Above Average
	---------- *yield (bu/ac)* ----------		
28,000			
32,000			
36,000			
Optimum Rate			

Summary:

Variable rate equipment is becoming widely available for crop production, but there are still questions regarding the return on investment of these technologies, and how to decide where and at what rate to apply inputs. This project is utilizing multiple input rates blocks or strips and yield monitor data collection to identify what variability in yield response to inputs exists over 25 field locations across Ontario. Management zone formation from yield or soil maps, as well as soil sampling and in-crop sensory will also

be compared to yield responses for their abilities to assist in predicting yield responses across a field landscape.

Next Steps:

2015 was the first field season of evaluating precision agriculture technologies. Evaluations will be conducted at the same fields for two more growing seasons.

Acknowledgements:

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