Northern NY Agricultural Development Program
2018 Final Report

Yield-Stability Management Zones for Higher Yields and Better Nitrogen Allocation

Project Leader:

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Collaborators:

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Background:

Zone management within fields can result in better use of resources and/or more stabilized crop yields over time. The best indicators to design zones around are yield itself, and yield stability over time (consistency in yields from one year to another). Until recently, we did not have a good way to identify such management zones due to lack of a consistent yield data-cleaning protocol and a limited number of farmers with multi-year yield records, especially for corn silage. In the past years, the number of farms that have implanted yield monitor technology has increased, and that has brought the opportunity to develop a farm-based zone management approach.

In 2016 we introduced "yield stability zones." In this approach, three or more years of yield data for a field are combined into one yield stability map with four zones as shown in Figure 1. In this figure, the fields in quadrant 1 (Q1) yield above the farm average and do so consistently across years. The fields in Q4 are consistent as well over years, but these are the low-yielding fields. Fields in Q2 and Q3 are much more variable from year to year (standard deviation [SD] exceeding 5 tons/acre, the average SD for the farm).

Quadrant maps can be developed for each field with at least three years of reliable yield data. Maps can be kept updated as extra years of yield data are added to capture trends in yield as well. With yield stability zones, we can implement management comparisons (with and without nitrogen (N); higher versus lower population densities; other treatment comparisons, etc.) to see if corn in the different quadrants reacts to the treatment. This would prevent allocation of resources (fertilizer, seed, etc.) to areas within a field where a crop response to the allocation is unlikely, and target cost-effective investment of resources in areas where they would benefit productivity.

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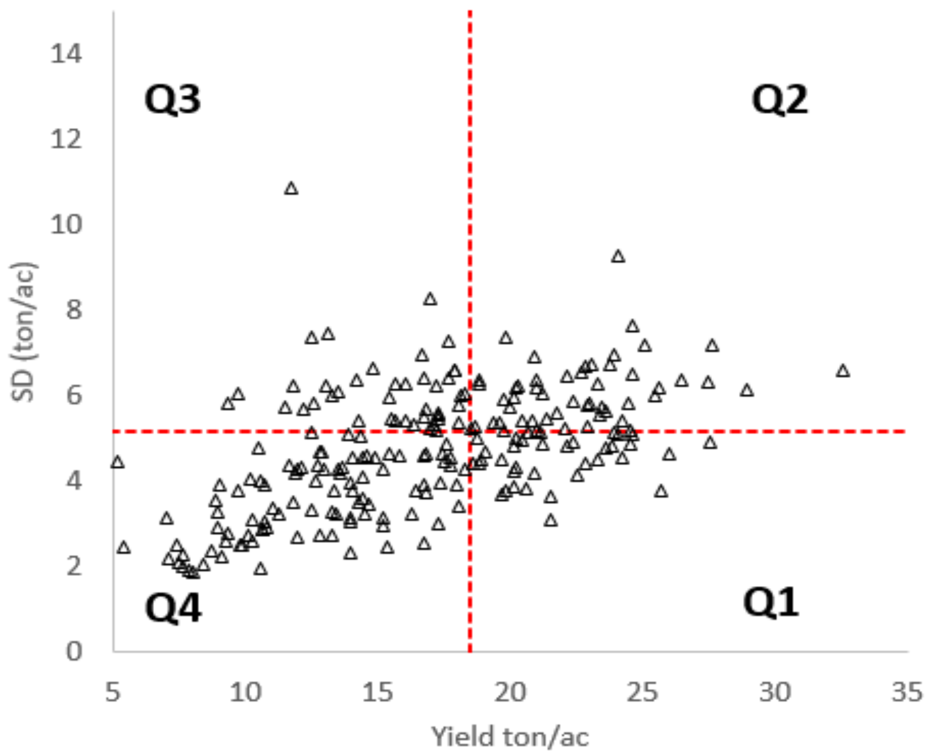

Figure 1: Average yield and standard deviation derived from 3 years of yield monitor data can be used to derive four yield stability based management zones per farm.

Here we proposed to implement N-rich strips (manure or fertilizer) across zones within fields to evaluate if additional N is needed for corn in Q1 (consistently higher yielding) versus Q2, Q3, and/or Q4 (consistently lower yielding)

Methods:

We worked with four farms in Northern NY, developing the quadrant maps for all fields with at least three years of yield data. Out of these fields, we selected two on each of the four farms (except for one farm where we selected four fields) that have clearly defined areas in Q1 and Q4 at a minimum.

Out of the ten selected fields, seven were for silage production and three for grain. Nitrogen-rich strips were implemented across the fields (Figure 2) so that the strip crosses areas in both quadrants, and yield response to the extra-applied N will be assessed.

Three farms implemented the N-rich strip with fertilizer (high N rate applied just before planting; 50-100 lbs N/acre), while one farm doubled the manure rate (slowing down the spreader) to generate the N-rich strip.

We used sensors and other spatial data (Greenseeker, drone-collected images, aerial images, electrical conductivity [EC] maps) to quantify differences, in addition to collecting yield data.

A 1-acre soil sampling round was completed prior to planting to aid in identification of soil fertility drivers for yield differences among the zones (basically trying to explain why areas in Q1 are different than those in Q2, Q3 and/or Q4). Moreover, before sidedress, we took soil samples (0-8 and 0-12 inches depth) every 200-ft to determine the amount of N available for the crop before sidedress both within the N-rich strip and directly outside of it.

We collected sensor data (drone and Greenseeker) before sidedressing, which can be used for assessment of crop response to N addition in each of the zones when comparing the crop with the N-rich strips.

Before harvest, we took corn stalk samples for the corn stalk nitrate test (CSNT) at the same locations that were sampled for soil nitrate before sidedress.

We lost one field from the study because it was accidently harvested without a yield monitor, but all other (nine) fields were successfully harvested with yield monitors.

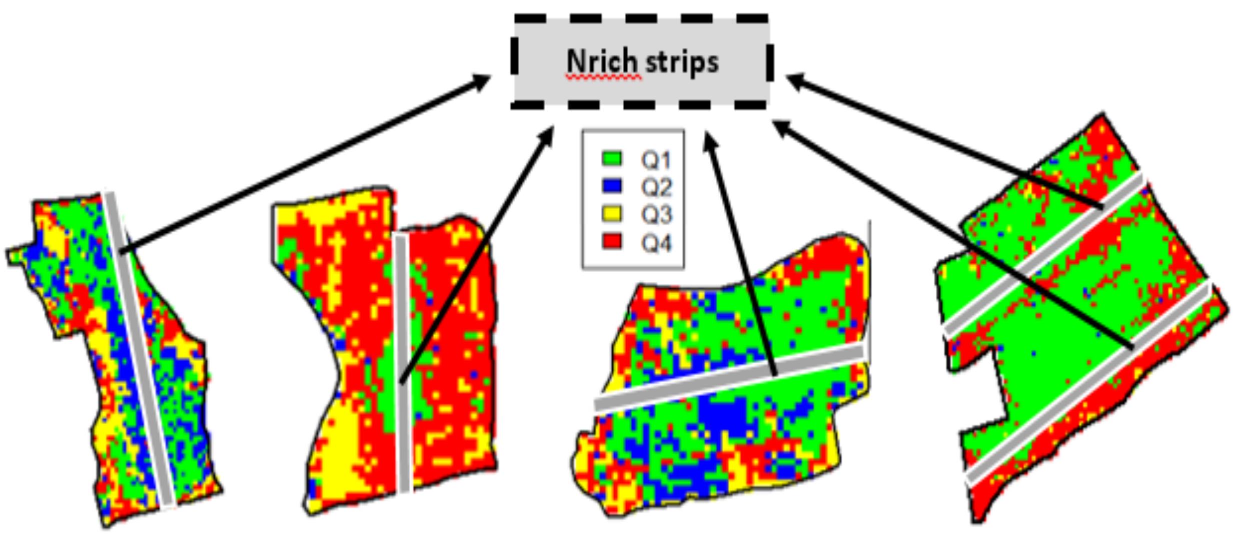

Figure 2: Nitrogen-rich strips implemented at planting in 2018 over quadrant maps developed with 3 years of yield data in the studied farms.

Results:

As of January 2019, data processing is still ongoing, reflecting a delay in harvest because of weather conditions in 2018, but, to date, yield data have been processed for five of the nine fields. The data for the remaining four fields are being processed for addition.

Our first approach to analyzing the data is to compare whole-strip yields, independent of quadrant maps. In this approach, the N treatment is not replicated so the results are an indication of yield response for the entire field and not per quadrant.

Two out of the five fields processed to date did not show a yield response to extra N (Fields 1 and 7). In the other three fields, yield differences between N-rich and the check strips (entire strip included) were 0.8 and 3.7 tons of silage/acre (35% DM), and 13.5 bu of grain/acre (15.5% DM) (Table 1).

Table 1. Whole strip silage yield (ton/acre at 35% DM) and grain yield (bu/acre at 15.5% moisture) of five of the fields in the study. Data processing is ongoing for four additional fields. One field was accidently harvested without a yield monitor and can no longer be included.

Field	Treatment	Yield	SD	Npoints
		(ton/acre at 35% DM)	(ton/acre at 35% DM)	
1	Check	20.4	4.0	524
1	N-rich	20.3	4.1	225
1	Delta yield	-0.1		
2	Check	18.7	4.0	285
2	N-rich	19.5	3.4	141
2	Delta yield	+0.8		
7	Check	19.4	1.7	381
7	N-rich	19.3	1.7	313
7	Delta yield	-0.1		
8	Check	17.0	2.2	466
8	N-rich	20.7	2.4	571
8	Delta yield	+3.7		
		(bu/acre at 85% DM)	(bu/acre at 85% DM)	
10	Check	147.9	21.6	697
10	N-rich	161.4	21.0	651
10	Delta yield	+13.5		

When whole strips are averaged, we obtain high variability (shown as standard deviation, SD, in Table 1). The variabilty assessment shows that the standard deviation in yield within a strip could be as high as 4.1 ton/acre (35% DM). Thus, evaluations of treatment effects (response to the N application in the N-rich strips) need to take into account management zones and sections of fields. This work is currently ongoing, in collaboration with an expert in spatial statistics.

The Greenseeker scans on the fields at sidedress time (whole strips) showed no impact from N application when the scaning was done at V4 or V5, but it showed a tendency of increasing normalized difference vegetation index (NDVI) when corn was scanned at V6 (Figure 3). This illustrates the importance of timely crop sensing: when a sensor is used early in the season (before V6), it is unlikely to distinquish deficient areas from areas that are not limited by N supply as the crop is too small to have exhausted all available N. In addition, if there are some differences between N-rich and the rest of the field, they could be masked by the large effect of the soil in the NDVI calculation at V5 or V5.

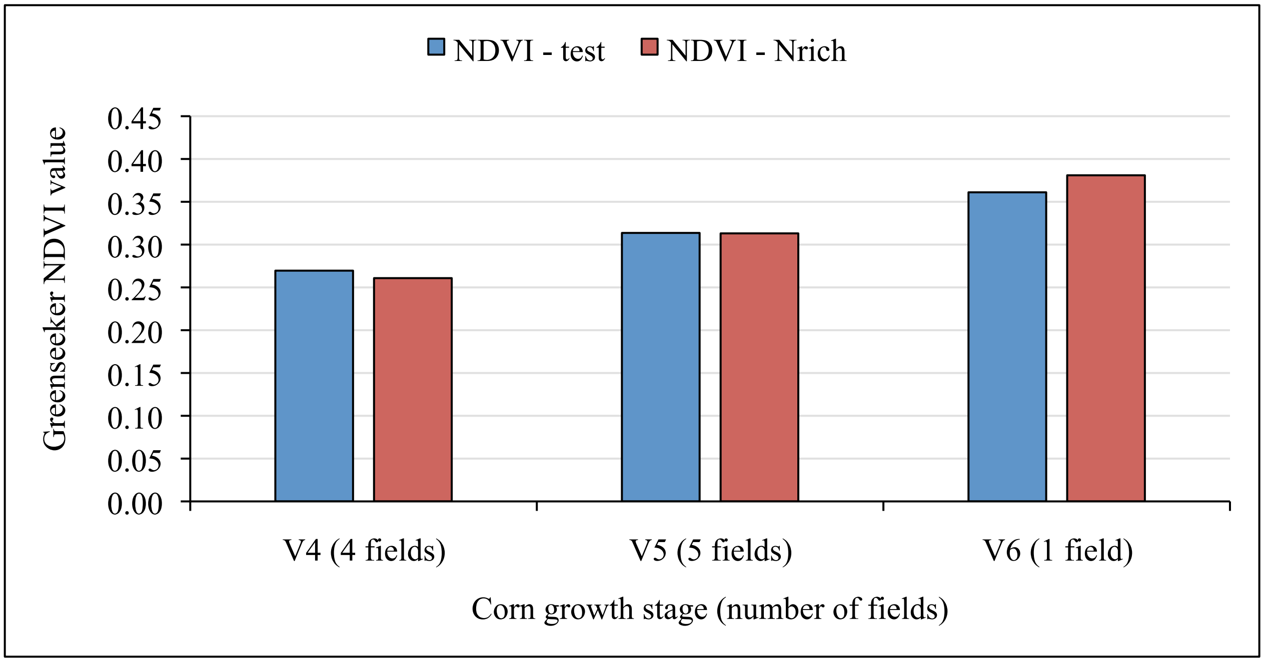

Figure 3. NDVI readings classified by corn growing stage of 10 fields in NNY in 2018 showed the need to scan at V6 rather than V4 and V5 in the 2018 growing season.

Conclusions/Outcomes/Impacts:

Quadrant maps were generated for ten farm fields in Northern NY. Five fields have been processed (yield monitor data cleaning protocols) to date. Data analysis is ongoing, in collaboration with an expert in spatial statistics, as the dataset requires a novel statistical approach that takes into account spatial correlation and zone classifications. This project is expected to provide us with data to develop a solid statistical method to analyze non-replicated strip trial experiments. Such trials would be easier to implement at the farm, and data would be more meaningful if yield results can be compared for management zones based on the quadrant method.

Outreach:

Each of the farms involved in the project was visited in the winter of 2018 to obtain historical yield data. Farmers received farm-specific yield reports, the quadrant maps were generated, and fields were selected for applications. Farmers and their crop consultant implemented the N-rich strips prior to planting in 2018. Once data summaries are done, another round of farm visits is expected in spring 2019.

Next Steps:

We will work on data analyses and yield predictions of the data collected in 2018 and four fields will be selected to continue with N-rich strips in 2019. Quadrant maps will updated with 2018 yield data as well and 3-yr versus 4-yr maps will be compared.

Acknowledgments:

In addition to NNYADP funding, we received a NYFVI (New York Farm Viability Institute) grant.

Reports/articles in which the results of this project have already been published:

Two factsheets were developed, one on use of sensors (active and passive), and one on calibration of grain monitors. These resources are available on the Nutrient Management Spear Program website:

#103: Multispectral Active and Passive Sensors in Agriculture (12/15/2018)
#104: Grain Yield Monitor Calibration (2/15/2018)

For More Information:

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