Northern NY Agricultural Development Program
2019 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:

Within-field management can result in better use of resources and/or changes in field yield towards more stabilized yields over time. The best indicator around which to design management zones is yield itself and yield stability over time (consistency in yields from one year to another). Initial analyses of yield monitor records for farms with a minimum of three years of yield data showed that variability in yield over space (within fields) and time (across years) is not consistent.

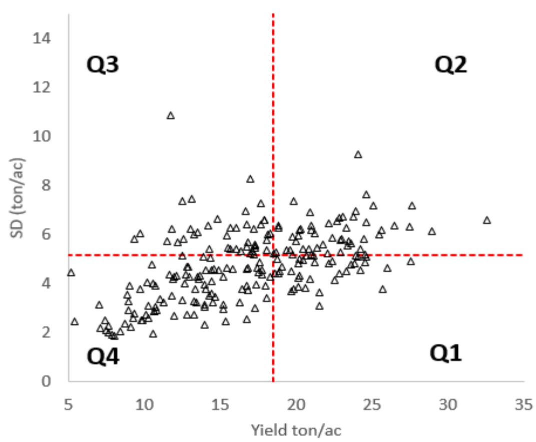

Figure 1: Average yield and standard deviation derived from 3 years of yield monitor data can be used to derive four yield stability management zones per farm.

Recognizing that some fields or areas in fields might be highest yielding in one year, while in another year these same fields/areas are lowest yielding, we introduced the concept of "yield stability zones". In this approach, three or more years of yield data 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 consistently across years. The fields in Q4 are also consistent over years but low yielding. 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).

If we know to which zone a specific area within a field belongs, we can evaluate zone-based management options, including evaluation of a higher (or lower) N application rate, evaluation of a tillage practice, change in population density, etc. Knowing where to expect a response and where not enables better allocation of limited resources (fertilizer, seed, etc.), away from areas within a field where a crop response to the allocation is unlikely, while investing resources in areas where they will benefit productivity. This is called yield-stability zone-based management.

Methods:

In the 2018 growing season we worked with four farms in Northern NY to develop the quadrant maps for all fields with at least three years of yield data. Out of the ten selected fields, seven were for silage production and three for grain. Nitrogen-rich strips were implemented in the fields so that the treatment crossed areas in two or more quadrants and yield response to the extra-applied N could 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 applicator) to generate the N-rich strip. One field was lost from the study because it was accidently harvested without a yield monitor, but all other (nine) fields were successfully harvested with yield monitors.

The farms were visited in the winter of 2018-19 to show initial results and discuss implementation of additional strips in 2019. However, the extreme weather conditions in 2019 prevented timely planting for everyone, impacting the farm's ability to implement additional N rich strips. Although this was for many reasons very unfortunate, while working with the 2018 yield monitor data in early 2019, it became clear that a re-evaluation of methodology for yield and zone mapping was needed. We recognized improvements could be made with different spatial models, and that zone delineation might be impacted by the number of years of data included in the evaluation (some farms had longer-term records than others). Thus, the focus of the work in 2019 became to evaluate the best methodologies to develop annual yield maps and multi-year zone maps with yield data from the farms collected through 2018.

Results:

Generation of Most Accurate Annual Yield Maps

With access to multiple years of yield data, we were able to compare seven different smoothing approaches for generating the most accurate annual yield maps for farmers. The models analyzed included inverse distance-weighted averaging with all data points (our current method) versus 10, 20, or 30 nearest neighboring points, as well as kriging methods that take into account spatial correlations between points. Our analysis suggests that kriging (Gaussian Process Regression) consistently generates the most accurate maps across all farms and fields (about 35,000 acres, grain and silage), reflecting that this method takes into account spatial variability within a field. With this result, we can now generate multi-year yield and yield stability maps.

Impact of Number of Years of Data on Yield Stability

Two farms with long-term yield records were evaluated to determine the impact of number of years of data on whole farm average yield and yield variability over time. This is important to know as both values (average yield and average yield variability for a farm) determine management zones on the farm). The results suggested that adding years of data over time (so not dismissing earlier years but simply adding years to the analysis as more years of reliable yield data are obtained) results in more stable values. As presented in Figure 2, our analysis suggests that 5-6 years of data resulted in stable signals for generating yield stability zones for all of the farms included in this study. Based on this we conclude it is more appropriate to use all data available instead of using just the latest 3 years of data to create consistent stability zones. Next steps include similar evaluations for other farms as yield records per farm expand over time.

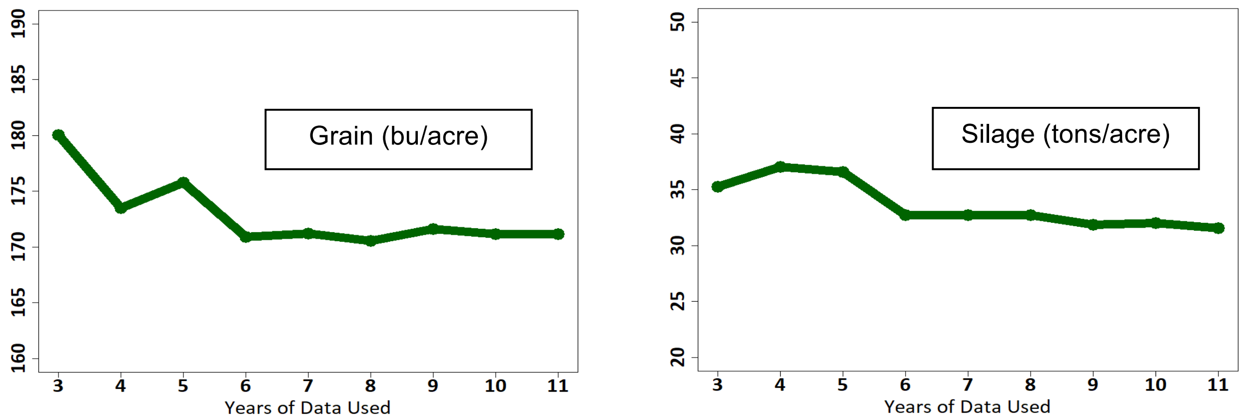

Figure 2: Impact of number of years of yield data on whole farm average yield and yield variability over time for a farm with corn silage yields (left) and a farm with corn grain yield.

Conclusions/Outcomes/Impacts:

Once the 2019 yield data are included, new zone maps will be generated for each of the farms using kriging to develop annual maps as the basis. We will then be able to analyze the N rich strip data from 2018 to determine impact of zone-based N management.

Outreach:

Each of the farms involved in the project was visited in the winter of 2019 to share initial results, discuss outcomes, and plan for the next growing season. A new factsheet was generated on zone-based management (http://nmsp.cals.cornell.edu/publications/factsheets/factsheet108.pdf).

Next Steps:

Quadrant maps will be generated with 2019 yield data. Once a final selection of approach is made, data summaries will be generated and maps will be shared with the farms and strips conducted in 2018 will be analyzed. Results will be published in a peer-reviewed journal article and summarized in an extension article. We expect another round of farm visits later in the 2019-2020 winter.

Acknowledgments:

In addition to NNYADP funding, we received a New York Farm Viability Institute grant to conduct this work elsewhere in New York State.

Reports/articles in which results of this project have already been published:
Factsheet #108: In-Field Zone Management of Field Crops (12/11/2019)

For More Information:
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