Northern NY Agricultural Development Program
2020/Final Project Series Report

Farm-Specific Corn Yield Potentials and Nitrogen and Phosphorus Crop Removal Estimates

Project Leader:

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Collaborators:

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- Cornell campus: Jonathan Berlingeri, Ben Lehman, Greg Godwin, Karl Czymmek (PRO-DAIRY)
- Northern New York producers with yield monitors

Background:

Yield monitoring equipment provides the opportunity to gather farm, field and within-field yield data. Over the past four years (2017-2020), we collected and evaluated corn silage and grain yield monitor data in collaboration with NNY farms and crop consulting firms with the goals to:

(1) evaluate and update the Cornell University corn yield potential database and associated nitrogen (N) guidelines (a request for this research was initiated by the farmers of the Northern New York Agricultural Development Program Committee;
(2) develop yield potentials for individual farms; and most recently
(3) evaluate the possibility of using yield and nutrient management information to determine field and within-field N and P balances.

We collaborated with farmers and consulting firms in Northern NY to develop annual and multi-year corn silage and grain yield reports and derive balances.

Methods:

Yield data (2019 cropping season) were shared by nine farms in Northern NY. All datasets were cleaned of errors using the standardized data cleaning protocol. Farmers who participated received individualized farm reports (yields calculated with and without headlands for whole fields as well as per-soil type within fields and across the farm). For fields with at least 3 years of data, multi-year reports were developed with average yield for individual fields, with or without dropping of one or two lowest-yielding years once 4 or 5 years of data are available.

Once reports were generated, data were included in the statewide database. This database was used to generate yield frequency histograms per soil type (distribution of yield across all fields with yield data for a specific soil type). Average yield per soil type across farms and year was determined once we had at least 20 datapoints and mean/median ratio between 0.9 and 1.1.

Results:

In collaboration with farmers and farm consultants, we expanded our Northern NY dataset to 31,518 acres harvested for silage and 8,889 acres harvested for grain (Table 1). Yields averaged 19.8 tons of silage per acre and 159 bu of grain per acre, but ranges were large, with maximum yield for individual fields reaching 33 tons per acre and 263 bu per acre (Figure 1).

Table 1: Total acres of corn yield data supplied by Northern New York farms.

	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
Grain			130	1109	1535		2080	2680	1355	8889
Silage	830	754	1475	2574	3925	3286	5801	6906	5967	31518
Total	830	754	1605	3683	546	3286	7881	9586	7322	40407

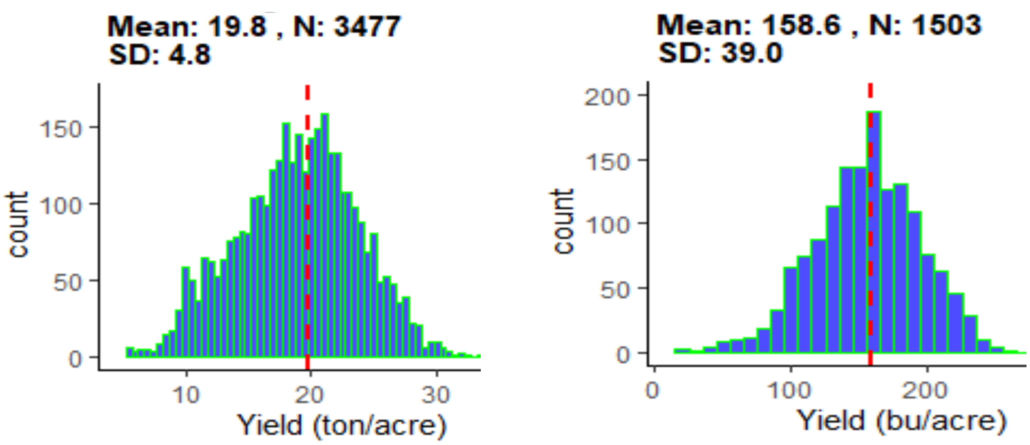

Figure 1: Northern New York histograms or yields for corn silage (left; yield in tons/acre at 35% DM) and corn grain (right; yield in bu/acre at 85% DM).

The data from these farms permitted expansion of yield per soil type analysis, generating yield potentials for soils of critical importance to Northern NY. Examples are shown in Figure 2.

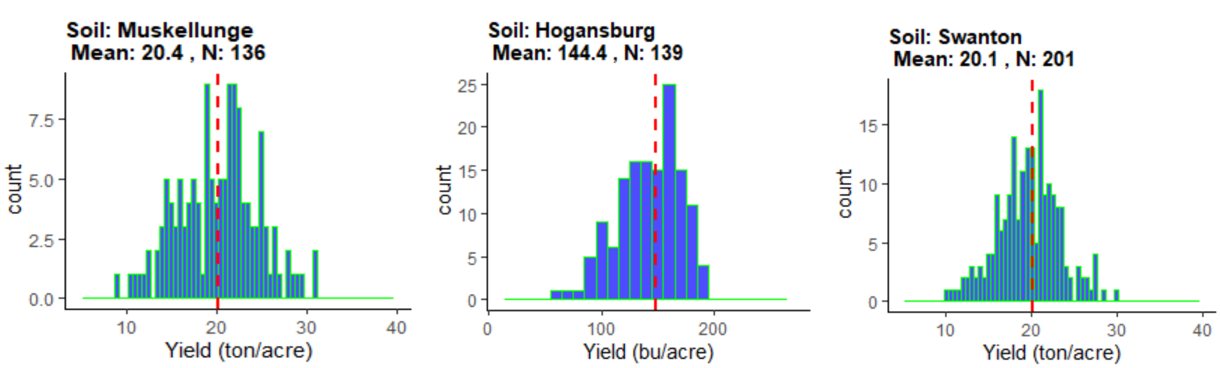

Figure 2: Examples of yield histograms of Northern NY soil types.

The wide range of yields per soil type across farms and for a given soil type *within* a farm emphasize the need to develop and manage field-specific yield potentials. Multiyear yield-by-field reports were developed according to options for calculating yield potential detailed in [adaptive management policy](http://nmsp.cals.cornell.edu/publications/files/AdaptiveManagementGuidelinesfor2018.pdf)*. This evaluation shows that N rates can be refined up or down to better reflect actual productivity when field-specific yields are being considered (Figure 3).
*http;//nmsp.cals.cornell.edu/publications/files/AdaptiveManagementGuidelinesfor2018.pdf

Field N and P field balances were determined per field and fields were ranked accordingly. For N, two balances were derived: (1) using total manure N addition (not adjusted for expected losses); and (2) including expected available N as impacted by manure application methods and timing instead of total N. A high total N balance in a dairy situation may be due to fall-applied manure (surface or injected, incorporated) or spring surface-applied manure where ammonium-N is not expected to be retained for the next crop. These field balances (N and P), ranked per farm, will allow for targeting fields where N applications might not have met crop needs and those where N applications exceeded crop N needs (Figure 4).

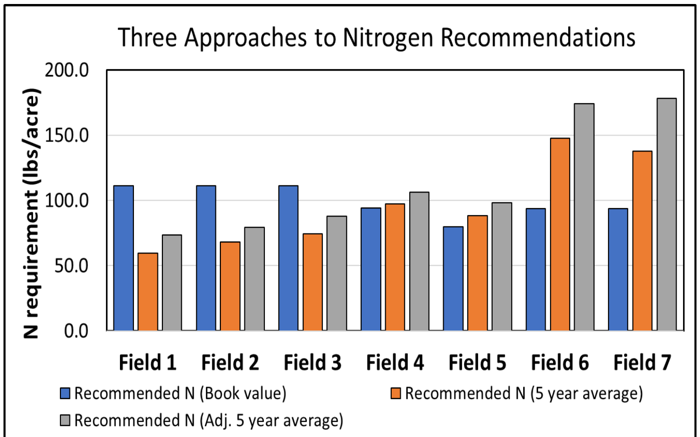

Figure 3. Corn nitrogen recommendations calculated using book values (yield potential per predominate soil type), rolling 5-year average, or adjusted 5-year average (yield potential dropping lower yielding years).

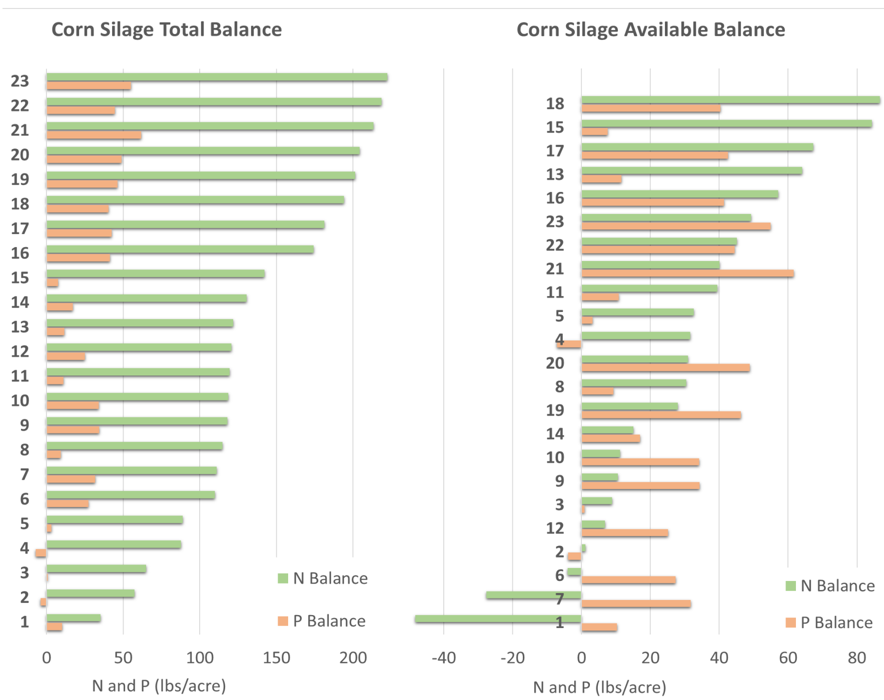

Figure 4. Nitrogen (N) and phosphorus (P) balances per field for a farm. The nitrogen balances are presented as a total balance (left, includes all N inputs, independent of their availability to the crop) and available balance (right, includes N inputs that were considered plant available).

Evaluation of contributions of N sources to the N balances showed that farm fields with the highest available N balances were often those with the lowest yield and hence N uptake (Figure 5). This could signal that N supply is not yield limiting for those fields (e.g. field 17 in Figure 5). It is possible that other factors (drainage, pest damage, disease issues) might have been the main cause of lower yields that year. Fields with very high available N and total N balances were unlikely to be N limited. It is those fields where additional N fertilizer might not have been needed and gains can be made. On the other hand, fields with negative available N balances might be fields to evaluate as well. Depending on the situation, fields with negative balances could be targeted for additional N in future years. Over time, farm managers can use this information to evaluate whether drought or other factors reduced expected N uptake or if N rates need to be adjusted more in line with field productivity.

Considering the nutrient needs and performance of each field on a farm can be an effective way to improve management. However, where yield varies greatly across an individual field, accounting for within-field yield differences may be of great benefit. Development of within-field N balances (Figure 6) showed substantial variation in N balances. Such maps could be used to evaluate zone-based management, especially when combined with multi-year yield stability maps.

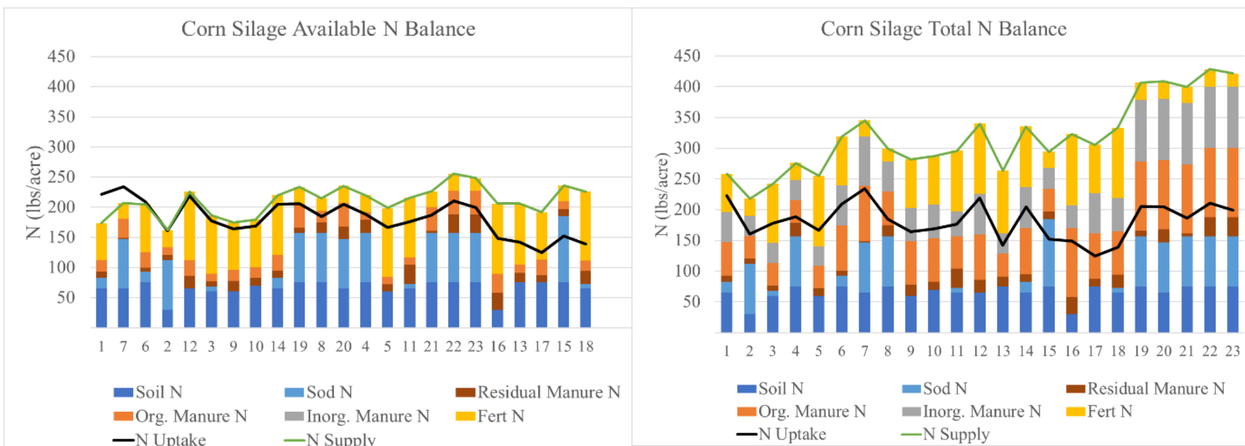

Figure 5. Available and total nitrogen (N) balances for 23 fields show some fields received more N than was taken up, while for others N supply greatly exceeded crop N removal. The black line shows N uptake (yield driven) versus N supply (green line).

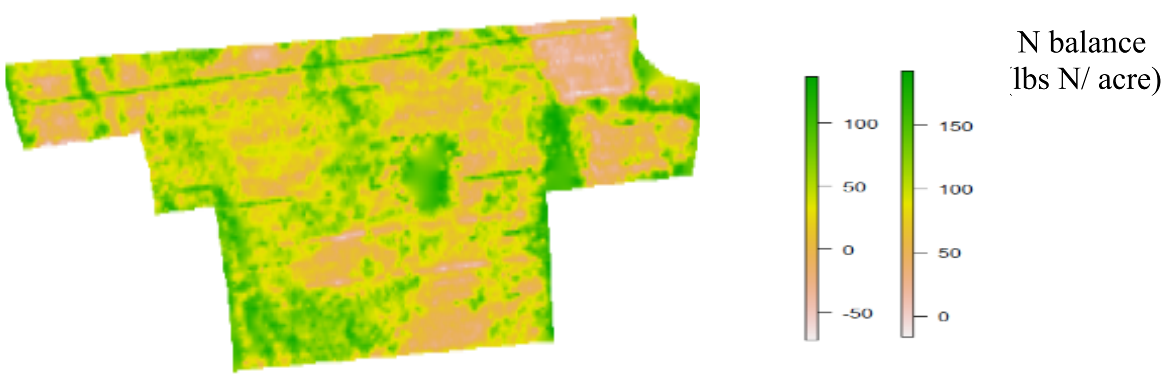

Figure 6. Available and total N balance variability within a field. For the total N balance use the legend on the right.

Conclusions/Outcomes/Impacts:

With farm-specific multi-year yield reports, farmers can now determine their own field-specific or soil type-specific yield potentials. The Northern New York farms' data, of which many reflect soils that are unique, are combined with the statewide data to derive yield potentials for all soils with at least 20 datapoints and mean/median ratios between 0.9 and 1.1 (normal distributions) in the database.

Work is ongoing to (1) determine how to address updating of yield potentials for all soil types in New York (including soil series that are not represented or do not have enough data yet; and (2) evaluate adjustments in the Cornell N equation that uses yield potentials to derive N guidelines. Multi-year yield reports and N and P balance approaches developed here for this NNYADP project show promise as an addition to current adaptive management, creating flexibility for farmers while benefiting the environment. We worked closely with Champlain Valley Agronomics to streamline deriving of N and P balances from information already collected in Cropware.net (soil type, rotation, drainage, past manure history, current manure composition, current manure application rate, method and timing). Information already in nutrient management plans and farm record keeping systems can then be combined with new yield data for seamless determination of N and P balances for each corn field on a farm.

Outreach:

- The farms that shared data received their farm-specific yield reports that included yield per year of data submitted, yield per field with and without headlands, yield per soil type within a field (headland areas excluded), and yield distribution per soil type on the farm.
- Five farms received multi-year farm-specific yield potential reports and balance reports will be supplied to a subset of the farms as well in the coming month.
- Presentations were held at the Northeast Region Certified Crop Advisor annual meeting and field crop dealer meetings (virtual) and results presented to the NMSP advisory committee that includes farmers and crop consultants in Northern NY.

Next Steps:

In 2021, we aim to:

(1) add 2020 data for four farms with at least four years of yield data to expand on farm specific yield potentials (per soil type and per field) using 3, 4, or 5 years of yield data, with and without the option to drop the lowest 1 or 2 years of yield data;
(2) expand on the database of field N and P balances with additional farms and an additional year of data; and
(3) develop within-field N and P balance maps to evaluate variability in N and P balance across yield stability zones in fields.

The larger database of field N and P balances can be used to determine feasible balances as part of the adaptive management process and help with determination of more appropriate manure application rates to match crop removal when the New York Phosphorus Index (NY-PI 2.0) limits P application rates with manure to P removal.

Acknowledgments:

In addition to NNYADP funding, we received Federal Formula and a 2019 New York Corn Growers grant to expand on the yield potential database project.

Reports/articles in which the results of this project have been published:
New Agronomy Factsheet #111: Importance of Knowing Yield.

Additional extension articles:
- Berlingeri, J., K.J. Czymmek, and Q.M. Ketterings (2021). In pursuit of improved nitrogen management for corn silage: tracking field nitrogen balances. Progressive Dairy. The Manager (March issue 2021).
- Lehman, B., D. Kharel, K. Czymmek, and Q.M. Ketterings (2020). Next steps for better silage yield maps. Progressive Dairy. The Manager.

For More Information:
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