Northern NY Agricultural Development Program
2015 Project Report

Corn Yield Potentials of Corn Grain and Silage in Northern New York

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Cooperating Producers:
- Clinton County: Adirondack Farm, B.C.S. Farm, Hidden View Farm, Leduc's Green Acres, Miner Institute
- Franklin County: Trainer Farm
- Jefferson County: Dodge Farms, North Harbor Dairy/Robbins Family Grain, Porterdale Farms, Sullivan Farm
- Lewis County: HanCor Holsteins
- St. Lawrence County: Chambers Farms, Greenwood Dairy Farm, Mapleview Dairy, McKnight's River Breeze Farm

Background:
This project is based on two questions identified by Northern New York farmers and researchers:

(1) With gains in corn genetics and overall crop production, should the corn yield potentials (YPs) that currently drive Cornell guidelines for nitrogen (N) fertilizer and manure use be re-evaluated?;

(2) Does higher productivity mean more N needs to be supplied through manure and/or fertilizer, requiring a change in the Cornell recommendation system, or are new varieties simply better able to make use of soil N resources?

The concept of using yield potential to determine N rates is based on the idea of fertilizing based on the better crop years. High performing soils (high YP) tend to have a greater capacity of supplying soil N and making use of fertilizer N or manure N than low YP soils. As a result, a higher yield does not necessarily mean that more external N is needed. Lower yielding soils are often impacted by factors other than N supply (i.e., drainage, root restrictive soil layers, etc.) and tend to need the highest N applications.

In past years, two approaches based on yield potential data were permissible for deriving N guidelines for corn on regulated farms:

(1) Corn yield potential for the soil type as documented in the Cornell soil database in conjunction with recommendations based on the corn N equation (Agronomy Factsheet 35);
(2) Actual corn yield measured over a 3-year period under current N guidelines (drought years excluded; N management as outlined in approach 1).

In consultation with agency partners involved in nutrient management planning in New York, two new adaptive management approaches were added recently that support additional fertility from manure and/or fertilizer for specific fields. The new guidance states that application of N fertilizer and/or manure *for a specific corn field* shall be based on approaches (1) or (2) above *or* one of the following two new adaptive management approaches:

(3) Findings of two years of on-farm replicated trials with a minimum of four replications and five N rates including a zero-N control treatment; or
(4) Yield measurements and the results of the corn stalk nitrate test (CSNT) and other tests such as the Illinois Soil Nitrogen Test (ISNT).

Approaches 3 and 4 are adaptive management approaches that allow producers to exceed current Cornell University N guidelines for corn. Here we evaluated yields for Northern New York farms and compare it to listed YPs (Part 1). We also evaluated state yield records for corn through 2015 (Part 2) and did an assessment of CSNT variability and targeted (yield based) CSNT sampling (Part 3).

Methods:

Part 1: Implement the Adaptive Management Protocol on 46 Northern New York Fields.

Yield data, forage quality and CSNT samples were collected at harvest from 46 Northern New York farm fields (22, 14, and 10 fields in 2013, 2014, and 2015, respectively). Field history forms were completed so actual N recommendations and nutrient balances could be estimated. Soil samples were taken mid-season (pre-sidedress nitrate test (PSNT) time).

Part 2: Evaluate State Recorded Yield Data.

We summarized state annual corn silage and grain yields from 1919 through 2015 using New York State annual agricultural statistics service data to determine trends in yields over time.

Part 3: "Targeted Sampling Protocol" for CSNT, Derived From Prior Year Yield Maps.

In 2015, "targeted CSNT sampling" was carried out on the fields of two farms. Fields 1 and 2 (same farm) were harvested for corn grain and Fields 3 and 4 (second farm) were harvested for corn silage. Yield monitor datasets from 2014 were used to categorize each field into three yield zones (low, medium, and high yield). The yield zones were sampled for CSNT at three locations per yield zone (9 locations per field in total). In each sampling location (60 feet diameter circle), 17 individual CSNT samples were collected. The 2015 yields were compared to 2014 yield maps.

Results:

Part 1: Implement the Adaptive Management Protocol on 46 Northern New York Fields.

The average yield across the three years was 116 bu/acre versus an average listed yield potential of 118 bu/acre for the soil types in the study (Table 1).

Table 1: Average yield data for 2013, 2014, and 2015 by year, combined years, and by BMR and non-BMR corn fields as compared to the Cornell yield potential database. Average nitrogen (N) applications across fields is given as the ratio of manure plus fertilizer N applied to the Cornell N recommendation for the fields.

	Fields	Average yield potential all fields	Average yield		Yield/yield potential	Average N applied/Cornell recommendation
	number	bu/acre	ton/acre	bu/acre	ratio (bu/bu)	ratio (lb/lb)
2013 All corn	22	119	20.9	124	1.04	2.0
2014 All corn	14	113	16.4	97	0.86	1.2
2015 All corn	10	123	21.5	127	1.04	1.1
2013 thru 2015	46	118	19.7	116	0.98	1.6
2013 Non BMR corn	18	122	22.3	131	1.08	1.7
2014 Non BMR corn	5	119	19.5	115	0.97	1.3
2015 Non BMR corn	5	128	23.3	138	1.09	1.1
2013 thru 2015	28	123	22.0	130	1.06	1.5
2013 BMR corn	4	105	14.9	88	0.83	3.4
2014 BMR corn	9	109	14.6	86	0.81	1.2
2015 BMR corn	5	117	19.6	116	0.99	1.1
2013 thru 2015	18	110	16.1	95	0.86	1.6

Although the average yield was very close to the listed yield potential, 15 fields (33%) yielded less than 90% of what was listed as the yield potential for the soil type (Cornell database), nineteen fields (41%) were within 10%, while twelve fields (26%) yielded more than 110% of the Cornell yield potential (Figures 1 and 2). The BMR varieties (18, 64, and 50% of all fields in 2013, 2014, and 2015, respectively) averaged a lower yield than conventional varieties (Table 1). Thus, there was field-to-field variability that needs to be taken into account.

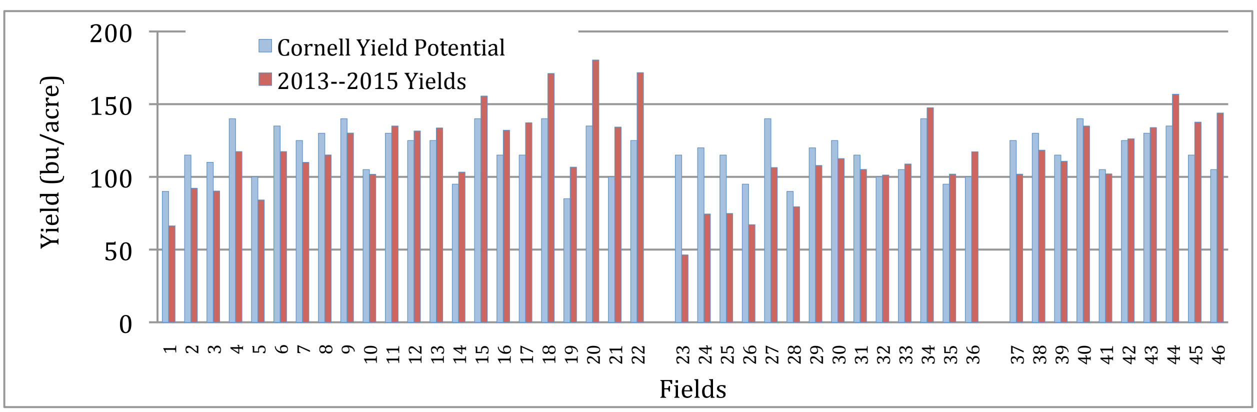

Figure 1: Actual 2013, 2014, and 2015 yields (measured in on-farm trials) for corn grain (sites 18, 22, 40, 41, 44, 46) and corn silage (yields converted to bushels per acre) and the yield potentials for those at sites that participated in the yield potential study. This database uses a conversion from silage to grain where 1 ton of silage at 35% dry matter equates to 5.9 bushels of grain at 15% moisture.

The highest yielding fields had the lowest ratio of N applied to N removed (Figure 3) suggesting that corn in high yielding fields gets more N from the soil (a ratio of 0.5 means that more than 50% of the N removed with silage harvest was supplied by soil N; since N removed in high yielding fields is also higher, soil N supply for high yielding fields is substantial).

The CSNT was less than 2000 ppm for all sites studied in 2015. For eight sites in 2014 and five sites in 2013 the CSNT exceeded 2000 ppm, with four (2014) and two (2013) sites exceeding the 3000 ppm cutoff (Figure 4). Only one of the high yielding sites had a CSNT exceeding 2000 ppm. These data show that high yields can be managed with acceptable CSNTs.

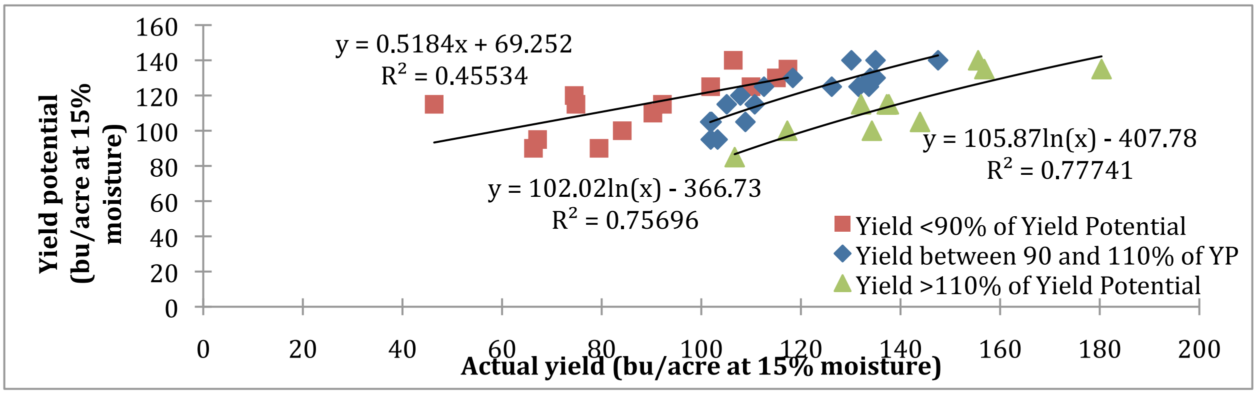

Figure 2: Actual corn yields (measured in northern NY on-farm trials 2013–2015) and yield potentials listed for the respective soils in the Cornell soil database. This database uses a conversion from silage to grain where 1 ton of silage at 35% dry matter equates to 5.9 bushels of grain at 15% moisture.

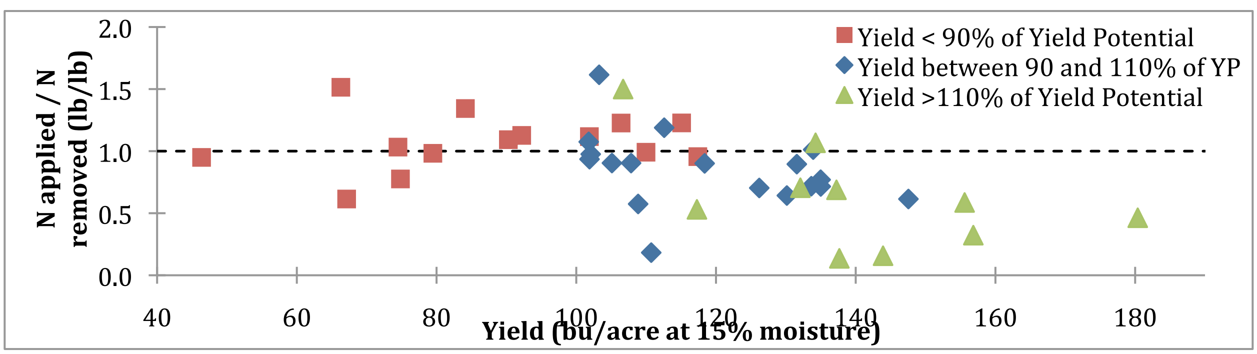

Figure 3: Ratio of nitrogen (N) applied (manure and fertilizer combined) to N removed with the actual harvest and the yield for each site. Two grain sites and two silage sites are not included due to missing data for crop N content. This database assumes 1 ton of silage at 35% dry matter equates to 5.9 bushels of grain at 15% moisture.

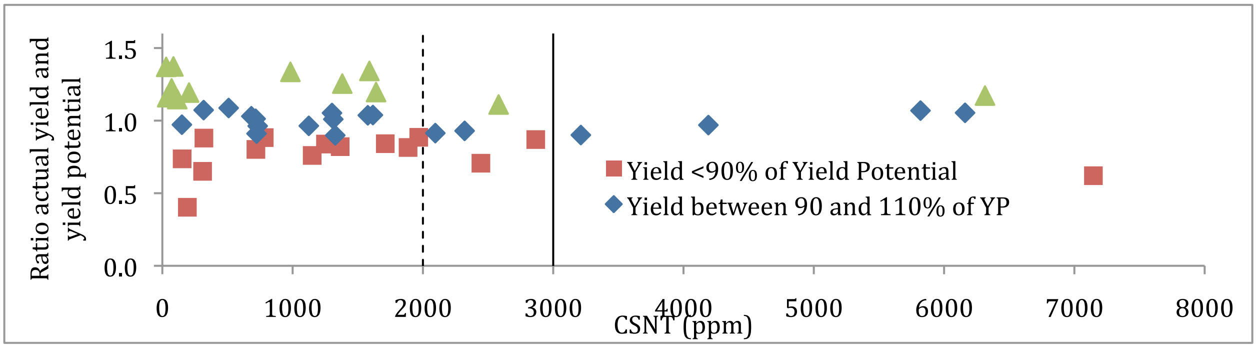

Figure 4: Ratio of actual yield to yield potential and the CSNT result for each site. Above 2000 ppm, the plant had more nitrogen than needed that season (excess). If CSNT exceeds 3000 ppm for two years, manure applications, yield, and soil information should be evaluated to reduce N application rates and manage the CSNT below 3000 ppm. This database assumes 1 ton of silage at 35% dry matter equates to 5.9 bushels of grain at 15% moisture.

Part 2: Evaluate state recorded yield data: Corn silage and grain yields have increased over the past 40 years (Figure 5) with a slightly greater increase per year for corn grain than for corn silage, possibly reflecting the efforts in plant breeding for grain in the past decades.

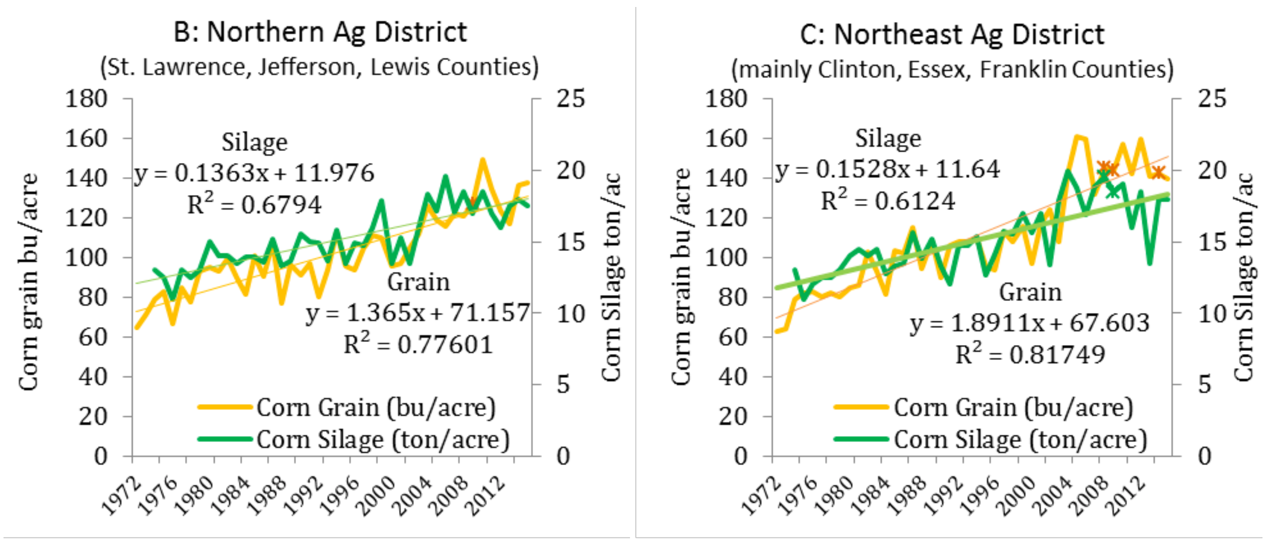

Figure 5. Northern New York (B and C) average corn silage and grain yields over time show a steady increase since 1948 in both silage and grain yields but also large year-to-year variation. Yield data source: New York State Agricultural Statistics Service.

Part 3: "Targeted sampling protocol" for CSNT, derived from prior year maps.

The fields that yielded lower in 2015 (Fields 2 and 3) averaged CSNTs <250 ppm, suggesting N deficiency. The average CSNT across all zones in Field 1 was in the upper limit of the marginal range, while the average CSNT across all zones in Field 4 was optimal (Table 2). These results suggest that Fields 1 and 4 did not need any additional N. However, averaging across the fields masked within-field variability. When the fields were separated, it was clear that Field 2 was N deficient based on the CSNTs (Figure 6B2). In Field 1, however, only one of the locations within the field was deficient and the rest were marginal and optimal (Figure 6B1). The CSNTs of the high yielding zones were optimal or marginal indicating no need for N addition while CSNTs suggested that the medium and low yielding zones could benefit from N addition. Thus, whole field sampling masks within-field variability.

Table 2. Corn stalk nitrate test (CSNT) and yield results on per zone basis for four fields.

		CSNT					Average yield of the 3 locations in each zone	
Field	2014 Zone	Average	StdDev	Min	Max	C.V.	2014 (grain or silage)	2015 (grain or silage)
		ppm	ppm	ppm	ppm	%	bu 85%DM /acre tons 35%DM /acre	bu 85%DM /acre tons 35%DM /acre
Field 1	Low	737	1147	65	4647	156	149	123
	Medium	435	653	43	2847	150	180	167
	High	876	1076	75	4513	123	201	161
	All zones	683	994	43	4647	146	177	150
Field 2	Low	177	407	39	2169	230	119	100
	Medium	60	57	28	303	96	148	114
	High	117	290	38	2066	248	165	132
	All zones	125	308	28	2169	247	144	115
Field 3	Low	46	26	16	163	57	84	8.5
	Medium	44	17	20	89	37	150	13.2
	High	359	572	26	2555	160	173	19.3
	All zones	150	361	16	2555	241	136	13.7
Field 4	Low	92	161	27	1085	175	10.9	10.5
	Medium	1737	763	541	3592	44	16.6	20.1
	High	1543	975	37	3170	63	20.0	22.4
	All zones	1124	1027	27	3592	91	15.9	17.7

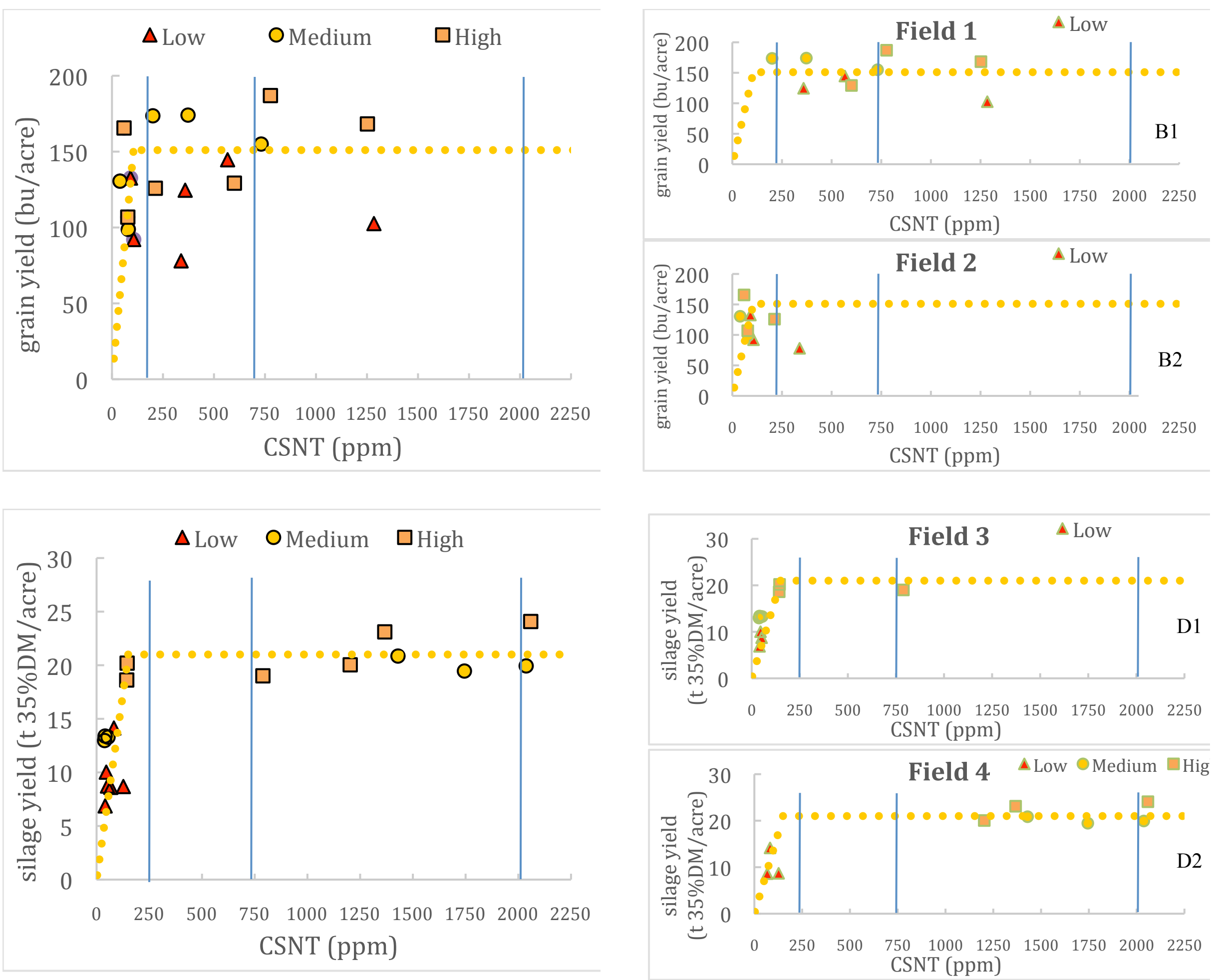

Figure 6. Relationship between corn yield and CSNT for the three zones (Low, Medium and High) for the two fields combined for Farm 1 (a) and Farm 2 (c) and individually for Farm 1 (b) and Farm 2 (d).

For the two silage fields, the low yielding zones showed low CSNTs, while the high yielding zones were classified as marginal (Field 3) or optimal (Field 4) (Table 2, Figure 6D1 and 6D2). For none of the zones was the 3000 ppm cutoff exceeded. Relationship between corn yield to CSNT ratio and CSNT shows consistency in recommendations (>10% yield response expected if yield to CSNT ratios exceed 0.045) (Figure 7). The data support the benefits of a yield-zone based CSNT sampling protocol. The data also indicate that yields cannot always be increased with further N addition. Especially in low yielding zones, other factors than N supply might be limiting yield.

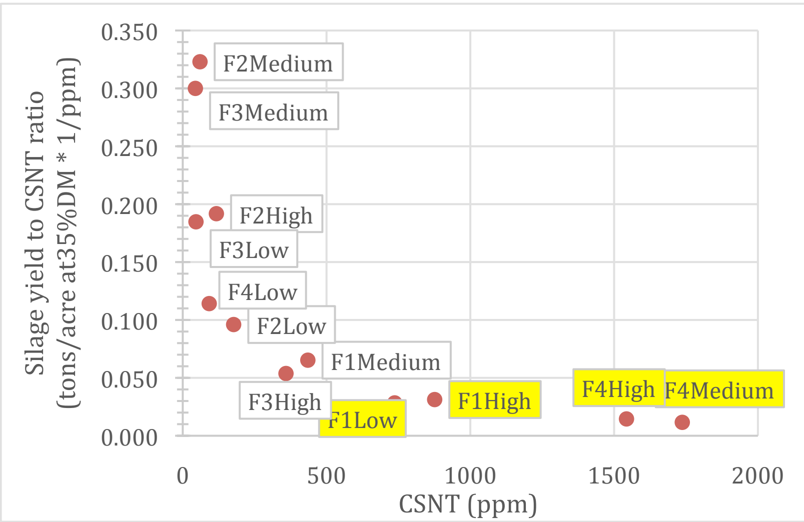

Figure 7. Relationship between corn yield to CSNT ratio and CSNT shows consistency in recommendations (>10% yield response expected if yield to CSNT ratios exceed 0.045).

Conclusions/Outcomes/Impacts:

Corn silage and grain yield trends show an increase since 1945. Weather-induced year-to-year differences were also observed. Those weather differences were evident in the past three years of on-farm yield assessment as well. There was excessive rainfall in June 2013 and 2015, and below average growing degree days in July and August 2014. Clinton County sites were particularly affected in 2013 and 2014. In 2015, corn yields benefited from greater than normal growing degree days in May and August with above normal rain only in June.

On average, yield across the 46 fields was 116 bu/acre versus an average listed yield potential of 118 bu/acre for the soil types in the study. However, of the 46 field sites, 15 fields (33%) yielded less than 90% of the Cornell yield potential, nineteen fields (41%) were within 10% of the listed yield potential, while twelve fields (26%) yielded more than 110% of the Cornell yield potential.

Stalk nitrate values exceeded the 3000-ppm threshold only in six of the 46 fields. The highest yielding fields had the lowest N applied to N removed ratio suggesting that high yielding fields typically supply more soil N than low yielding fields. The use of a yield-to-CSNT ratio in addition to CSNT alone will be evaluated in future work; preliminary data show this ratio to be an important tool in the evaluation of the potential for a crop response to N. Similarly, yield-based, targeted CSNT sampling, seems promising and needs to be evaluated in future work.

Experiences in 2013 through 2015 show that the biggest challenges with the adaptive management approach is actually retrieving farm management and yield records. Several collaborators with yield monitors faced challenges with their equipment in the field and with downloading of data in both 2014 and 2015. These challenges need to be addressed in future years for the greatest benefit of an adaptive management program for dairy farmers.

Outreach:

A website was established as part of the NY On-Farm Research Partnership: http://nmsp.cals.cornell.edu/NYOnFarmResearchPartnership/YieldDatabase.html. The protocols for field selection and sampling were added to the project website. Two factsheets on adaptive management approaches to N management for corn were released, following extensive discussions with certified nutrient management planners, NRCS, NYSDAM, and NYSDEC:

- Agronomy Factsheets #77: Nitrogen for Corn; Management Options.
- Agronomy Factsheets #78: Adaptive Management of Nitrogen for Corn.

These factsheets were shared at various extension meetings and made available through the factsheet website (http://nmsp.cals.cornell.edu/guidelines/factsheets.html). Adjustments in factsheets will be made as needed based on the findings of the project and further investigation of the targeted yield-based CSNT sampling approach. Talks on yield potentials and the importance of measuring yield for corn in NY as well as use of technology (yield monitors and crop sensors) were given in Northern NY as part of the NNYADP reporting days.

Next Steps:

We proposed to process in 2016, yield data collected from all fields of three farms that use yield monitoring technology in a given year so we can more quickly update the Cornell yield database. The results from the analysis of the collected yield data will be compared to the current yield potential database. Yield data will be combined with field information (soil types, drainage, manure and N management, soil test data etc.) and yield-to-CSNT ratios will be calculated to also evaluate drivers for high yields.

Acknowledgments:

In addition to NNYADP funding, we received funding from the Natural Resource Conservation Service in the form of a conservation innovation grant (CIG) that allowed us to evaluate the accuracy and precision of yield monitoring equipment for corn silage on one of the participating farms in this project.

Reports and/or articles in which results of this project have been published:

Project website (includes protocols):

1. http://nmsp.cals.cornell.edu/NYOnFarmResearchPartnership/YieldDatabase.html.

For More Information:

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Photos:

Photo 1, left: Manure application at a corn silage site in the Northern New York Agricultural Development Program yield potential study. Photo: Nutrient Management Spear Program.

Photo 2, right: Soil sampling and stand counts mid-season in the NNYADP yield potential study. Photo: Nutrient Management Spear Program.

Photo 3: Harvest of a corn silage site in the NNYADP yield potential study. Photo: Nutrient Management Spear Program.