Engaged Farmers: Building a Corn Silage and Grain Yield Potential Database for Nutrient Management Decisions in New York

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Context

- Common rotation for New York dairy farms: 3-4 years corn and 3-4 years alfalfa/grass hay
- For corn, manure first; fertilizer N only if manure N is deemed insufficient
- Manure allocation is done before corn planting (fall and/or spring)
- (Regulated) farms need planning tools for allocation of manure and fertilizer (Certified Nutrient Management Plans)
- In New York, Cornell University provides baseline (foundational) guidelines (Land Grant University)

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Cornell Nitrogen Guidelines in Fall 2000

$$\text{N req.} = \frac{(\textbf{yield potential}*1.2) - \text{soil N} - \text{sod N}}{(\text{fertilizer efficiency}/100)}$$

- yield potential: in bushels/acre
- soil N, sod N: in lbs N/acre
- N req.: in lbs N/acre
- fertilizer efficiency: in %

- past and/or current manure credits

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Context

- Yield potential: "yield 3-4 years out of 5 under good management"
- New York has about 600 soil types; sand to heavy clay
- Cornell database has yield potential values per soil type, with/without drainage
- Database last updated ~20 years ago

Yield Potential

Soil Type	HC	D	Flooding Frequency	SMG	N uptake efficiency %		Soil N supply lbs N/acre		Yield Potential Corn bu/acre		Yield Potential Alfalfa tons/acre	
					UDr	Dr	UDr	Dr	UDr	Dr	UDr	Dr
Acton	C	M	Rare/None	4	65	70	65	65	120	125	4.0	5.5
Adams	A	W	Rare/None	5	70	70	40	40	95	95	4.5	4.5
Adirondack	D	W	Rare/None	4	75	75	70	70	75	75	4.0	4.0
Adjidaumo	D	P	Frequent	1	55	60	65	75	75	105	2.5	3.5
Adrian	A/D	V	Rare/None	6	55	65	90	120	60	120	2.5	4.0
Agawam	B	W	Rare/None	4	75	75	65	65	140	140	6.0	6.0
Albia	C	S	Rare/None	3	60	65	60	70	100	120	3.5	4.5
Albrights	C	M	Rare/None	2	70	70	75	75	110	120	4.5	5.0
Alden	D	V	Rare/None	3	50	60	65	80	65	90	2.0	3.5
Allagash	B	W	Rare/None	5	75	75	65	65	105	105	5.0	5.0
Allard	B	W	Rare/None	3	75	75	70	70	135	135	6.0	6.0
Allendale	D	P	Rare/None	3	55	60	60	70	80	100	2.5	3.5
Allis	D	P	Rare/None	3	60	65	65	75	80	100	2.5	4.5
Alluvial Land	C	S	Rare/None	3	60	65	70	75	75	100	3.0	4.0
Almond	C	S	Rare/None	3	60	65	65	75	90	95	2.5	3.0

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Cornell N Guidelines in 2000

Two options:

1. Corn yield potential for the soil type as per Cornell soil database and recommendations based on corn N equation (Agronomy Factsheet 35)
2. Actual corn yield measured (3 years of data) under current N guidelines (N management as in approach 1)

http://nmsp.cals.cornell.edu/guidelines/factsheets.html

Cornell University Cooperative Extension

Agronomy Fact Sheet Series — **Fact Sheet 35**

N Guidelines for Corn

With increasing fertilizer prices and concerns about nutrient losses to the environment, it is especially important to account for all nutrient sources when determining the optimum nitrogen (N) application rate for corn.

Recommendations for phosphorus (P), potassium (K) and other nutrients are derived from soil tests. However, in the humid climate of the Northeastern US, it is difficult to base N guidelines on soil nitrate because soil nitrate levels change rapidly depending on rainfall and temperature. Instead, Cornell N guidelines for corn consider soil specific yield potentials (YP in bushels/acre), annual N contribution from the soil organic matter (SoilN in lbs N/acre), N release from a decomposing sod (SodN in lbs N/acre), and soil specific fertilizer N uptake efficiency (Neff as a percentage):

Recommended N = (YP*1.2-SoilN-SodN)/(Neff/100)

In this fact sheet we describe each of these inputs, identify where you can find the necessary information, and show some example calculations.

Yield Potential (YP)

Yield potential is defined as the expected yield over 3-4 of 5 years under good management. Corn yield potentials have been derived for all agricultural soils in New York and are updated as new research is conducted. Yield potentials are drainage dependent, reflecting different yields under drained and undrained conditions for soils that are, by nature, poorly drained. A few examples for New York soils are given in Table 1.

Table 1: Examples of corn yield potentials (YP) for New York soils.

Soil type	Corn yield potential Undrained	Corn yield potential Drained
	bushels per acre	bushels per acre
Howard	135	135
Hamlin	155	155
Volusia	95	105
Rhinebeck	105	120

Yield potentials can be looked up in Appendix 1 of the Nitrogen Guidelines for Field Crops in New York (see additional resources). They are given in bushels/acre (85%DM). To convert to the equivalent yield as silage (35% DM), divide grain yield by 5.9 bu/ton. Use a local soil survey to determine the soil type.

Soil Nitrogen (SoilN)

Soil N availability through mineralization of soil organic matter is a function of soil type and artificial drainage class. Look-up tables exist that show estimates of SoilN under undrained (UD) and under excellent artificial drainage conditions (see Appendix 1 of the Nitrogen Guidelines for Field Crops in New York).

Table 2: Examples of soil N contributions for New York soils.

Soil type	Soil N supply (SoilN) Undrained	Soil N supply (SoilN) Drained
	lbs per acre	lbs per acre
Howard	70	70
Hamlin	80	80
Volusia	60	70
Rhinebeck	65	75

Sod Nitrogen (SodN)

Sods provide a substantial amount of N for three years following plow down. When the sod is killed, the organic N will become available through mineralization. The amount of N available is a function of the sod density and quality, the percent of legume, and time since the sod crop was plowed or killed. The amount of N available from different sods can be estimated using Table 3.

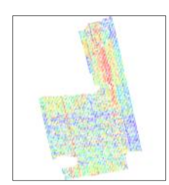
Table 3: Sod N release rates.

Legume in sod (%)	Total N pool	Available N Yr 1*	Yr 2	Yr 3
	lbs per acre			
0	150	83	18	8
1-25	200	110	24	10
26-50	250	138	30	13
50 or more	300	165	36	15

* First year following plow down.

Context: Issues that Surfaced

- Use of increased N rates with limited or no documentation
  - Risk to farmers and environment
- General belief: higher yield = more N needed
  - Not supported by data
- Limited funds to re-evaluate book values
- Yield potentials per soil type may not capture real variability; farm and field specific data better



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Adaptive Management NRCS

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Adaptive Management in New York since 2018

1. Targeted CSNT from top 25% yield area of the field
2. Comparison strip with control treatment (check strip)
3. 2-3 georeferenced photos of leaf N status within the top 25% yield area; when the 1-3 lowest true leaves are green, a targeted CSNT needs to be taken
4. For crops other than corn, determine and record an individual field N balance
   - [total N applied + N supply by soil and crop rotation credits per Cornell soils database] minus N removed in harvest

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Adaptive Management in New York since 2018

- All adaptive management options require *measuring yield*
- Farmers with yield monitors can set farm-specific and field-specific yield potentials (3 or more years of data)
- Their data can contribute to updating of book values
  - For those without yield data
  - For those with insufficient amount of yield data
- Calibration and data cleaning are important

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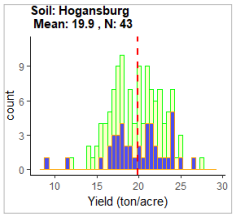
Updating of the Cornell Yield Database

- Update existing corn grain yield database
- Develop an independent corn silage yield database
- Essential step: all yield monitor data were cleaned using the protocol of Kharel et al. (2019).
- Farmers received their own yield reports (yield per field and per soil type)



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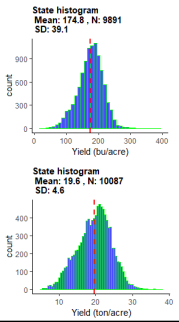
State Yield Histograms

The new database showed higher average yields than state reported averages

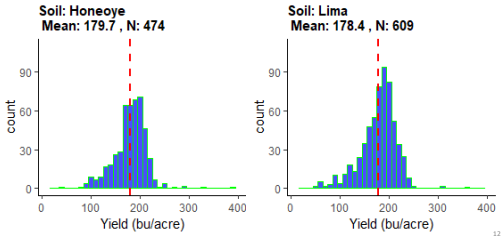
Yield monitor dataset (83% from 2014-2018):
19.6 tons/acre and 175 bu/acre

Ag Statistics averages (2014-2018):
17.6 tons/acre and 148 bu/acre

NY Ag Statistics averages (2017-2018):
18.5 tons/acre and 160 bu/acre



Corn Grain Yield Histograms for New York



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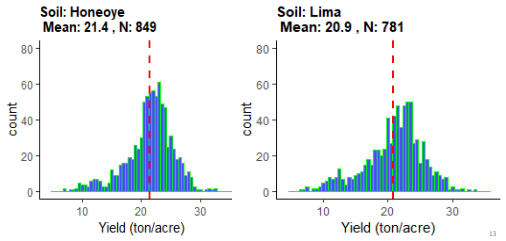
Corn Silage Yield Histograms for New York



Corn Yields for New York

Grain:
- 41 soil types with 50 or more datapoints
- Mean yields ranged from 140 to 196 bu/acre
- Standard deviation: 39 bu/acre

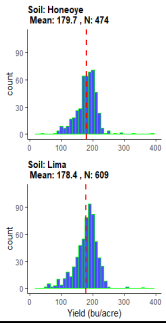
Silage:
- 44 soil types with 50 or more datapoints
- Mean yields ranged from 17.0 to 20.6 tons/acre
- Standard deviation 4.6 tons/acre

How to Proceed?

Given:
- Some bias in the data (higher yielding fields)?

Aim:
- Set realistic yield potentials
- Incentivize continued yield assessment

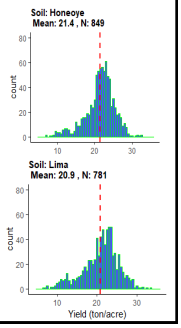
Proposed approach:
- Use means; assume soils are drained
- Include soils with at least 50 data points and where mean ≈ median

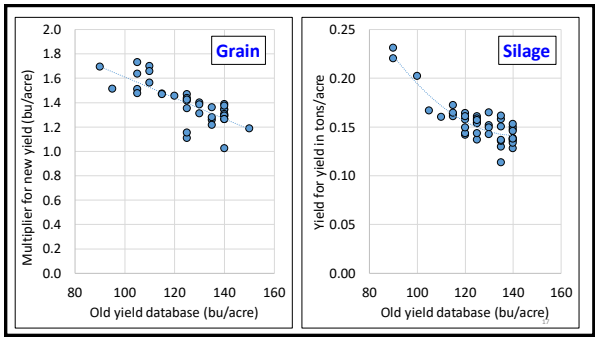


How to Proceed?

What about other soil types?

Options:
- Update only those for which we have histograms?
- Extract a relationship from current soil type data:
  - Extrapolate to entire database?
  - Use lowest multiplier for all other soil types?
  - Reduce values for undrained scenarios?





How to Proceed?

Participatory approach

Meetings with:
- NMSP internal advisory committee (Cornell faculty, staff, extension)
- NMSP external advisory committee (consultants, farmers, agencies, Farm Bureau, Northeast Dairy Producers Association, etc.)
- Certified crop advisor annual meeting
- Winter extension meetings

Cornell Nitrogen Guidelines in Fall 2000

$$\text{N req.} = \frac{(\text{yield potential} * \mathbf{1.2}) - \text{soil N} - \text{sod N}}{(\text{fertilizer efficiency}/100)} - \text{past and/or current manure credits}$$

in bushels/acre; in lbs N/acre; in lbs N/acre; in lbs N/acre; in %; in lbs N/acre

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Other States and the 1.2 Multiplier?

- Maryland, Pennsylvania, Tennessee, Virginia: 1.0-1.25 lb N/bu
- Florida: 0.8–1.2 lb N/bu
- Vermont: 0.9–1.0 lb N/bu
- North Carolina: 0.8–1.0 lb N/bu

- Kansas, Utah, Wyoming: 1.6 lb N/bu
- Idaho, Washington, Oregon: 1.4–1.5 lb N/bu
- Mississippi: 1.3 lb N/bu

Idaho and South Carolina decrease by 0.1–0.2 lb N/bu across yield levels ranging from 100–200 bu/acre

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Summary

- Yield potential databases are needed
  - Models for in-season adjustments require user-entered "yield goal"
- Updates are feasible now but yield monitor data cleaning is essential!
- Setting of yield potentials needs to incentivize measuring yield and avoid excessive N applications; work ongoing
- Higher yielding fields typically need less N per lbs of N taken up
  - Adjust the 1.2 multiplier as yields increase
- Research focus on quicker/better ways to measure yield
- Development of farm specific yield stability zones

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Thanks!

Questions?

- Farmers
- Consultants
- Cornell Cooperative Extension
- Cornell students
- Northern New York Agricultural Development Program (NYADP)
- New York Farm Viability Institute (NYFVI)
- New York Corn Growers Association (NYCGA)
- Federal Formula Funds

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