How much manure?

Using CNMP tools to make manure application recommendations in NYS

Kirsten Workman

Sr. Extension Associate
Nutrient Management &
Environmental Sust. Specialist

CERTIFIED CROP ADVISER

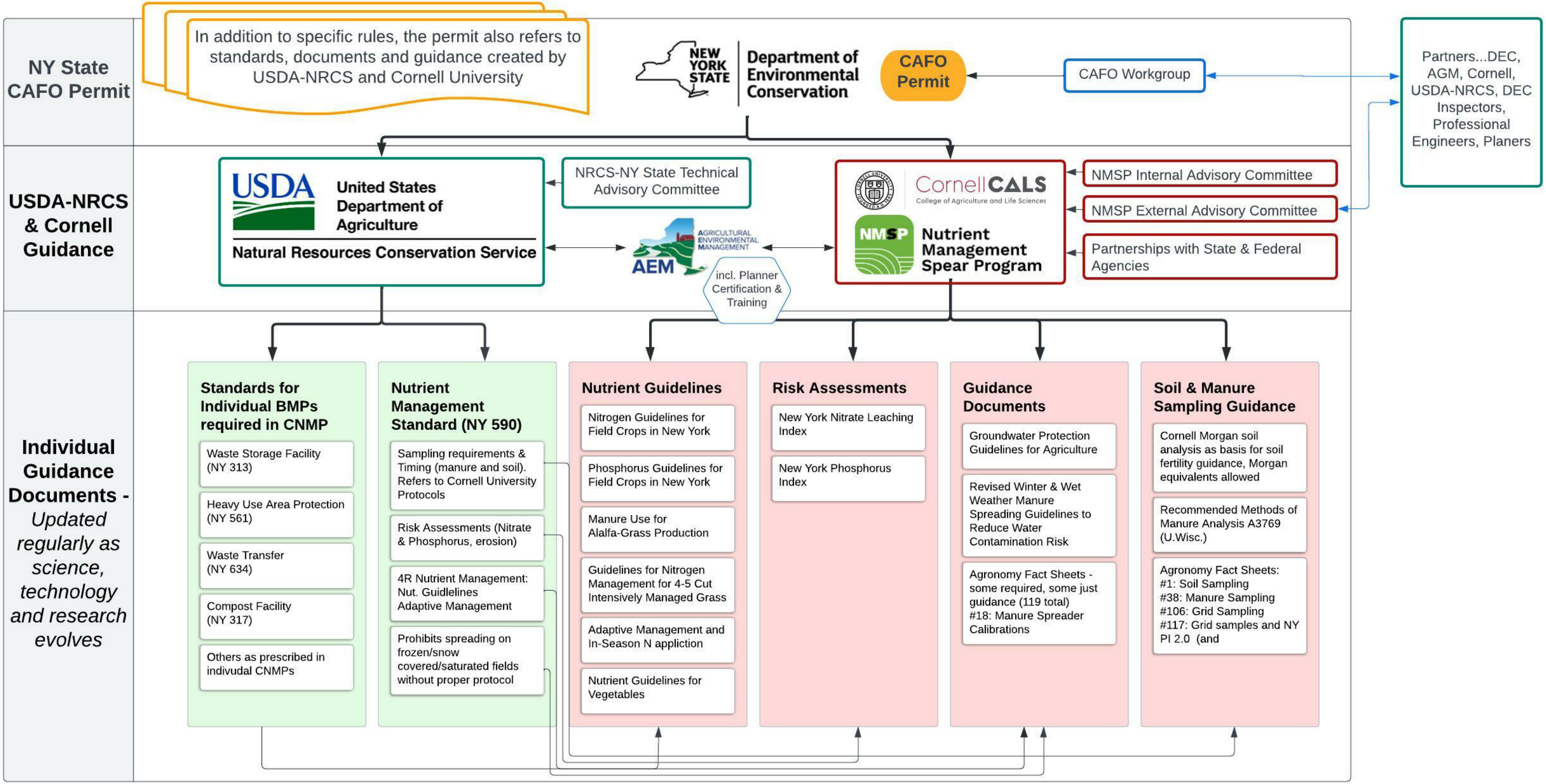
PRO DAIRY Education & Applied Research

NMSP Nutrient Management Spear Program

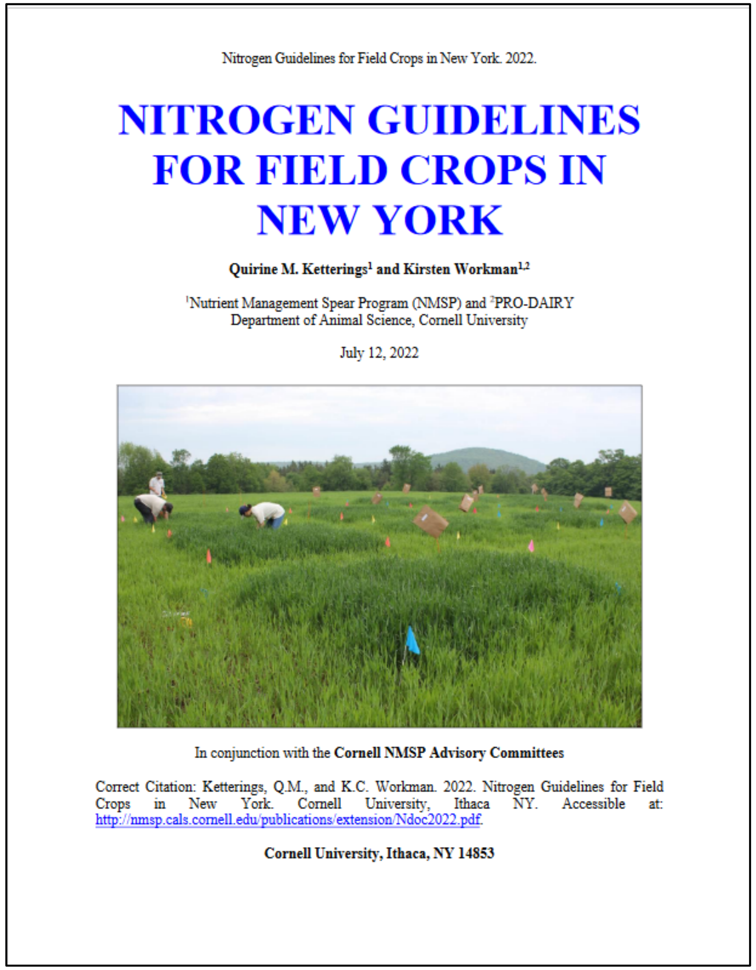
Cornell CALS College of Agriculture and Life Sciences

Nutrient Management Planning

- Concentrated Animal Feeding Operations (*required*)
- Farms who receive financial assistance from AEM or NRCS for waste storage or other nutrient management practices
- Farms who WANT one…
  - NRCS
  - AEM
  - DAP
- Follow the NRCS 590 Standard


NY State CAFO Permit
In addition to specific rules, the permit also refers to standards, documents and guidance created by USDA-NRCS and Cornell University
NEW YORK STATE
Department of Environmental Conservation
CAFO Permit
CAFO Workgroup
Partners...DEC, AGM, Cornell, USDA-NRCS, DEC Inspectors, Professional Engineers, Planers
USDA-NRCS & Cornell Guidance
USDA
United States Department of Agriculture
Natural Resources Conservation Service
NRCS-NY State Technical Advisory Committee
AGRICULTURAL ENVIRONMENTAL MANAGEMENT
AEM
incl. Planner Certification & Training
Cornell CALS
College of Agriculture and Life Sciences
NMSP
Nutrient Management Spear Program
NMSP Internal Advisory Committee
NMSP External Advisory Committee
Partnerships with State & Federal Agencies
Individual Guidance Documents - Updated regularly as science, technology and research evolves
Standards for Individual BMPs required in CNMP
Waste Storage Facility (NY 313)
Heavy Use Area Protection (NY 561)
Waste Transfer (NY 634)
Compost Facility (NY 317)
Others as prescribed in indivudal CNMPs
Nutrient Management Standard (NY 590)
Sampling requirements & Timing (manure and soil). Refers to Cornell University Protocols
Risk Assessments (Nitrate & Phosphorus, erosion)
4R Nutrient Management: Nut. Guidlelines Adaptive Management
Prohibits spreading on frozen/snow covered/saturated fields without proper protocol
Nutrient Guidelines
Nitrogen Guidelines for Field Crops in New York
Phosphorus Guidelines for Field Crops in New York
Manure Use for Alalfa-Grass Production
Guidelines for Nitrogen Management for 4-5 Cut Intensively Managed Grass
Adaptive Management and In-Season N appliction
Nutrient Guidelines for Vegetables
Risk Assessments
New York Nitrate Leaching Index
New York Phosphorus Index
Guidance Documents
Groundwater Protection Guidelines for Agriculture
Revised Winter & Wet Weather Manure Spreading Guidelines to Reduce Water Contamination Risk
Agronomy Fact Sheets - some required, some just guidance (119 total) #18: Manure Spreader Calibrations
Soil & Manure Sampling Guidance
Cornell Morgan soil analysis as basis for soil fertility guidance, Morgan equivalents allowed
Recommended Methods of Manure Analysis A3769 (U.Wisc.)
Agronomy Fact Sheets: #1: Soil Sampling #38: Manure Sampling #106: Grid Sampling #117: Grid samples and NY PI 2.0 (and

CORNELL GUIDANCE DOCUMENTS



Nitrogen Guidelines for Field Crops in New York. 2022.

NITROGEN GUIDELINES FOR FIELD CROPS IN NEW YORK

Quirine M. Ketterings[1] and Kirsten Workman[1,2]

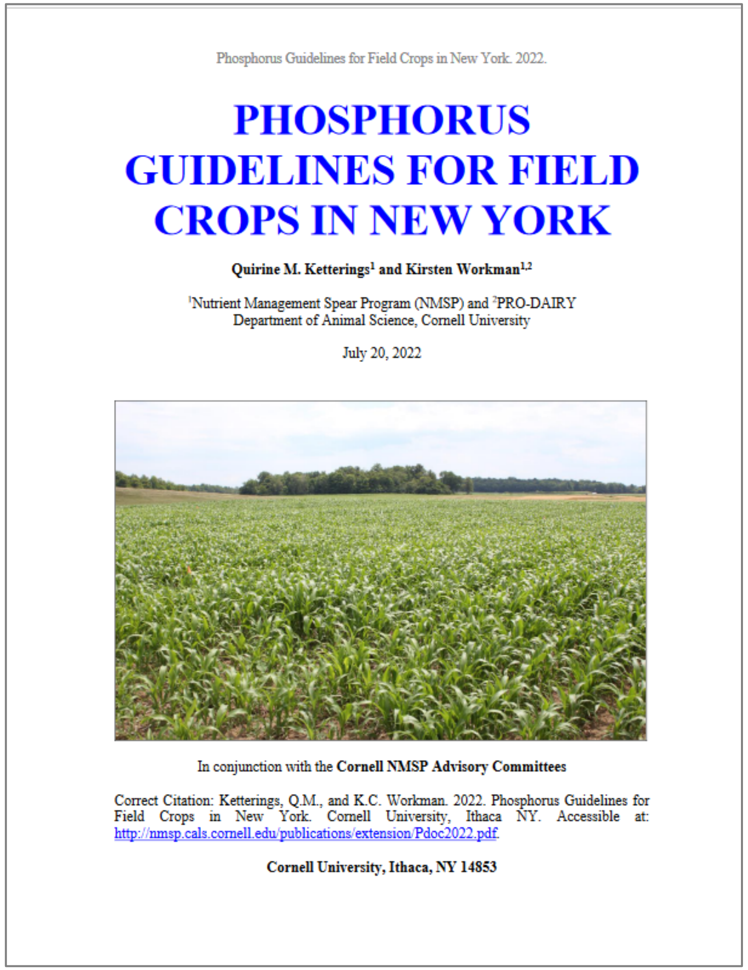
[1]Nutrient Management Spear Program (NMSP) and [2]PRO-DAIRY
Department of Animal Science, Cornell University

July 12, 2022

In conjunction with the **Cornell NMSP Advisory Committees**

Correct Citation: Ketterings, Q.M., and K.C. Workman. 2022. Nitrogen Guidelines for Field Crops in New York. Cornell University, Ithaca NY. Accessible at: http://nmsp.cals.cornell.edu/publications/extension/Ndoc2022.pdf.

Cornell University, Ithaca, NY 14853



Phosphorus Guidelines for Field Crops in New York. 2022.

PHOSPHORUS GUIDELINES FOR FIELD CROPS IN NEW YORK

Quirine M. Ketterings[1] and Kirsten Workman[1,2]

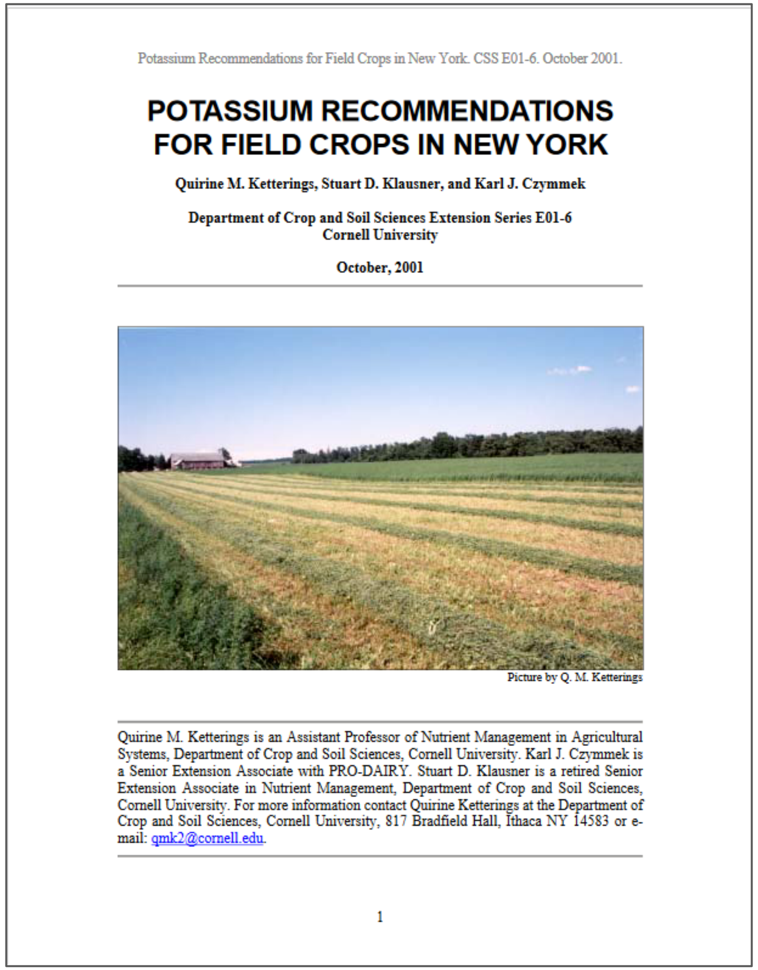
[1]Nutrient Management Spear Program (NMSP) and [2]PRO-DAIRY
Department of Animal Science, Cornell University

July 20, 2022

In conjunction with the **Cornell NMSP Advisory Committees**

Correct Citation: Ketterings, Q.M., and K.C. Workman. 2022. Phosphorus Guidelines for Field Crops in New York. Cornell University, Ithaca NY. Accessible at: http://nmsp.cals.cornell.edu/publications/extension/Pdoc2022.pdf.

Cornell University, Ithaca, NY 14853



Potassium Recommendations for Field Crops in New York. CSS E01-6. October 2001.

POTASSIUM RECOMMENDATIONS FOR FIELD CROPS IN NEW YORK

Quirine M. Ketterings, Stuart D. Klausner, and Karl J. Czymmek

Department of Crop and Soil Sciences Extension Series E01-6
Cornell University

October, 2001

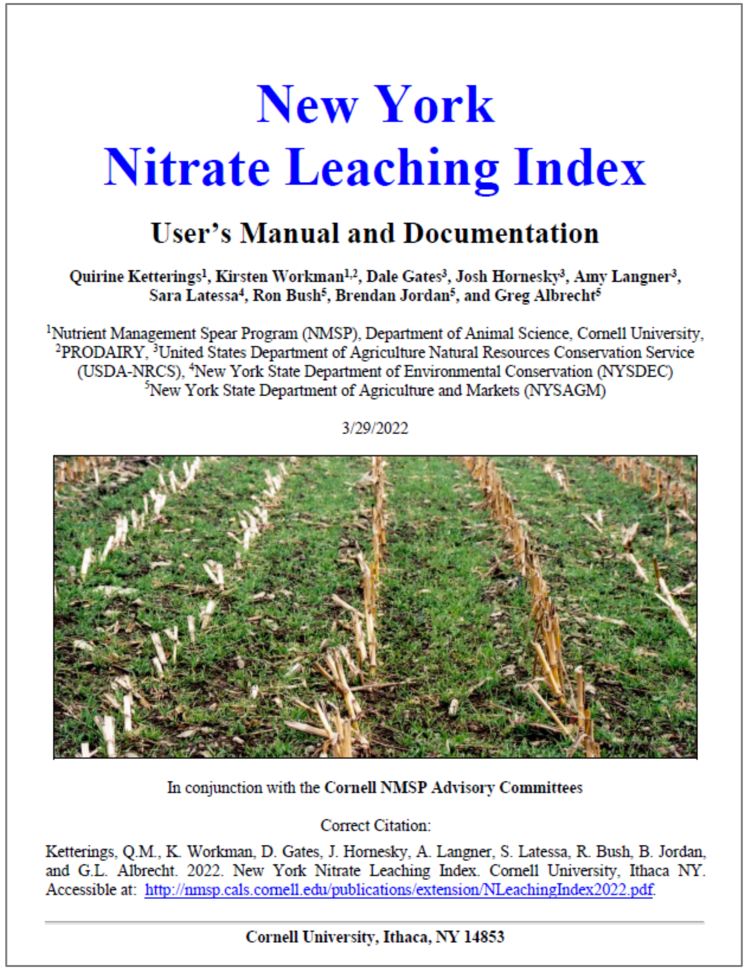
Picture by Q. M. Ketterings

Quirine M. Ketterings is an Assistant Professor of Nutrient Management in Agricultural Systems, Department of Crop and Soil Sciences, Cornell University. Karl J. Czymmek is a Senior Extension Associate with PRO-DAIRY. Stuart D. Klausner is a retired Senior Extension Associate in Nutrient Management, Department of Crop and Soil Sciences, Cornell University. For more information contact Quirine Ketterings at the Department of Crop and Soil Sciences, Cornell University, 817 Bradfield Hall, Ithaca NY 14583 or e-mail: qmk2@cornell.edu.

1

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

CORNELL GUIDANCE DOCUMENTS



New York
Nitrate Leaching Index

User's Manual and Documentation

Quirine Ketterings[1], Kirsten Workman[1,2], Dale Gates[3], Josh Hornesky[3], Amy Langner[3], Sara Latessa[4], Ron Bush[5], Brendan Jordan[5], and Greg Albrecht[5]

[1]Nutrient Management Spear Program (NMSP), Department of Animal Science, Cornell University, [2]PRODAIRY, [3]United States Department of Agriculture Natural Resources Conservation Service (USDA-NRCS), [4]New York State Department of Environmental Conservation (NYSDEC) [5]New York State Department of Agriculture and Markets (NYSAGM)

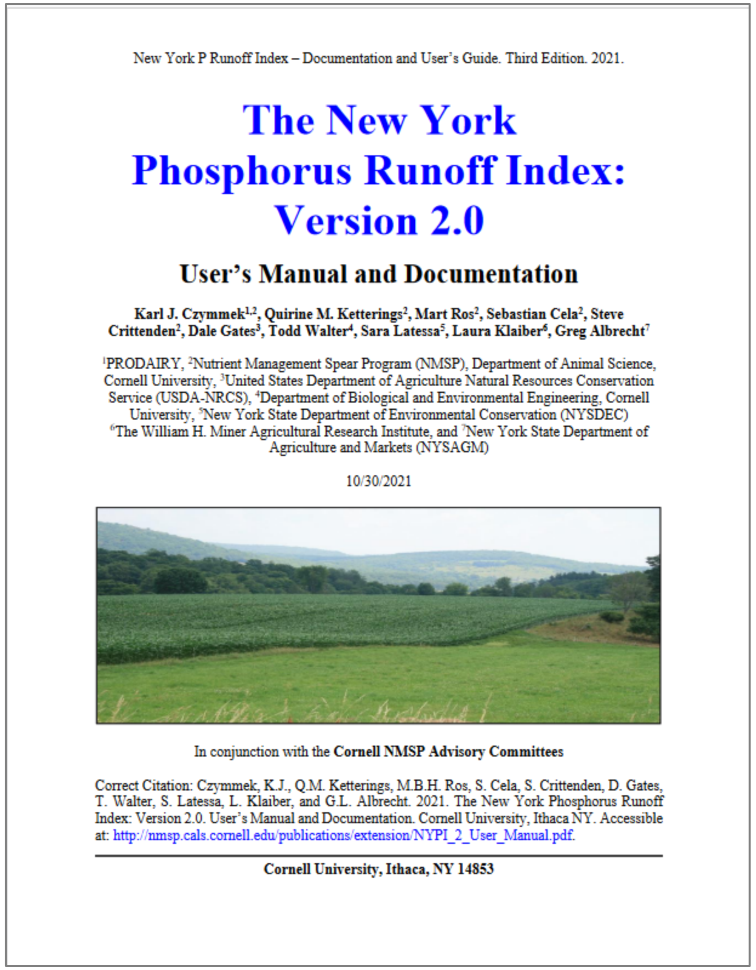
3/29/2022

In conjunction with the **Cornell NMSP Advisory Committees**

Correct Citation:

Ketterings, Q.M., K. Workman, D. Gates, J. Hornesky, A. Langner, S. Latessa, R. Bush, B. Jordan, and G.L. Albrecht. 2022. New York Nitrate Leaching Index. Cornell University, Ithaca NY. Accessible at: http://nmsp.cals.cornell.edu/publications/extension/NLeachingIndex2022.pdf.

Cornell University, Ithaca, NY 14853



New York P Runoff Index – Documentation and User's Guide. Third Edition. 2021.

The New York
Phosphorus Runoff Index:
Version 2.0

User's Manual and Documentation

Karl J. Czymmek[1,2], Quirine M. Ketterings[2], Mart Ros[2], Sebastian Cela[2], Steve Crittenden[2], Dale Gates[3], Todd Walter[4], Sara Latessa[5], Laura Klaiber[6], Greg Albrecht[7]

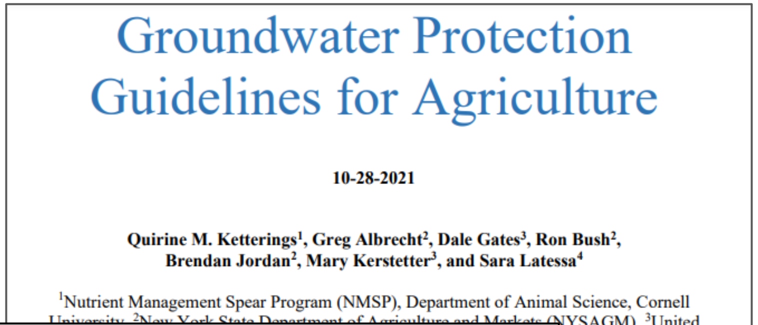
[1]PRODAIRY, [2]Nutrient Management Spear Program (NMSP), Department of Animal Science, Cornell University, [3]United States Department of Agriculture Natural Resources Conservation Service (USDA-NRCS), [4]Department of Biological and Environmental Engineering, Cornell University, [5]New York State Department of Environmental Conservation (NYSDEC) [6]The William H. Miner Agricultural Research Institute, and [7]New York State Department of Agriculture and Markets (NYSAGM)

10/30/2021

In conjunction with the **Cornell NMSP Advisory Committees**

Correct Citation: Czymmek, K.J., Q.M. Ketterings, M.B.H. Ros, S. Cela, S. Crittenden, D. Gates, T. Walter, S. Latessa, L. Klaiber, and G.L. Albrecht. 2021. The New York Phosphorus Runoff Index: Version 2.0. User's Manual and Documentation. Cornell University, Ithaca NY. Accessible at: http://nmsp.cals.cornell.edu/publications/extension/NYPI_2_User_Manual.pdf.

Cornell University, Ithaca, NY 14853



Groundwater Protection
Guidelines for Agriculture

10-28-2021

Quirine M. Ketterings[1], Greg Albrecht[2], Dale Gates[3], Ron Bush[2], Brendan Jordan[2], Mary Kerstetter[3], and Sara Latessa[4]

[1]Nutrient Management Spear Program (NMSP), Department of Animal Science, Cornell

NYSAGM), [3]United
ice (USDA-NRCS),
NYSDEC)

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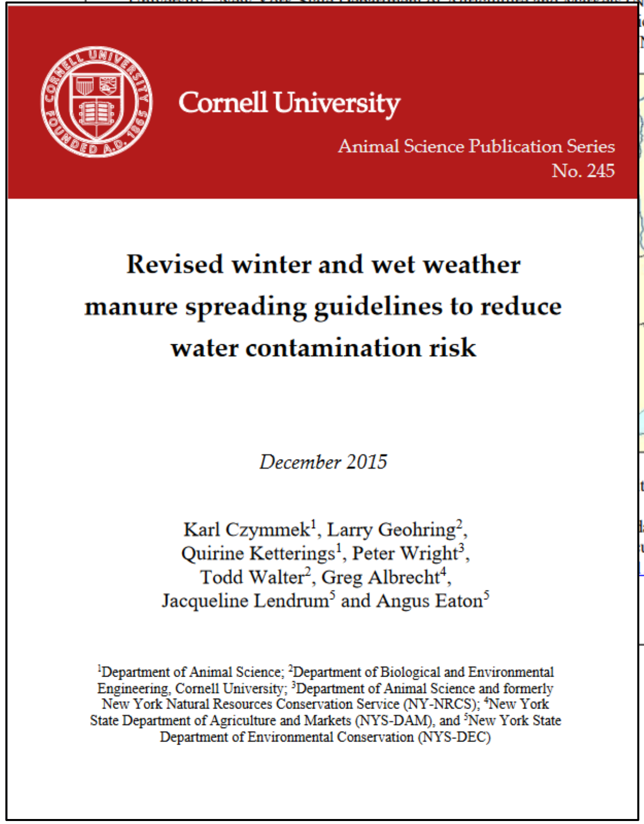
lan, B., Kerstetter, M.,
ulture. Accessible at:
.pdf.



Cornell University
Animal Science Publication Series
No. 245

Revised winter and wet weather manure spreading guidelines to reduce water contamination risk

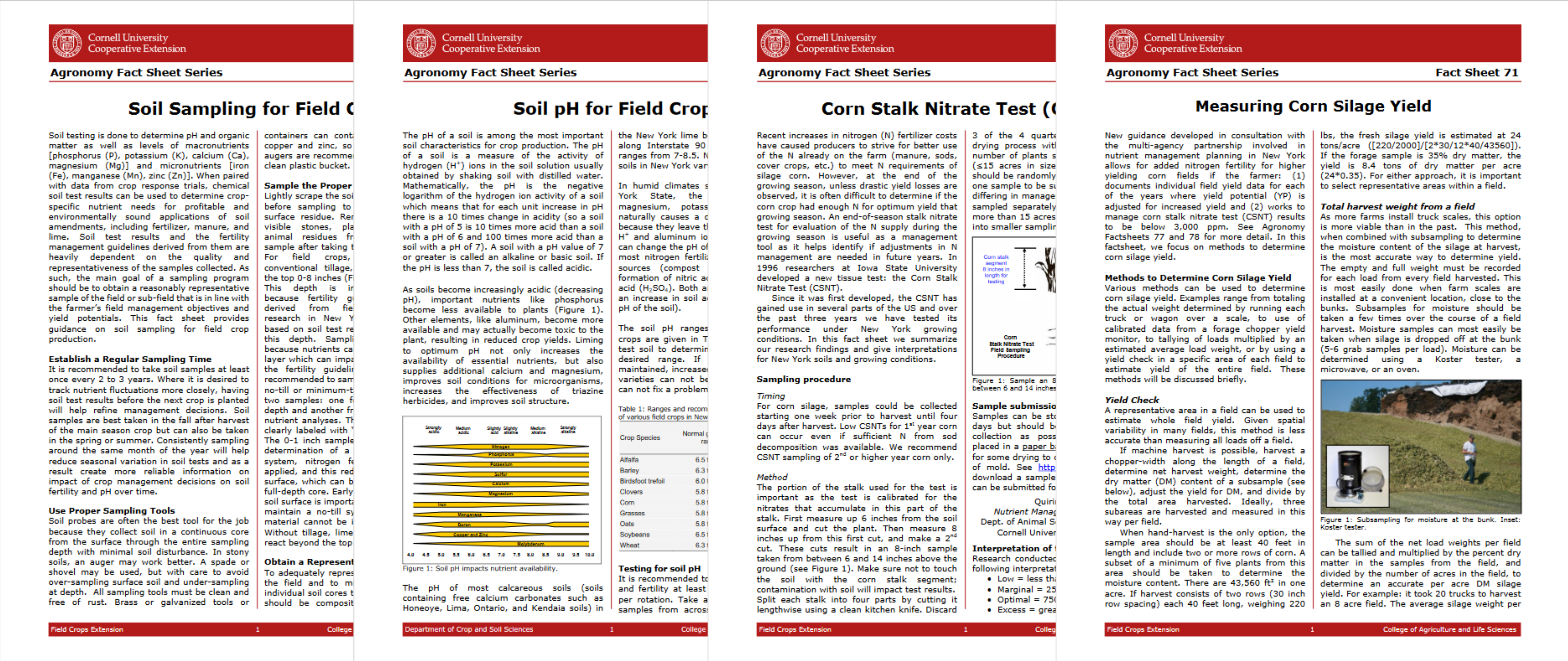
December 2015

Karl Czymmek[1], Larry Geohring[2], Quirine Ketterings[1], Peter Wright[3], Todd Walter[2], Greg Albrecht[4], Jacqueline Lendrum[5] and Angus Eaton[5]

[1]Department of Animal Science; [2]Department of Biological and Environmental Engineering, Cornell University; [3]Department of Animal Science and formerly New York Natural Resources Conservation Service (NY-NRCS); [4]New York State Department of Agriculture and Markets (NYS-DAM), and [5]New York State Department of Environmental Conservation (NYS-DEC)

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

CORNELL GUIDANCE DOCUMENTS



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

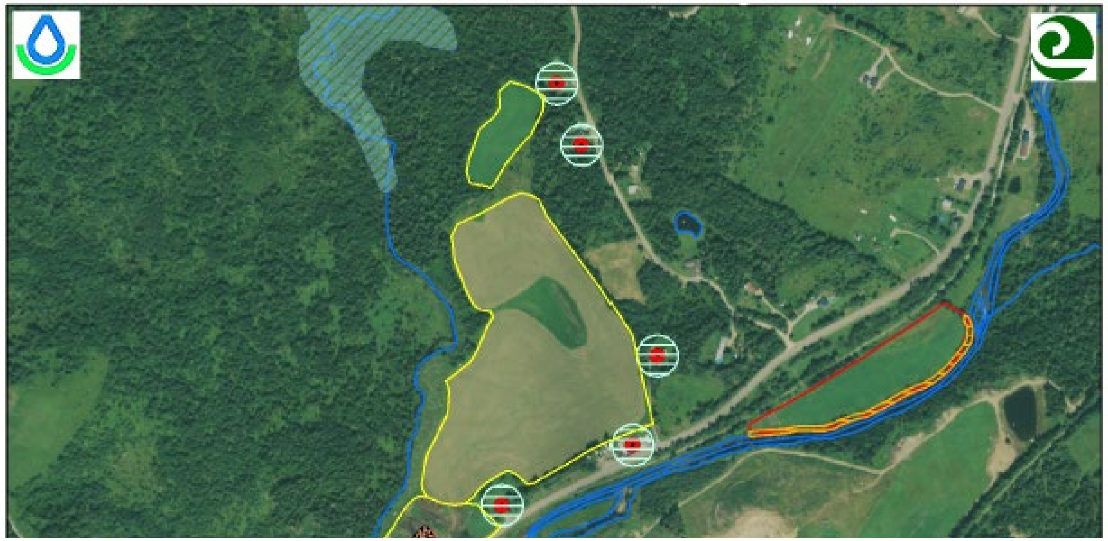
Breakdown

- Basic information required FIRST
- Risk Assessments
- Crop Needs
- Nutrient Guidelines vs. Actual Rates
- Management during application to avoid losses
- Q&A…

REMINDER: This ENTIRE process gets repeated for EVERY field in the CNMP

Step 1: Field Information

- Location, size
- Soil type
- Field characteristics
  - Slope, concentrated flows, existing erosion
- Proximity to environmentally sensitive areas & setbacks required
- Soil test
- Cropping history & management
  - Yield, rotation, previous nutrient applications
- **S**oil, **W**ater, **A**ir, **P**lants, **A**nimals, **H**umans, **E**nergy analysis



Soils Analysis Report
with Dairy One Nutrient Guidelines

Dairy One Agronomy Services

Dairy One
730 Warren Road
Ithaca NY 14850
Ph: 800.496.3344
Fax: 607.257.1350
www.dairyone.com

Sample #: 74860100
Date Sampled:
Date Received: 2/23/2023
Date Mailed: 2/24/2023

Crop, 3 Years Ago:
Crop, 2 Years Ago: Soybeans
Crop, Last Year: Corn-Grain
Plow Depth: Less than 9 inches
Manure: No

Farm Name / Client:
Field / Location:
Soil Name:
Acres:
Statement ID:

Component	Mehlich 3, ppm	Morgan, lbs/acre	Soil Test Levels (Very Low / Low / Medium / High / Very High)
Phosphorus (P)	66.0	5.9	*****************
Potassium (K)	151.4	268.4	***********************************
Calcium (Ca)	1,432.0	2,500.0	****************************
Magnesium (Mg)	155.8	282.4	**

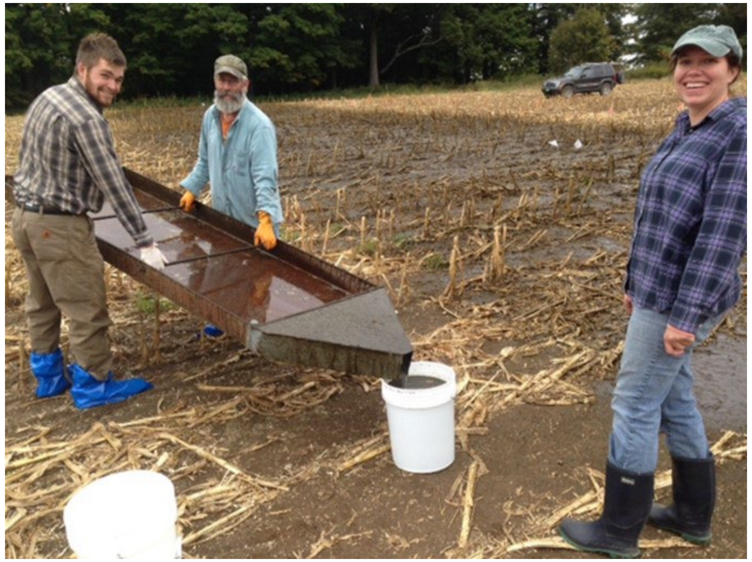
pH	Buffer pH	Organic Matter, %	CEC meq/100g	Exchg. Acidity meq/100g	Nitrate-N ppm	Total N %	Sol. Salts mmhos/cm	Base Saturation Values, %: K	Ca	Mg	Na	H	Total
6.4	6.2	3.5	10.3	1.44				3.8	69.2	12.4	0.6	14.0	86.0

Other Nutrients, ppm

Na	Al	S	Zn	Mn	Fe	Cu	B	Mo
14.8	897.9		2.7					

Step 2: Nutrient Information

- Types & volumes available
- Nutrient analysis
- Spreader calibration



Manure Test Report

Agricultural & Environmental Testing Laboratory
and UVM Extension

6.11 % Dry Matter

8.34 Density (lbs per ga

Description	*lbs/wet ton*	*lbs/1,000 gal*	*Dry Wt. Basis*
			(%)
Total Nitrogen	4.2	17.4	3.41
Ammonium Nitrogen (NH_4-N, part of total)	1.1	4.8	0.94
Organic Nitrogen (part of total)	3.0	12.6	2.48
Phosphorus as P_2O_5	2.0	8.2	1.61
Potassium as K_2O	5.3	21.9	4.30
Calcium	3.3	14.0	2.74
Magnesium	0.9	3.9	0.76
Sodium	0.3	1.1	0.22
Micronutrients			*(ppm or mg/kg)*
Copper	<0.01	< 0.05	23
Zinc	<0.01	< 0.05	65
Iron	0.14	0.6	1,119
Manganese	<0.01	< 0.05	110
Boron	<0.01	< 0.05	29

Step 3: Risk Assessment

- Soil Loss – Revised Universal Soil Loss Equation (RUSLE)
  - Must meet thresholds or 'tolerable' limits
- Phosphorus Runoff Index
- Nitrate Leaching Index
- Environmental Concerns - Setbacks
  - Surface water
  - Ground water & wells
  - Plants, wildlife
  - Air

Hydrologic Soil Group (HSG)	Type	Infiltration capacity/ permeability	Leaching potential	Runoff potential
A	Deep, well-drained sands and gravels.	High	High	Low
B	Moderately drained, moderately fine to moderately coarse texture.	Moderate	Moderate	Moderate
C	Impeding layer, or moderately fine to fine texture.	Low	Low	High
D	Clay soils, soils with high water table.	Very low	Very low	Very high

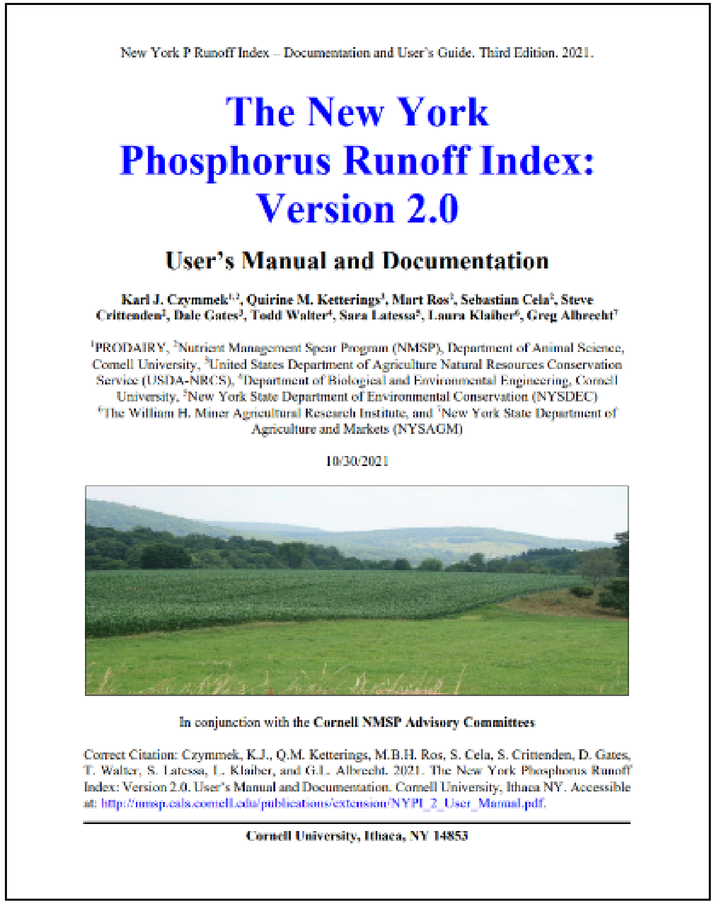
Phosphorus Runoff Index

<u>National NRCS Code 590</u>

P application shall be consistent with either:

- *Agronomic soil test*
  - If STP says no P needed, no P can be added
- *P threshold*
  - If STP > threshold, no more P
- *P index - risk determination*
  - Combine source and transport risk → **NY Phosphorus Index**

NY-PI 2.0 User's Manual



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User's Manual and Documentation

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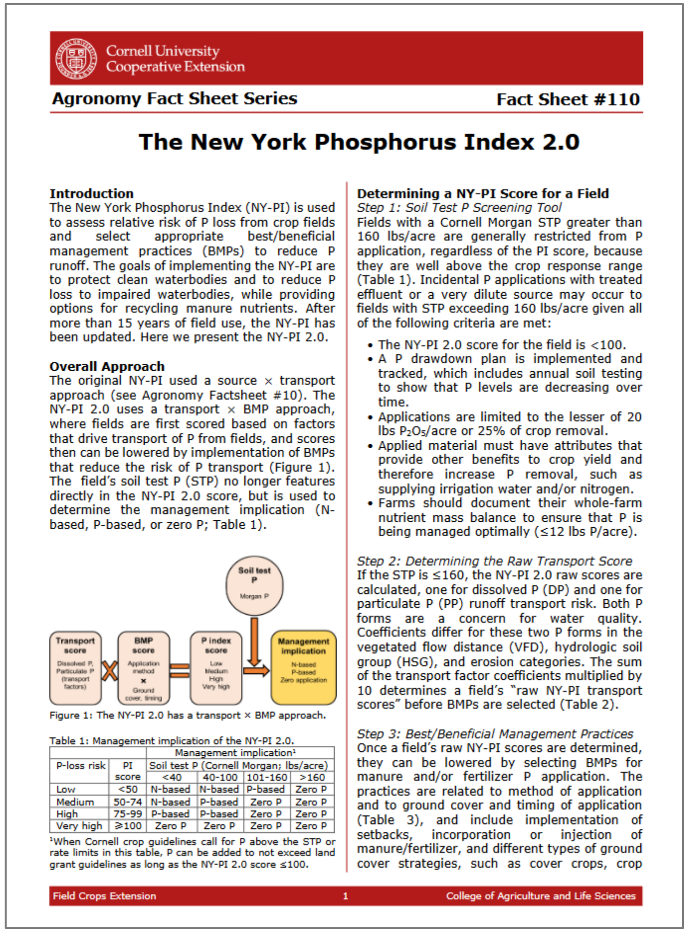
Cornell University, Ithaca, NY 14853

NY-PI 2.0:

- Released Dec. 2019
- Added to NRCS 590 for NY
- NY CAFO Permit -2022 (2025 implementation)



Cornell University Cooperative Extension

Agronomy Fact Sheet Series **Fact Sheet #110**

The New York Phosphorus Index 2.0

Introduction
The New York Phosphorus Index (NY-PI) is used to assess relative risk of P loss from crop fields and select appropriate best/beneficial management practices (BMPs) to reduce P runoff. The goals of implementing the NY-PI are to protect clean waterbodies and to reduce P loss to impaired waterbodies, while providing options for recycling manure nutrients. After more than 15 years of field use, the NY-PI has been updated. Here we present the NY-PI 2.0.

Overall Approach
The original NY-PI used a source × transport approach (see Agronomy Factsheet #10). The NY-PI 2.0 uses a transport × BMP approach, where fields are first scored based on factors that drive transport of P from fields, and scores then can be lowered by implementation of BMPs that reduce the risk of P transport (Figure 1). The field's soil test P (STP) no longer features directly in the NY-PI 2.0 score, but is used to determine the management implication (N-based, P-based, or zero P; Table 1).

Figure 1: The NY-PI 2.0 has a transport × BMP approach.

Table 1: Management implication of the NY-PI 2.0.

P-loss risk	PI score	Management implication[1] Soil test P (Cornell Morgan; lbs/acre) <40	40-100	101-160	>160
Low	<50	N-based	N-based	P-based	Zero P
Medium	50-74	N-based	P-based	Zero P	Zero P
High	75-99	P-based	P-based	Zero P	Zero P
Very high	≥100	Zero P	Zero P	Zero P	Zero P

[1]When Cornell crop guidelines call for P above the STP or rate limits in this table, P can be added to not exceed land grant guidelines as long as the NY-PI 2.0 score ≤100.

Determining a NY-PI Score for a Field
Step 1: Soil Test P Screening Tool
Fields with a Cornell Morgan STP greater than 160 lbs/acre are generally restricted from P application, regardless of the PI score, because they are well above the crop response range (Table 1). Incidental P applications with treated effluent or a very dilute source may occur to fields with STP exceeding 160 lbs/acre given all of the following criteria are met:

- The NY-PI 2.0 score for the field is <100.
- A P drawdown plan is implemented and tracked, which includes annual soil testing to show that P levels are decreasing over time.
- Applications are limited to the lesser of 20 lbs P_2O_5/acre or 25% of crop removal.
- Applied material must have attributes that provide other benefits to crop yield and therefore increase P removal, such as supplying irrigation water and/or nitrogen.
- Farms should document their whole-farm nutrient mass balance to ensure that P is being managed optimally (≤12 lbs P/acre).

Step 2: Determining the Raw Transport Score
If the STP is ≤160, the NY-PI 2.0 raw scores are calculated, one for dissolved P (DP) and one for particulate P (PP) runoff transport risk. Both P forms are a concern for water quality. Coefficients differ for these two P forms in the vegetated flow distance (VFD), hydrologic soil group (HSG), and erosion categories. The sum of the transport factor coefficients multiplied by 10 determines a field's "raw NY-PI transport scores" before BMPs are selected (Table 2).

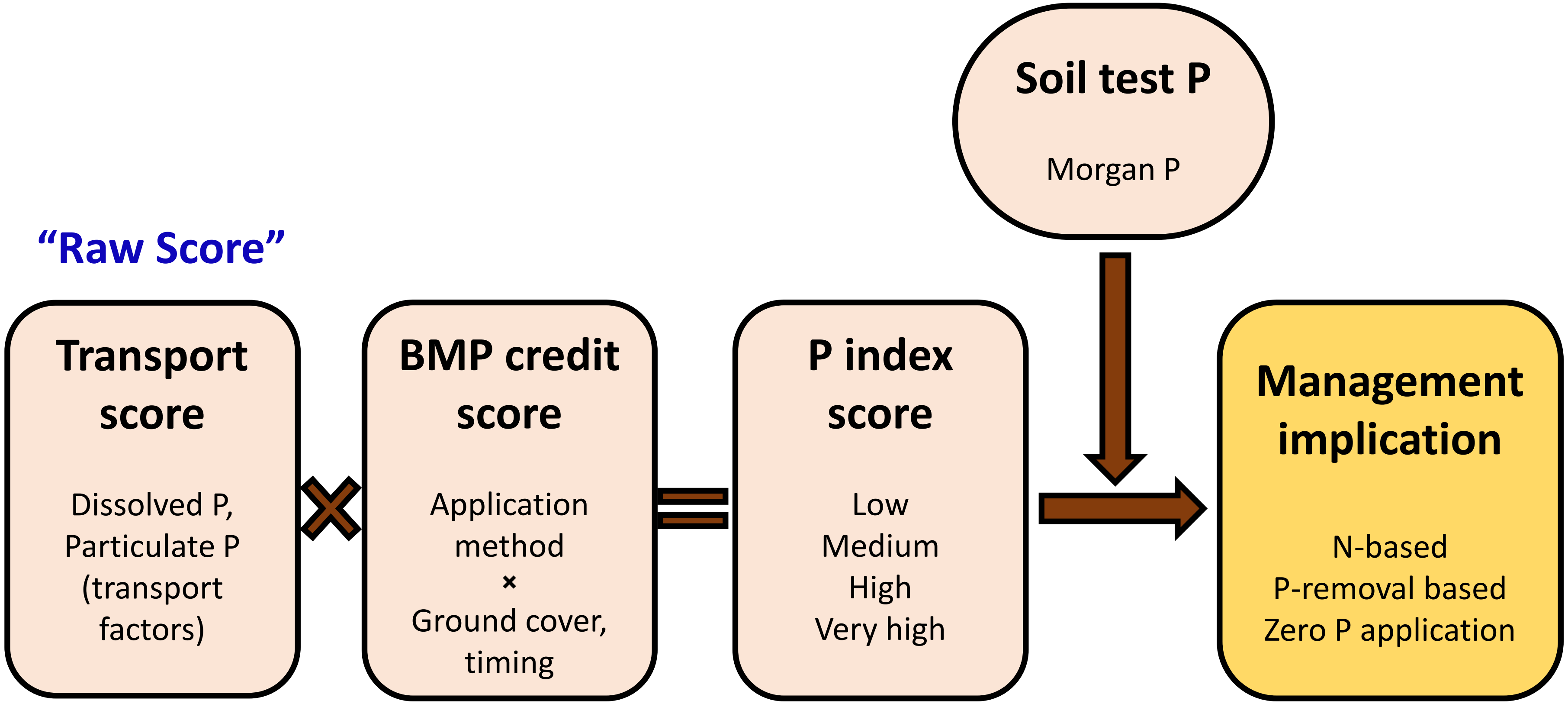
Step 3: Best/Beneficial Management Practices
Once a field's raw NY-PI scores are determined, they can be lowered by selecting BMPs for manure and/or fertilizer P application. The practices are related to method of application and to ground cover and timing of application (Table 3), and include implementation of setbacks, incorporation or injection of manure/fertilizer, and different types of ground cover strategies, such as cover crops, crop

Field Crops Extension 1 College of Agriculture and Life Sciences

Documentation and User's Guide:
http://nmsp.cals.cornell.edu/publications/extension/NYPI_2_User_Manual.pdf

Factsheet:
http://nmsp.cals.cornell.edu/publications/factsheets/factsheet110.pdf

NY-PI 2.0 structure



Dissolved P
Particulate P
} Both have to be <100 to apply P

Determining a Field NY-PI 2.0 Score

Four steps:

- Step 1: Soil Test P (STP) Screening Tool
- Step 2: Determining the Raw Transport Scores
- Step 3: Best/Beneficial Management Practices (BMPs)
- Step 4: Determine management implications (N-based, P-based, zero)

Additional considerations:

- Adaptive management option (farm with NMBs ≤12 lbs P/acre)
- Incidental P application to fields with STP > 160 lbs P/acre

Determining a Field NY-PI 2.0 Score

Step 1: Soil Test P Screening Tool

Cornell Morgan *STP >160 lbs P/acre*: zero P, regardless of PI score

PI categories	PI score	Cornell Morgan-extractable soil test P (lbs P/acre)			
		< 40	40-100	101-160	> 160
Low	< 50	N-based	N-based	P-based	Zero P
Medium	50 to 74	N-based	P-based	Zero P	Zero P
High	75 to 99	P-based	P-based	Zero P	Zero P
Very High	≥100	Zero P	Zero P	Zero P	Zero P

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PRODAIRY Education & Applied Research

NMSP Nutrient Management Spear Program

Step 2: Determination of Raw Transport Scores

Transport score

Dissolved P, Particulate P (transport factors)

Dissolved P (DP score) =
$$10*[FD+VFD_{DP}+FF+HSG_{DP}+CF]$$

Particulate P (PP score) =
$$10*[FD+VFD_{PP}+FF+HSG_{PP}+E+CF]$$

Factor	Option	Coefficient	
Flow distance (FD) to stream in ft	> 500	0	
	301-500	4	
	101-300	6	
	≤ 100	8	
Vegetated flow distance (VFD)[1]	<35 ft	0	
	≥35 ft	DP: -2	PP: -4
Flooding frequency (FF)	Never	0	
	Occasionally	2	
	Frequent	5	
Hydrologic soil group (HSG)	A	DP: 0	PP: 0
	B	DP: 4	PP: 1
	C	DP: 6	PP: 3
	D	DP: 8	PP: 5
Erosion (E) in ton/acre[2]	≤ 1.0	0	
	1.1-3.0	1	
	3.1-5.0	3	
	> 5.0	5	
Concentrated flow (CF)	None/treated	0	
	Present	4	

[1]Only for fields with FD ≤ 500 ft. [2]RUSLE2 A-value (yearly).

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Step 3: Best/Beneficial Management Practices

Select One from Each List and Multiply

BMP score

Application method
×
Ground cover, timing

Method of application	
Surface spread without setback	1.0
Surface spread with ≥100-ft setback from the field boundary (start of the predominant flow path)[1]	0.8
Surface spread with ≥35-ft managed vegetated (sod/harvested) setback from the field boundary (start of the predominant flow path)[1]	0.7
Incorporation within 24 h with ≥15-ft setback from down-gradient surface waters	0.7
Injection with ≥15-ft setback from down-gradient surface waters	0.5
Ground cover and timing	
Bare ground and more than 2 weeks before planting	1.0
Bare ground and within 2 weeks of planting (in spring)	0.8
Winter-hardy cover crop (fall/winter)	0.8
Whole-plant crop residue (~80% or more ground cover, e.g. corn grain)	0.7
Sod after last cutting (fall/winter)	0.6
Growing sod or row crop/planting green	0.5

[1]Only for fields with FD ≤ 500 ft.

Implementing the Phosphorus Index 2.0

BMP COEFFICIENTS			
Method of Application	**Coefficient** Scen. A	Scen. B	Scen. C*
Surface spread without setback	1.0	1.0	1.0
Surface spread with ≥100-ft setback from the field boundary (start of the predominant flow path)	0.8	0.8	0.8
Surface spread with ≥35-ft managed vegetated (sod/harvested) setback from the field boundary (start of the predominant flow path)	0.7	0.7	0.7
Incorporation within 24 hours with ≥15-ft setback from down-gradient surface waters	0.7	0.7	0.7
Injection with ≥15-ft setback from down-gradient surface waters	0.5	0.5	0.5
Ground Cover/Timing			
Bare ground and more than 2 weeks before planting	1.0	1.0	1.0
Bare ground and within 2 weeks of planting (in spring)	0.8	0.8	0.8
Winter-hardy cover crop (fall/winter)	0.8	0.8	0.8
Whole-plant crop residue (~80% or more ground cover, e.g. corn grain)	0.7	0.7	0.7
Sod after last cutting (fall/winter)	0.6	0.6	0.6
Growing sod or row crop/planting green	0.5	0.5	0.5

Phosphorus Index Score													
Higher Total Transport Score *(of DP/PP above)*		Method Coefficient				Cover/Timing Coefficient				P Index Score			
		Scen. A	Scen. B	Scen. C		Scen. A	Scen. B	Scen. C		Scen. A	Scen. B	Scen. C	
100	X	0.5	0.8	1.0	X	0.5	0.7	1.0	=	25	56	100	

*You have the option to choose three different BMP Scenarios to compare results based on different combinations of BMP's.

For example:

Scen. A =
*100 * 0.5 * 0.5 = 25*

Scen. B =
*100 * 0.8 * 0.7 = 56*

Scen. C =
*100 * 1.0 * 1.0 = 100*

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Determining a Field NY-PI 2.0 Score

Step 4: Determine management implications (N-based, P-based, zero)

PI categories	PI score	Cornell Morgan-extractable soil test P (lbs P/acre) < 40	40-100	101-160	> 160
Low	< 50	N-based	N-based	P-based	Zero P
Medium	50 to 74	N-based	P-based	Zero P	Zero P
High	75 to 99	P-based	P-based	Zero P	Zero P
Very High	≥100	Zero P	Zero P	Zero P	Zero P

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N-based, P-based or No P?

P-Index Management	What does that mean
N-based	Manure and fertilizer application not to exceed annual nitrogen (N) needs for the crop grown based on the Cornell Nutrient Guidelines.
P-based	Manure and fertilizer P application not to exceed annual P removal with harvest.
Zero P	No manure or P-containing fertilizer.

Nitrate Leaching Index

- Identification of fields with elevated nitrate leaching risk and implementation of beneficial management practices (BMPs) to reduce nitrate loss
- Hydrologic Soil Groups
- Percolation Index and the Seasonal Index
  - **PI**=annual average precipitation and the hydrologic soil group
  - **SI**=annual precipitation and the sum of the fall and winter precipitation at the township level
- >10 = must implement practices
- 2-10 = should implement practices

New York Nitrate Leaching Index

User's Manual and Documentation

Quirine Ketterings[1], Kirsten Workman[1,2], Dale Gates[3], Josh Hornesky[3], Amy Langner[3], Sara Latessa[4], Ron Bush[5], Brendan Jordan[5], and Greg Albrecht[5]

[1]Nutrient Management Spear Program (NMSP), Department of Animal Science, Cornell University, [2]PRODAIRY, [3]United States Department of Agriculture Natural Resources Conservation Service (USDA-NRCS), [4]New York State Department of Environmental Conservation (NYSDEC) [5]New York State Department of Agriculture and Markets (NYSAGM)

3/29/2022

In conjunction with the **Cornell NMSP Advisory Committees**

Correct Citation:

Ketterings, Q.M., K. Workman, D. Gates, J. Hornesky, A. Langner, S. Latessa, R. Bush, B. Jordan, and G.L. Albrecht. 2022. New York Nitrate Leaching Index. Cornell University, Ithaca NY. Accessible at: http://nmsp.cals.cornell.edu/publications/extension/NLeachingIndex2022.pdf.

Cornell University, Ithaca, NY 14853

Nitrate Leaching Index - BMPs

- Use Cornell N Guidelines
- Winter cover crops
- Avoid early and pre-plant N
- Utilize enhanced efficiency fertilizers
- Starter n <50 lbs/acre
- Split apply
- Use PSNT to eliminate unneeded side dress
- Minimize fall/winter manure applications
- Don't terminate sod in the fall
- Frost injections

New York Nitrate Leaching Index

User's Manual and Documentation

Quirine Ketterings[1], Kirsten Workman[1,2], Dale Gates[3], Josh Hornesky[3], Amy Langner[3], Sara Latessa[4], Ron Bush[5], Brendan Jordan[5], and Greg Albrecht[5]

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Step 4:
Determine the nutrient need of the crop

- Which crop are you growing and what is your yield?
- Start with a soil test.
- Determine likelihood of a yield response to fertilizer for P & K
- Nitrogen calculation (not based on a soil test).

- Nutrient recommendations, manure nutrient availability are all based in decades of research on NY farms.

Soil Fertility – Soil Testing and P & K

Soil Fertility – Soil Testing, P & K Fertilization

Table 2.10.1 from 2022 Cornell Guide for Integrated Field Crop Management

Soil Management Group	Phosphorus Soil Test Value[2]					Potassium Soil Test Value					Magnesium Soil Test Value[3]				
	Very Low	*Low*	*Medium*	*High*	*Very High*	*Very Low*	*Low*	*Medium*	*High*	*Very High*	*Very Low*	*Low*	*Medium*	*High*	*Very High*
I	<1	1-3	4-8	9-39	40+	<35	35-64	65-94	95-149	150+	<20	20-65	66-100	101-199	200+
II	<1	1-3	4-8	9-39	40+	<40	40-69	70-99	100-164	165+	<20	20-65	66-100	101-199	200+
III	<1	1-3	4-8	9-39	40+	<45	45-79	80-119	120-199	200+	<20	20-65	66-100	101-199	200+
IV	<1	1-3	4-8	9-39	40+	<55	55-99	100-149	150-239	240+	<20	20-65	66-100	101-199	200+
V	<1	1-3	4-8	9-39	40+	<60	60-114	115-164	165-269	270+	<20	20-65	66-100	101-199	200+

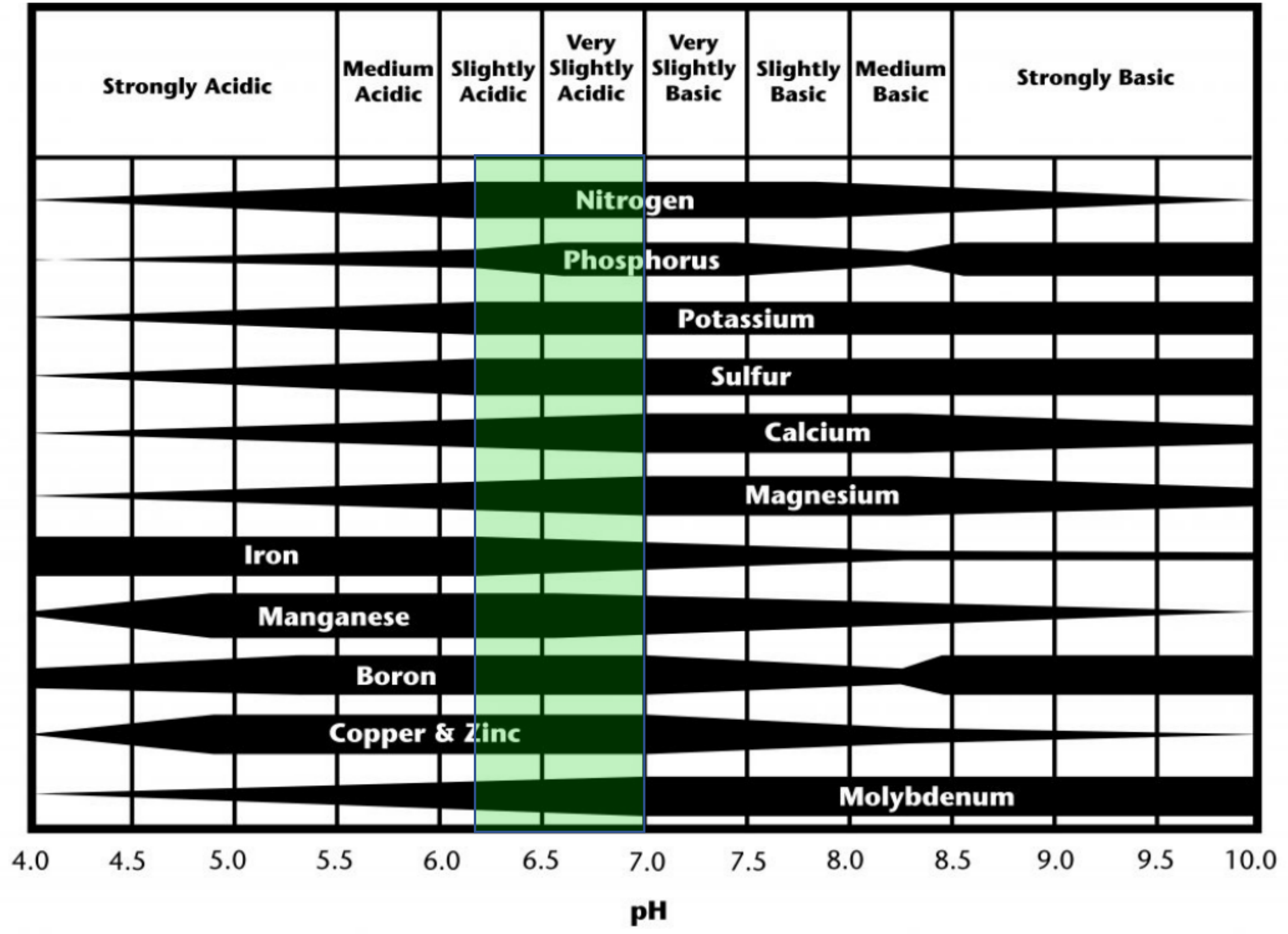
[1] Values are in pounds per acre of soil test extractable nutrient using the Cornell Morgan soil test. Using a different test will add uncertainty to the interpretations and recommendations.

[2] Soil test phosphorus values differ for winter grains. High is 9-20 lbs P/acre and Very High is 20+ lbs P/acre.

[3] Magnesium levels shown are for all field crops except birdsfoot trefoil and soybeans. For these two crops, double the values shown above.

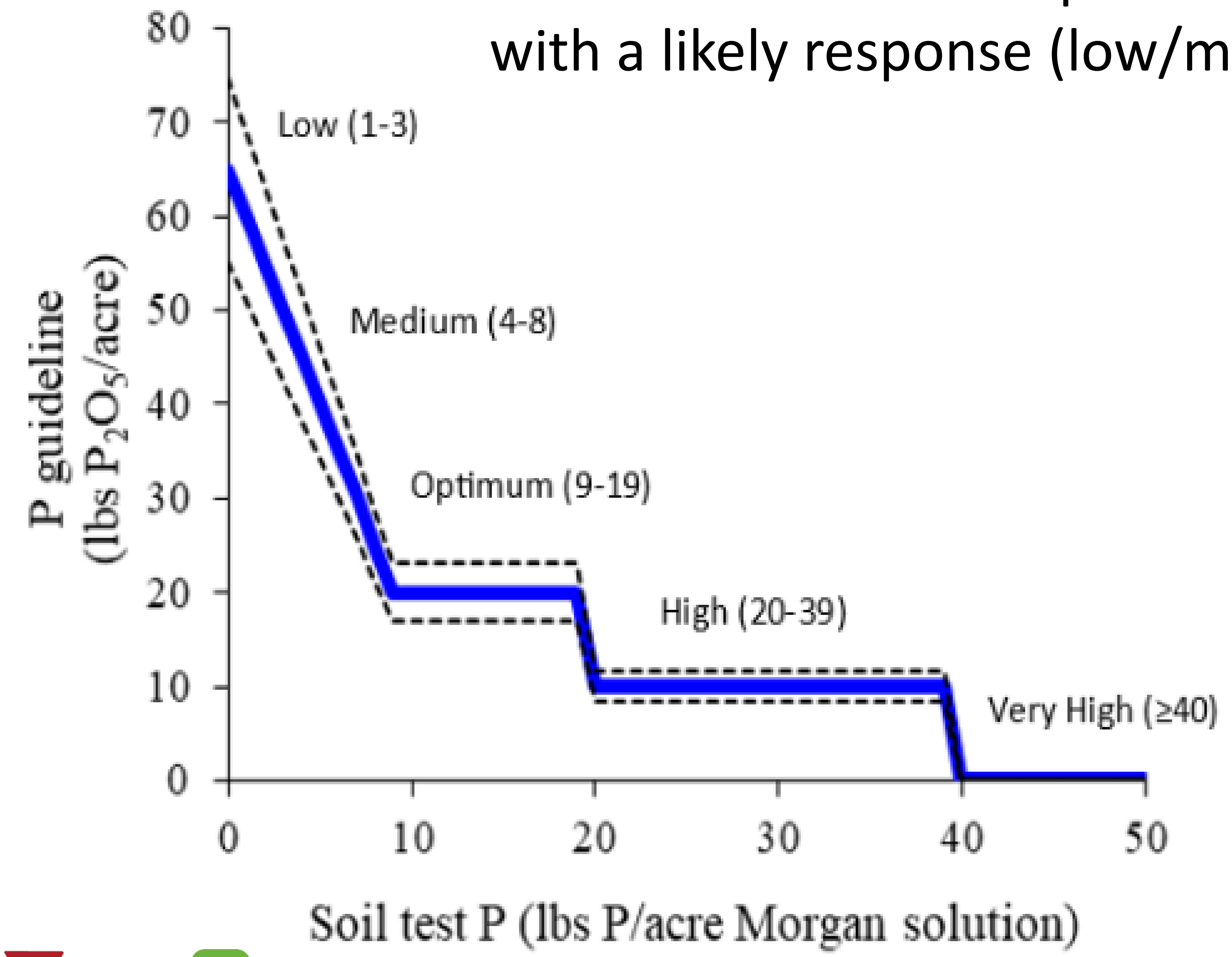
Soil Fertility - Lime! Lime! Lime!

- pH management helps with nutrient management
- To know when to apply lime, soil test



Fertilizer – P & K

Start with soil tests & prioritize fields with a likely response (low/medium STP)



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A note about Cornell Guidance vs. other agronomic rates

- P-Index governs upper limits for manure application
- Fertility guidelines assume fertilizer use (purchased), so recommendations go to zero if no yield response expected in that year
- There are other benefits to manure beyond P content, which is why P-Index is soil test based and transport based
  - Increases soil carbon, improves soil structure, increases infiltration, reduces erosion
- Those benefits offset environmentally unfriendly purchases of fertilizer
  - Energy intensive production, importing nutrients into the watershed
- Not every pound of P applied (over a recommendation) is a pound lost
- Over 100 STP most and over 160 STP all fields would get cut off through P-Index assessment

A note about Cornell Guidance vs. other agronomic rates

PI categories	PI score	Cornell Morgan-extractable soil test P (lbs P/acre) < 40	40-100	101-160	> 160
Low	< 50	N-based	N-based	P-based	Zero P
Medium	50 to 74	N-based	P-based	Zero P	Zero P
High	75 to 99	P-based	P-based	Zero P	Zero P
Very High	≥100	Zero P	Zero P	Zero P	Zero P

- Over 100 STP most and over 160 STP all fields would get cut off through P-Index assessment

Corn N Equations

Corn Grain

$$NetN = \frac{(YI\_corngrain*A-SoilN-SodN)}{(N\_eff/100)} - SoyN - CCN$$

Corn Silage

$$NetN = \frac{(YI\_cornsilage*B-SoilN-SodN)}{(N\_eff/100)} - SoyN - CCN$$

NetN = the total N (lbs N/acre) from any source for optimum crop production.

YI is the soil and drainage specific yield index. A and B are YI multipliers (Table 6)

SoilN & **SodN** are N (lbs N/acre) from soil organic matter and alfalfa/grass sods

N_eff is the soil type and drainage dependent uptake efficiency (Appendix Table 2)

SoyN and **CCN** are soybean and cover crop N credits in lbs N/acre

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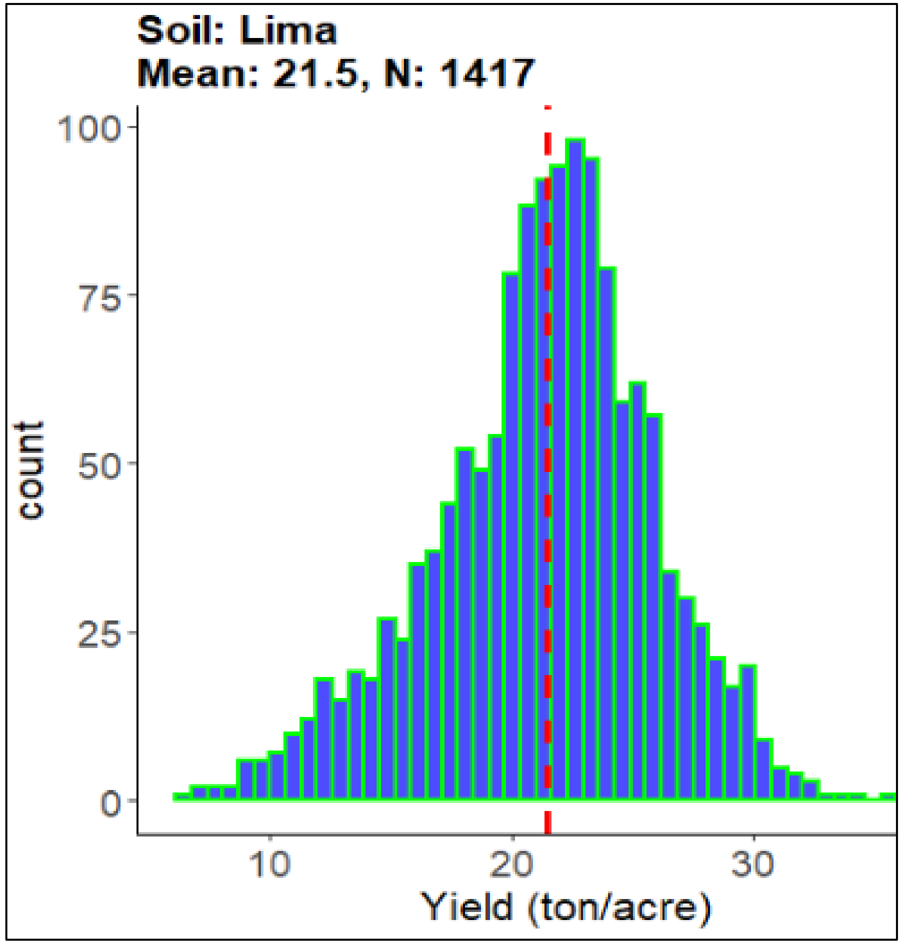
Corn Yield Index Database

Corn Yield Database > Corn Yield Index

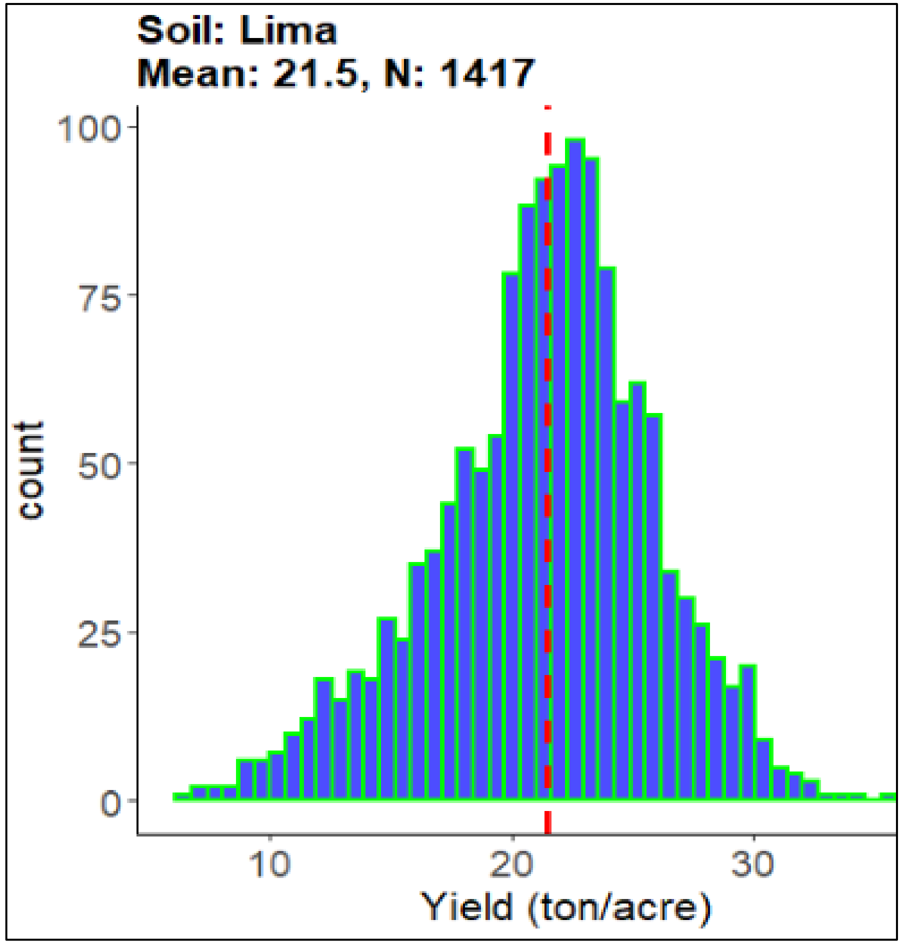
- About 230,000 acres of corn yield data were collected, cleaned through 2020
- About half was corn grain, the other half contributed to a new silage database
- ~90% from 2015-2020
- Developed yield distribution histograms for each soil type



Corn Yield Index Database

Corn Yield Database > Corn Yield Index

- Soil types included: ≥ **3 farms, 20 fields, 250 acres**
- Mean:Median ratio between 0.9 and 1.1
- Applying these filters resulted in reliable data for **58** soil types for grain and **66** soil types for silage
- Consensus among consultants: use these data to set new yield potentials for all ~600 soil types ("**learn and apply**")



New Corn Yield Index Database

Corn Yield Database > Corn Yield Index

Silage: 35% dry matter
Grain: 85% dry matter

Name	SMG	D	FF	N_eff		N_sup		YI_corngrain		YI_cornsilage		YI_alf	
				DR	UD	DR	UD	DR	UD	DR	UD	DR	UD
Acton	4	M	Rare/None	70	65	65	65	165	160	18.0	17.5	5.5	4.0
Adams	5	W	Rare/None	70	70	40	40	140	140	15.0	15.0	4.5	4.5
Adirondack	4	W	Rare/None	75	75	70	70	110	110	12.0	12.0	4.0	4.0
Adjidaumo	1	P	Frequent	60	55	75	65	155	125	16.5	13.5	3.5	2.5
Adrian	6	V	Rare/None	65	55	120	90	165	105	18.0	11.5	4.0	2.5
Agawam	4	W	Rare/None	75	75	65	65	165	165	18.5	18.5	6.0	6.0
Allendale	3	P	Rare/None	60	55	70	60	150	130	16.0	14.0	3.5	2.5

Farms are encouraged to use their own yield data.

Yield Check

- Subareas are harvested along the length of a field
- Determine net harvest weight
- Determine the DM of a subsample

$$Yield = \frac{Net\ Harvest\ weight\ x\ DM}{Harvested\ area}$$

Total Harvest Weight

- Record empty and full weight for each load from harvested field
- Subsample to determine the moisture using a Koster tester, a microwave, or an oven

$$Yield = \frac{Sum\ of\ net\ load\ weights\ for field\ x\ DM}{Field\ acres}$$

Yield Monitor System

- Records information on location, mass flow, and moisture content while combine is traveling
- Typically records data every second
- It is very important that yield monitors are calibrated properly

Corn Grain

If YI <= 155, use 1.2
If 160-225, use 1.9233-0.0047*YI
If 230 or more, use 0.85

Yield (bu/acre at 85% DM)	A
150	1.20
155	1.20
[illegible]	1.17
[illegible]	1.15
[illegible]	1.12
[illegible]	1.10
[illegible]	1.08
185	1.05
190	1.03
195	1.01
200	0.98
205	0.96
210	0.94
215	0.91
220	0.89
225	0.87
230	0.85
235	0.85
240	0.85
276	0.85
300	0.85

Multiplier…
Yield x A/B lbs N/unit of yield

Corn Silage

If YI <= 17.0 tons, use 11
If YI 17.5-24.5 tons/acre, use 18.013-0.4125*YP
If YI 25.0 or more, use 7.7

Yield (tons/acre at 35% DM)	B
16.0	11.0
16.5	11.0
17.0	11.0
17.5	10.8
18.0	10.6
18.5	10.4
19.0	10.2
19.5	10.0
20.0	9.8
20.5	9.6
21.0	9.4
21.5	9.1
22.0	8.9
22.5	8.7
23.0	8.5
23.5	8.3
24.0	8.1
24.5	7.9
25.0	7.7
25.5	7.7
26.0	7.7

Corn N Equation

Name	SMG	D	FF	N_eff		N_sup		YI_corngrain		YI_cornsilage		YI_alf	
				DR	UD	DR	UD	DR	UD	DR	UD	DR	UD
Acton	4	M	Rare/None	70	65	65	65	165	160	18.0	17.5	5.5	4.0

Yield (tons/acre at 35% DM)	B
16.0	11.0
16.5	11.0
17.0	11.0
17.5	10.8
18.0	10.6

$$\text{Net N} = \frac{18 \times 10.6 - SoilN - SodN}{N_{eff}/100} - SoyN - CCN$$

190 lbs N required for this corn crop…

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Soil N Contribution

40 – 80 lbs N/acre is typical in NYS

Name	SMG	D	FF	N_eff		N_sup		YI_corngrain		YI_cornsilage		YI_alf	
				DR	UD	DR	UD	DR	UD	DR	UD	DR	UD
Acton	4	M	Rare/None	70	65	65	65	165	160	18.0	17.5	5.5	4.0
Adams	5	W	Rare/None	70	70	40	40	140	140	15.0	15.0	4.5	4.5
Adirondack	4	W	Rare/None	75	75	70	70	110	110	12.0	12.0	4.0	4.0
Adjidaumo	1	P	Frequent	60	55	75	65	155	125	16.5	13.5	3.5	2.5
Adrian	6	V	Rare/None	65	55	120	90	165	105	18.0	11.5	4.0	2.5
Agawam	4	W	Rare/None	75	75	65	65	165	165	18.5	18.5	6.0	6.0
Allendale	3	P	Rare/None	60	55	70	60	150	130	16.0	14.0	3.5	2.5

Soil N Contribution

Name	SMG	D	FF	N_eff		N_sup		YI_corngrain		YI_cornsilage		YI_alf	
				DR	UD	DR	UD	DR	UD	DR	UD	DR	UD
Acton	4	M	Rare/None	70	65	65	65	165	160	18.0	17.5	5.5	4.0

$$\text{Net N} = \frac{\mathbf{18 \times 10.6 - 65} - SodN}{N_{eff}/100} - SoyN - CCN$$

190 lbs N required for this corn crop…

but 65 lbs coming from Soil OM = 125 lbs

Sod N Credits

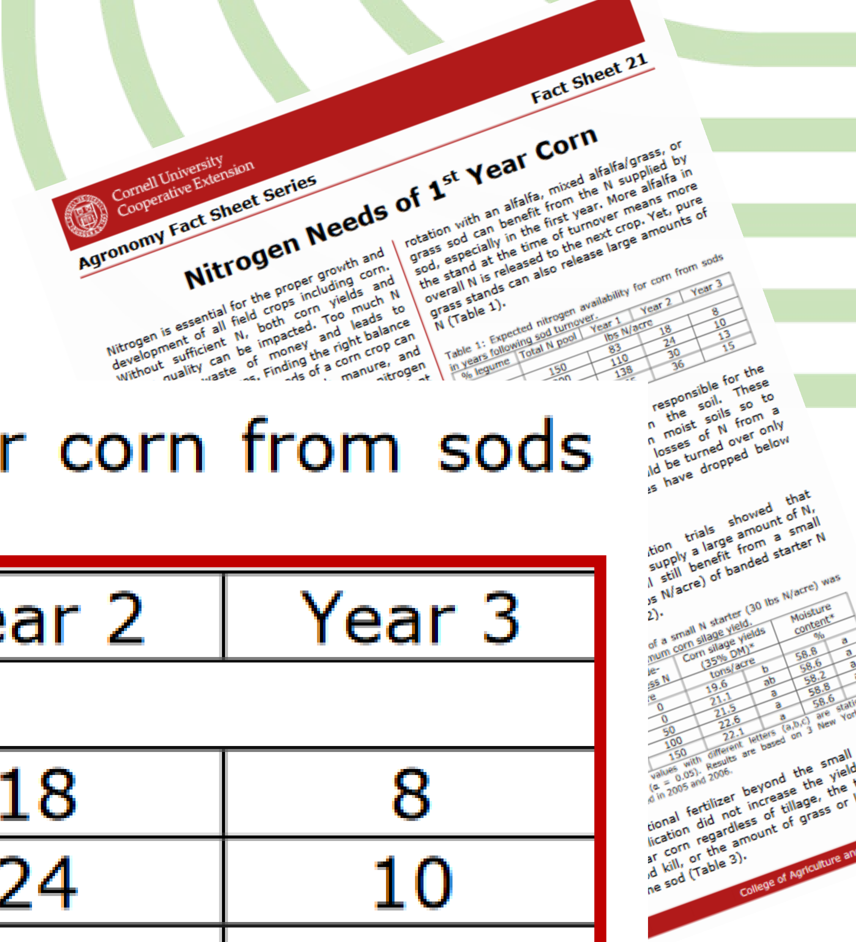

Table 1: Expected nitrogen availability for corn from sods in years following sod turnover.

% legume	Total N pool	Year 1	Year 2	Year 3
		lbs N/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

1st Year Corn | 2nd Year Corn | 3rd Year Corn

Corn N Equation

Name	SMG	D	FF	N_eff	
				DR	UD
Acton	4	M	Rare/None	70	65

Table 1: Expected nitrogen availability for corn from sods in years following sod turnover.

% legume	Total N pool	Year 1	Year 2	Year 3
	lbs N/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

$$\text{Net N} = \frac{\mathbf{18 \times 10.6 - 65 - 15}}{\mathbf{0.7}} - SoyN - CCN$$

190 lbs N required for this corn crop…
but 65 lbs coming from Soil OM = 125 lbs
15 lbs from alfalfa sod turned down three years ago = 110 lbs

Soil type is 70% efficient = 160 lbs

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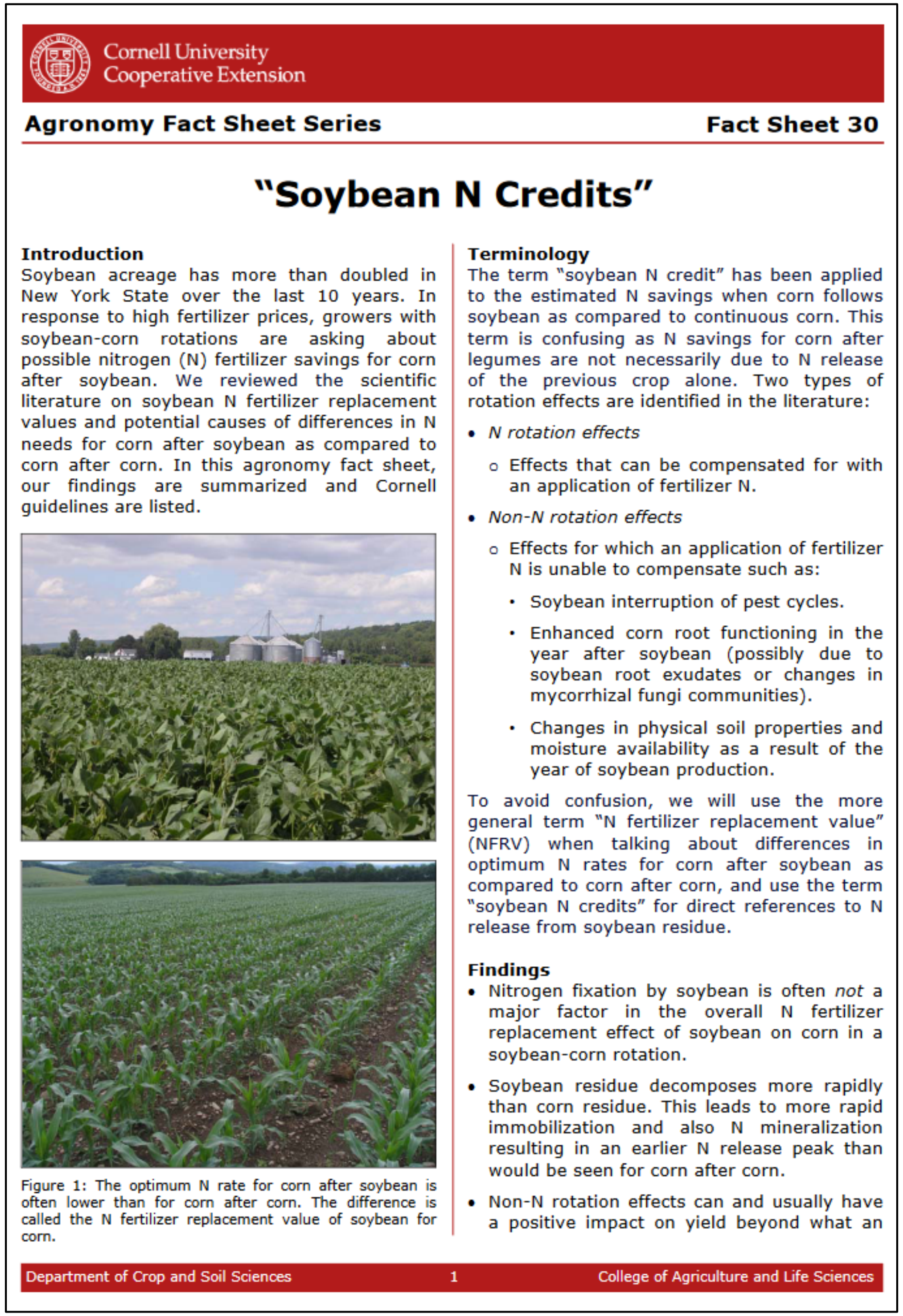
Soybean Credits

The optimum economic N rate for corn grown after soybeans in New York can be lowered by **20-30 lbs N/acre** (SoyN credits) as compared to corn after corn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Agronomy Fact Sheet Series — Fact Sheet 30

"Soybean N Credits"

Introduction
Soybean acreage has more than doubled in New York State over the last 10 years. In response to high fertilizer prices, growers with soybean-corn rotations are asking about possible nitrogen (N) fertilizer savings for corn after soybean. We reviewed the scientific literature on soybean N fertilizer replacement values and potential causes of differences in N needs for corn after soybean as compared to corn after corn. In this agronomy fact sheet, our findings are summarized and Cornell guidelines are listed.

Figure 1: The optimum N rate for corn after soybean is often lower than for corn after corn. The difference is called the N fertilizer replacement value of soybean for corn.

Terminology
The term "soybean N credit" has been applied to the estimated N savings when corn follows soybean as compared to continuous corn. This term is confusing as N savings for corn after legumes are not necessarily due to N release of the previous crop alone. Two types of rotation effects are identified in the literature:

- *N rotation effects*
  - Effects that can be compensated for with an application of fertilizer N.
- *Non-N rotation effects*
  - Effects for which an application of fertilizer N is unable to compensate such as:
    - Soybean interruption of pest cycles.
    - Enhanced corn root functioning in the year after soybean (possibly due to soybean root exudates or changes in mycorrhizal fungi communities).
    - Changes in physical soil properties and moisture availability as a result of the year of soybean production.

To avoid confusion, we will use the more general term "N fertilizer replacement value" (NFRV) when talking about differences in optimum N rates for corn after soybean as compared to corn after corn, and use the term "soybean N credits" for direct references to N release from soybean residue.

Findings
- Nitrogen fixation by soybean is often *not* a major factor in the overall N fertilizer replacement effect of soybean on corn in a soybean-corn rotation.
- Soybean residue decomposes more rapidly than corn residue. This leads to more rapid immobilization and also N mineralization resulting in an earlier N release peak than would be seen for corn after corn.
- Non-N rotation effects can and usually have a positive impact on yield beyond what an

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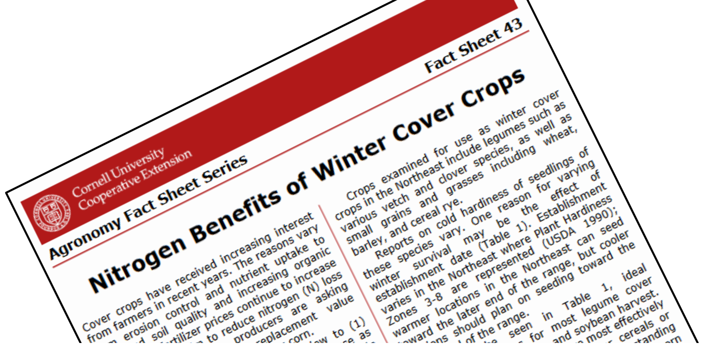
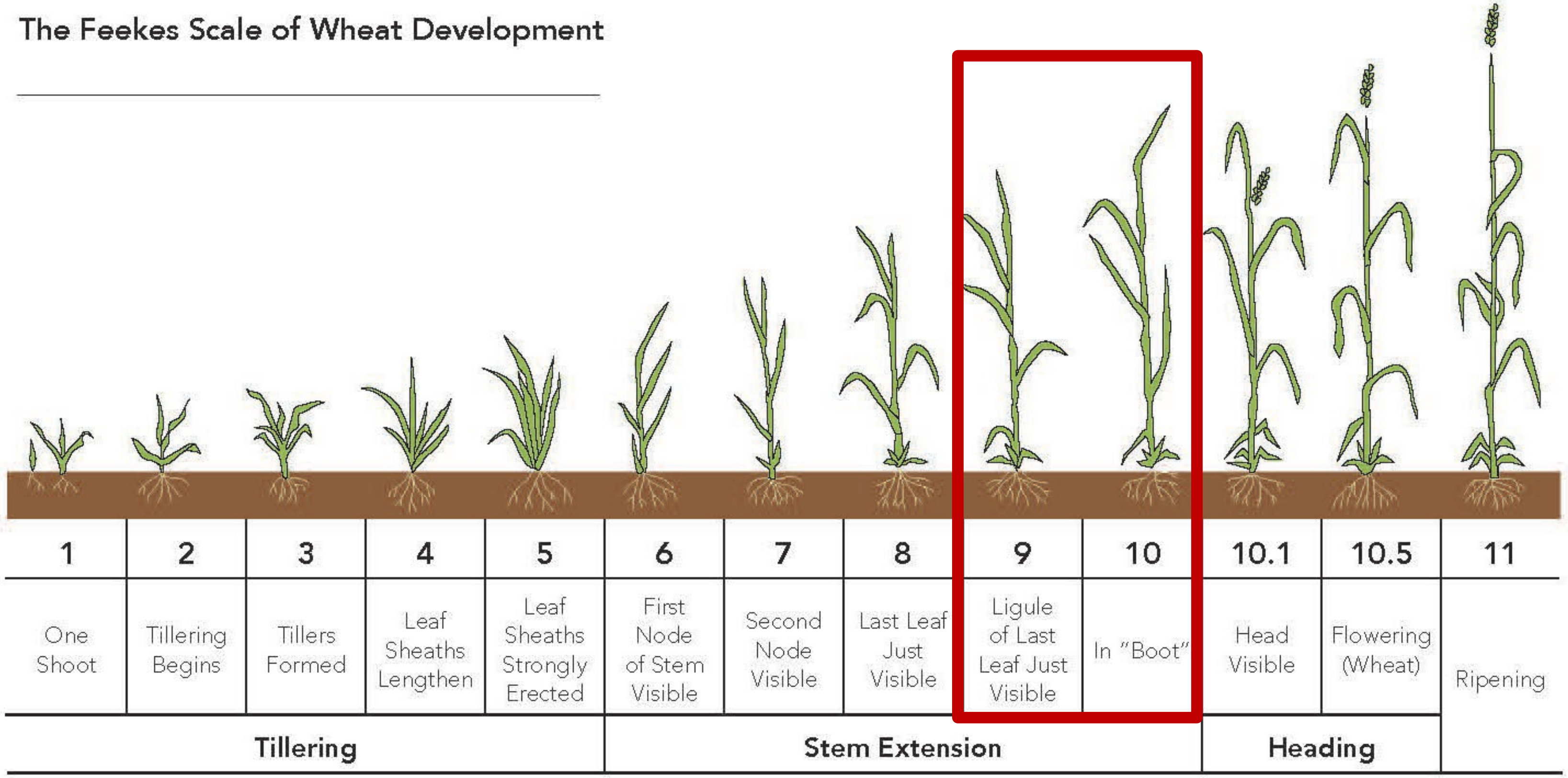
Cover Crop Credits (CCN)

- **20-30 lbs** winter cereal (after corn)
- **40-50 lbs** for winter cereal interseeded or after cereal grain
- **70-120 lbs** for clover
- **IF…C:N ratio of the cover crop biomass is less than 25**





Corn N Equation

$$120 \text{ lbs N}/acre = \frac{18 \times 10.6 - 65 - 15}{0.7} - 20 - 20$$

190 lbs N required for this corn crop…
but 65 lbs coming from Soil OM,
15 lbs from alfalfa sod turned down three years ago = 110 lbs N

Soil type is 70% efficient = 160 lbs N

Subtract 30 lbs for a cover crop =
130 lbs Net N needed for your 18-ton corn silage crop

Step 5: Determine the manure application rate (and/or fertilizer) to meet the crop need

- MUST use a current manure test for each source (or rolling average of the farm/source) that includes the inorganic and organic portions of N, P & K
- Calibrate spreaders so you know you are applying the right rate

Manure Test Report

Agricultural & Environmental Testing Laboratory and UVM Extension

6.11 % Dry Matter

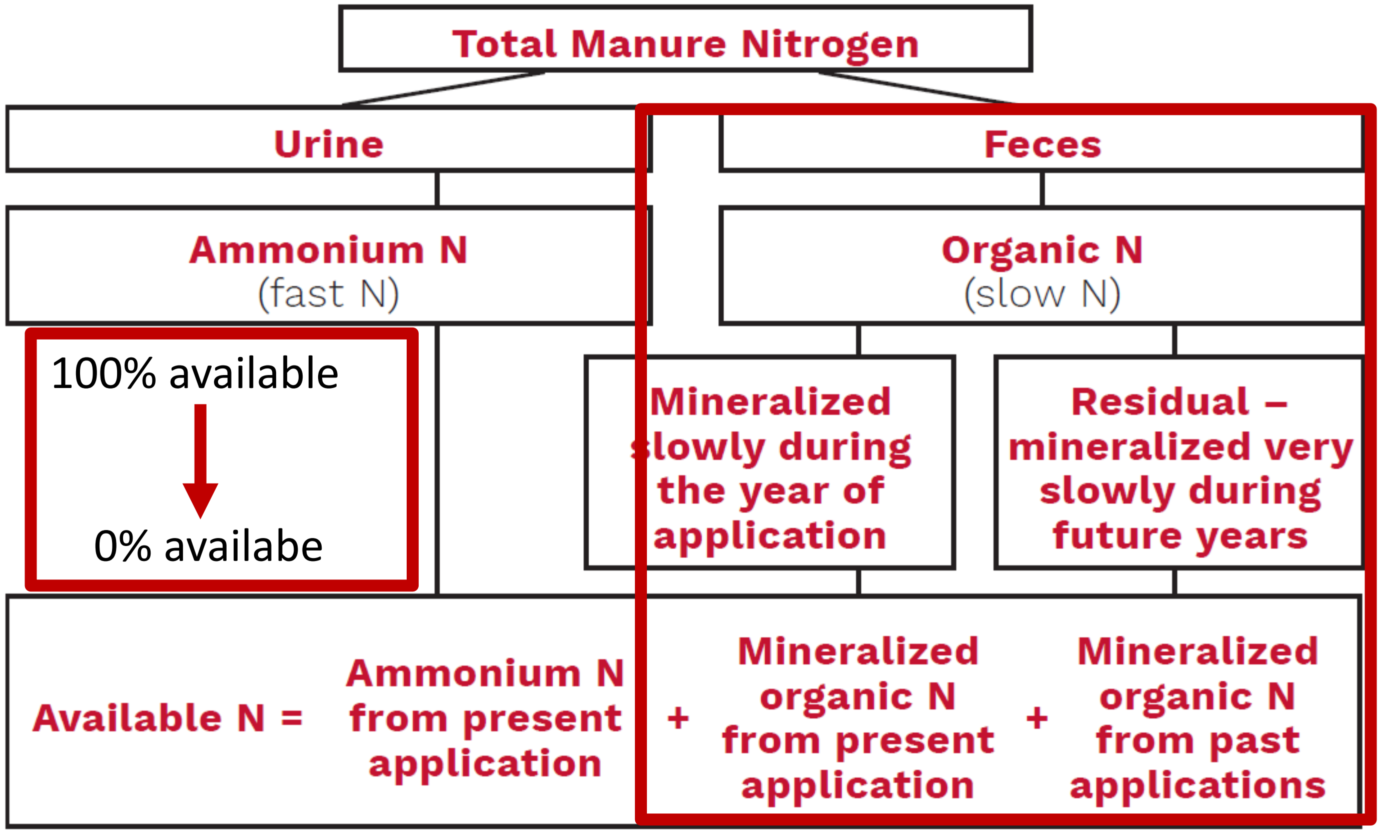
8.34 Density (lbs per ga

Description	lbs/wet ton	lbs/1,000 gal	Dry Wt. Basis
			(%)
Total Nitrogen	4.2	17.4	3.41
Ammonium Nitrogen (NH_4-N, part of total)	1.1	4.8	0.94
Organic Nitrogen (part of total)	3.0	12.6	2.48
Phosphorus as P_2O_5	2.0	8.2	1.61
Potassium as K_2O	5.3	21.9	4.30
Calcium	3.3	14.0	2.74
Magnesium	0.9	3.9	0.76
Sodium	0.3	1.1	0.22
Micronutrients			(ppm or mg/kg)
Copper	<0.01	< 0.05	23
Zinc	<0.01	< 0.05	65
Iron	0.14	0.6	1,119
Manganese	<0.01	< 0.05	110
Boron	<0.01	< 0.05	29

Start with Manure

- Manure has all 17 essential nutrients
- Nitrogen occurs in two major forms
  - Organic N
    - Behaves like a slow-release nitrogen source with credits over 3 years
  - Inorganic N
    - Behaves like urea and can easily be lost if not incorporated and applied when plants need it

FIGURE 1
Manure N consists of ammonium and organic N. Taken from Agronomy Fact Sheet #4.



Don’t forget to credit previous year’s manure N credits (from organic portion of N)
35% liquid/25% solid from THIS YEAR
12% from last year
5% from two years ago

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Start with Manure

Phosphorus Based

N recommendation = **130 lbs Net N** needed for your 18-ton corn silage crop

P Crop removal = 70 lbs P_2O_5 (18 tons/acre x 3.85 lbs P_2O_5/ton)

Rate/Method	N/Acre Target = 130	P2O5/Acre Target = 70	K2O/Acre Target = 100	Additional N Fertilizer Needed
10,000 injected	135	70	210	0
10,000 incorporated in 1 day	100	70	210	20
10,000 incorporated in 3 days	76	70	210	44
10,000 incorporated in >5 days	35	70	210	85

Start with Manure

Nitrogen Based

N recommendation = 130 lbs Net N needed for your 18-ton corn silage crop

P Crop removal = 70 lbs P_2O_5 (18 tons/acre x 3.85 lbs P_2O_5/ton)

Rate/Method	N/Acre Target = 130	P2O5/Acre Target = 70	K2O/Acre Target = 100	Acres covered by 1,000,000 gal
10,000 injected	135	70	210	100 acres
13,000 incorporated in 1 day	127	105	314	67 acres
17,000 incorporated in 3 days	129	119	357	59 acres

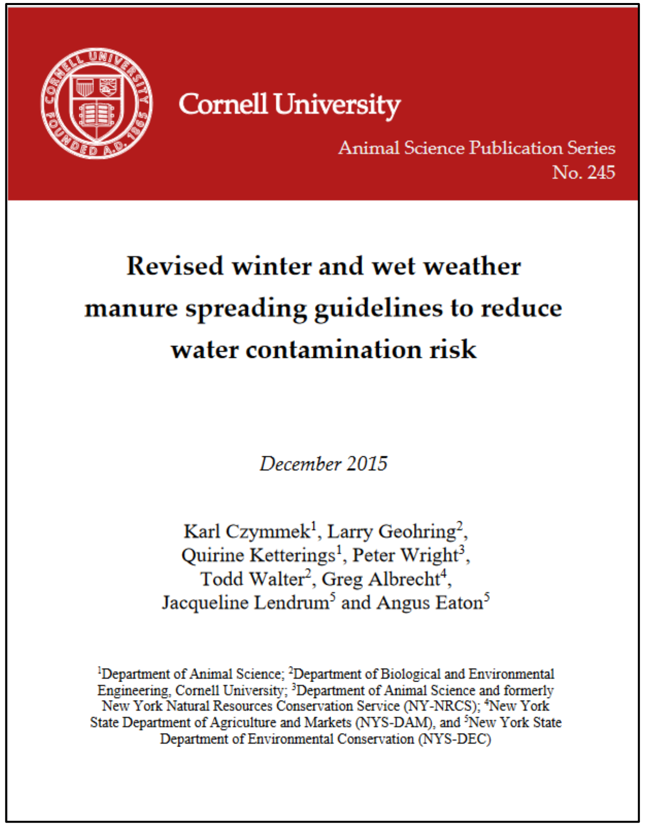
Step 6: Management of actual applications

- Follow the plan
  - Rate, timing, method (by source)
- Check the weather…and record it
- Winter & Wet Weather Guidance
- Groundwater Guidance
- Keep records

Winter & Wet Weather Guidelines

- If Wet…significant precipitation or snowmelt forecast
- If Winter…soil frozen >4", snow cover >4", surface icing

- Low risk fields – identified ahead of time
  - No history of runoff, groundwater issues
  - Limited surface connections to streams/ditches
  - Mild slopes
  - No concentrated flows
  - No karst/shallow soil features
  - High crop residue and surface roughness
- Emergency fields – identified ahead of time
  - Same as above +…300 feet away from water features, accessible, not prone to flooding
- BMPs used
  - Inject, incorporate, reduced rates, increased setbacks, groundcover, spread out applications


Cornell University

Animal Science Publication Series
No. 245

Revised winter and wet weather manure spreading guidelines to reduce water contamination risk

December 2015

Karl Czymmek[1], Larry Geohring[2], Quirine Ketterings[1], Peter Wright[3], Todd Walter[2], Greg Albrecht[4], Jacqueline Lendrum[5] and Angus Eaton[5]

[1]Department of Animal Science; [2]Department of Biological and Environmental Engineering, Cornell University; [3]Department of Animal Science and formerly New York Natural Resources Conservation Service (NY-NRCS); [4]New York State Department of Agriculture and Markets (NYS-DAM), and [5]New York State Department of Environmental Conservation (NYS-DEC)

Groundwater Guidelines

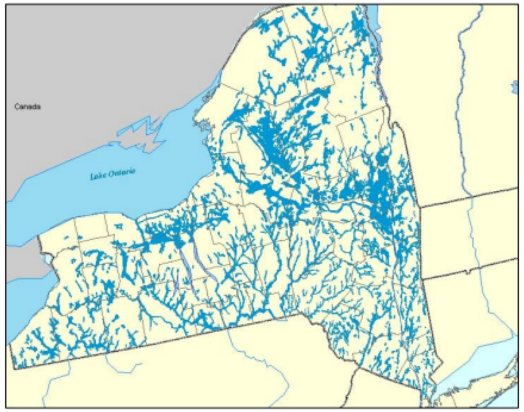
- CNMP must identify sensitive soil types
- **Follow winter/wet weather guidelines <u>AND</u>**
  - Inject/incorporate same day
  - 100-foot setbacks from wells/springs
  - If Karst features (sinkholes, exposed bedrock), 35-foot vegetative buffer and 100-foot setbacks from entry points

Groundwater Protection Guidelines for Agriculture

10-28-2021

Quirine M. Ketterings[1], Greg Albrecht[2], Dale Gates[3], Ron Bush[2], Brendan Jordan[2], Mary Kerstetter[3], and Sara Latessa[4]

[1]Nutrient Management Spear Program (NMSP), Department of Animal Science, Cornell University, [2]New York State Department of Agriculture and Markets (NYSAGM), [3]United States Department of Agriculture Natural Resources Conservation Service (USDA-NRCS), [4]New York State Department of Environmental Conservation (NYSDEC)

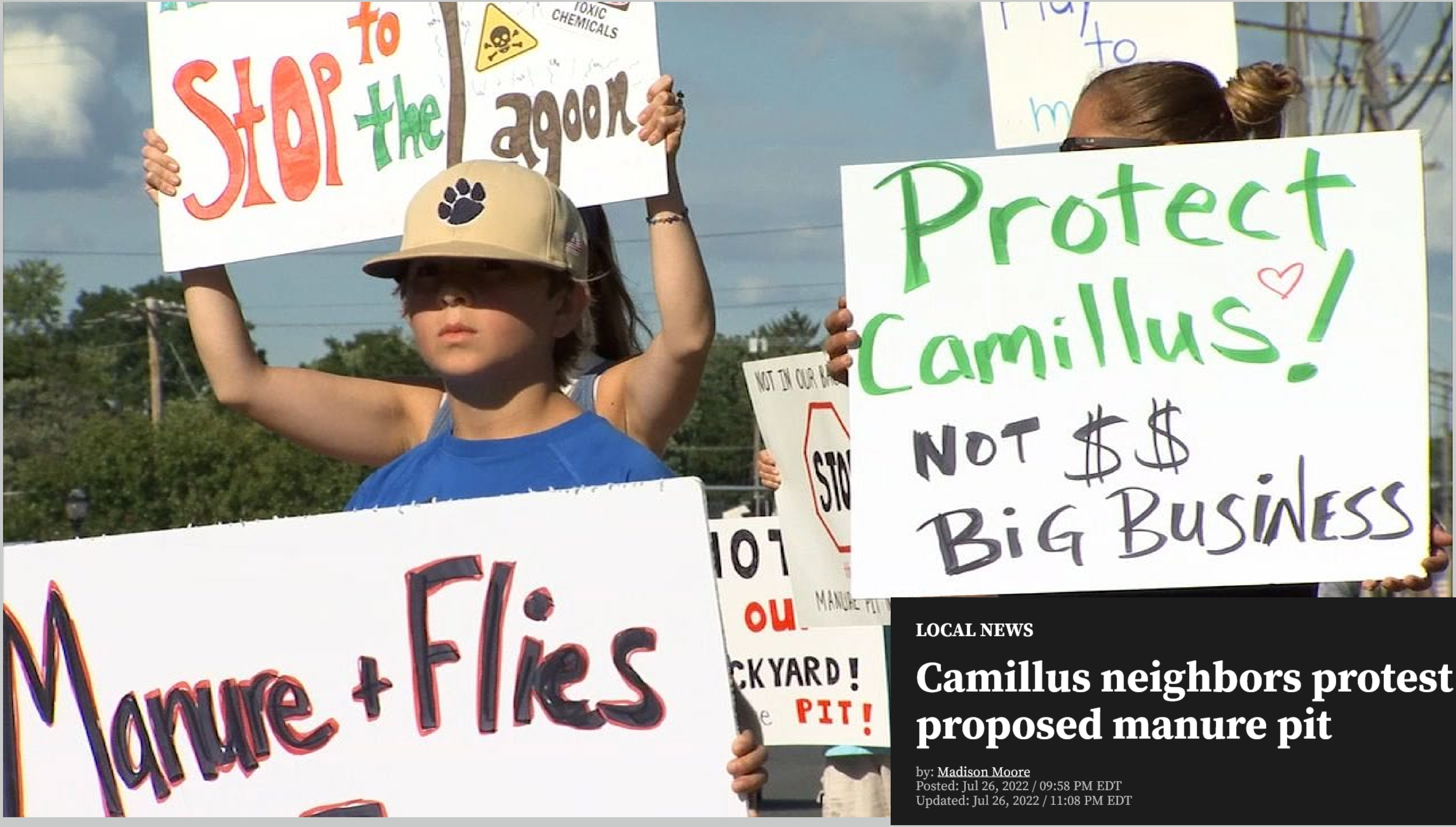


In conjunction with the Cornell NMSP Advisory Committees

Correct Citation: Ketterings, Q.M., Albrecht G., Gates, D., Bush, R., Jordan, B., Kerstetter, M., and Latessa, S. (2021). Groundwater Protection Guidelines for Agriculture. Accessible at: http://nmsp.cals.cornell.edu/publications/files/GroundwaterGuidelines2021.pdf.

Cornell University, Ithaca, NY 14853

How do we avoid spreading in winter & wet weather and maximize nutrient efficiency in manure?



LOCAL NEWS

Camillus neighbors protest proposed manure pit

by: Madison Moore
Posted: Jul 26, 2022 / 09:58 PM EDT
Updated: Jul 26, 2022 / 11:08 PM EDT

Let’s Chat

- Questions
- Scenarios
- Challenges
- Concerns

Thoughts?

Questions?

Kirsten C. Workman

Senior Extension Associate

Nutrient Management & Environmental Sustainability Specialist

kw566@cornell.edu

607-255-4890

http://nmsp.cals.cornell.edu/

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