Development of an Adaptive Management Approach for Nutrient Management in New York

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Department of Animal Science, Cornell University
Dairy Farming is Important in New York
Agriculture Environmental Management is Key for the Future of Agriculture!

CAFO permitted farms (NYSDEC)
Keeping Clear Water Clean
Reduce Nitrogen and Phosphorus Loss to the Chesapeake Bay Watershed

Chesapeake Bay Model delivery factors.
Source: Chesapeake Bay Program.
Job Description

Nutrient Management in Agricultural Systems (70/30 extension/research)

“…to provide leadership for the nutrient management extension program …”

“The program should improve grower and agricultural industry awareness of crop nutrient needs, crop quality, management of organic wastes, environmentally sound nutrient management practices, and overall soil fertility management.”

Started fall 2000
Nutrient Management Spear Program (NMSP)

Overall Goal
Enhance farm productivity while protecting the environment for long-term sustainability of agriculture in New York

(http://nmsp.cals.cornell.edu)
Ultimate Goal: Impact

- Development and implementation of best management practices at field and farm levels
- Contribute to agriculture and environmental management policy
- Engage farmers in on-farm research
- Train students in multi-disciplinary projects including research, extension and teaching
A collaboration among Cornell Dept. of Animal Science, PRODAIRY, Cornell Cooperative Extension and many stakeholders
Little History…

- Mid-1990’s: Agricultural groups press the New York State Department of Environmental Conservation (NYSDEC) to develop a Concentrated Animal Feeding Operation (CAFO) permit
- 1999: NYSDEC released its first CAFO permit and gave 5 years for farms to comply
- Full compliance is now required
- Permit relies on Natural Resources Conservation Service (NRCS) Standards
Little History…

- The NRCS 590 Nutrient Management Standard refers to Land Grant University guidelines (Cornell University)
  - Fertility management
  - Risk assessment for nitrogen leaching and phosphorus runoff
  - Manure management
  - Etc.
NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

NUTRIENT MANAGEMENT
(Ac.)
CODE 590

DEFINITION
Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments.

PURPOSE
- To budget, supply, and conserve nutrients for plant production.
- To minimize agricultural nonpoint source pollution of surface and groundwater resources.
- To properly utilize manure or organic by-products as a plant nutrient source.
- To protect air quality by reducing odors, nitrogen emissions (ammonia, oxides of nitrogen), and the formation of atmospheric particulates.
- To maintain or improve the physical, chemical, and biological condition of soil.

*Note, the term, “minimize”, used throughout the standard is intended to characterize efforts that reduce to the practical extent possible.

CONDITIONS WHERE PRACTICE APPLIES
This practice is applicable to all lands where plant nutrients and soil amendments are applied. A requirement to follow this practice standard may be defined by specific regulations and/or certain state or federal conservation programs. This practice standard does not apply to establishment applications for long-term, non-rotated perennial crops that do not receive supplemental nutrient applications.

Within this context, the General Criteria, Plans and Specifications, and Operation and Maintenance sections apply to all lands where plant nutrients and soil amendments are applied. The Additional Criteria included in this standard are only applicable when air quality and/or soil condition are identified as a
New York Starter P Project
2001-2003

Nutrient Management Spear Program
A collaboration among the Dept. of Crop & Soil Sciences, PRODAIRY, and Cornell Cooperative Extension
Producers had many questions about P guidelines for corn:

“Real farms need more P than research farms”
“Poor quality silage without P”
“Modern hybrids need more P”
“Corn silage needs more P”
“Cold soils need more P”
“Won’t build soil test P”
“Too low!”
New York Starter P Project

Funding
• NRCS
• NESARE
• NNYADP
• Agway
• Carovail
• Agriculturer
• Pioneer

Collaborators
• 13 Cornell Cooperative Extension Offices
• 48 farms
• SWCD staff
• Morrisville Technical College
• Private Consultants
• Miner Institute
Starter P Project
65 on-farm, 13 research station trials, 3 years

1. No starter
2. 200 lbs 10-0-10
3. 200 lbs 10-10-10
4. Producer’s blend & rate

1. No starter
2. 200 lbs 10-0-10
3. 200 lbs 10-10-10
4. 200 lbs 10-20-10
Field Days on Farms and Research Stations
## 2001-2003 On-farm Trials

**Silage yields (tons/acre 35% dry matter)**

<table>
<thead>
<tr>
<th></th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>3-Year Average</th>
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<tbody>
<tr>
<td></td>
<td>27 trials</td>
<td>16 trials</td>
<td>22 trials</td>
<td>High P</td>
</tr>
<tr>
<td>No starter</td>
<td>16.7 b</td>
<td>15.7 a</td>
<td>20.6 b</td>
<td>17.7 b</td>
</tr>
<tr>
<td>N(+K) only</td>
<td>19.3 a</td>
<td>16.2 a</td>
<td>20.7 b</td>
<td>17.9 b</td>
</tr>
<tr>
<td>N(+K) + 10-25 lbs P$_2$O$_5$/acre</td>
<td>19.9 a</td>
<td>16.5 a</td>
<td>21.7 a</td>
<td>19.2 a</td>
</tr>
<tr>
<td>N(+K) + &gt;25 lbs P$_2$O$_5$/acre</td>
<td>19.8 a</td>
<td>16.0 a</td>
<td>21.1 ab</td>
<td>18.2 ab</td>
</tr>
</tbody>
</table>
## No Impact on Forage Quality

<table>
<thead>
<tr>
<th>Quality parameter</th>
<th>Research Station Trials</th>
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<th></th>
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<th></th>
<th>On-Farm Trials</th>
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<tr>
<td></td>
<td>No Starter</td>
<td>200 lbs</td>
<td>200 lbs</td>
<td>200 lbs</td>
<td>No</td>
<td>N(+K) only</td>
<td>&gt;25 lbs</td>
<td>P2O5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10-0-10</td>
<td>10-10-10</td>
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<td>starter</td>
<td>P2O5</td>
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<td>Moisture content</td>
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<td>NDF</td>
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<td>42.3</td>
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<td>Digestibility of NDF (48h)</td>
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<td>62.2</td>
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<td>62.6</td>
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<td>Crude protein</td>
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<td>P</td>
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<td>0.23</td>
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<td>K</td>
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<td>0.84</td>
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<td>Ca</td>
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<td>0.20</td>
<td>0.19</td>
<td>0.20</td>
<td>0.17</td>
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<td>Mg</td>
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<td>15.6</td>
<td>17.6</td>
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<td>4.2</td>
<td>4.3</td>
<td>3.8</td>
<td>3.9</td>
<td>3.7</td>
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<tr>
<td>Mn</td>
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<td>16.9</td>
<td>16.2</td>
<td>16.8</td>
<td>13.3</td>
<td>13.7</td>
<td>13.6</td>
</tr>
</tbody>
</table>
Ultimate Goal: Impact

New York Corn Producers Make a Difference!!

Phosphorus Fertilizer Imports 2003-2005 Reduced by 26.7 million lbs of P$_2$O$_5$

Quirine Ketterings, Associate Professor, Dept. of Crop and Soil Sciences, Cornell University
Karl Czymmek, Senior Extension Associate, PRODAIRY, Cornell University

From 2001 through 2003, the Northeast Sustainable Agriculture Research and Extension (NESARE) program, with contributions from Agway, Carovail, Pioneer Hi-Bred International Inc., AgriCulver Seeds, the New York State Natural Resources Conservation Service (NRCS), and Northern New York Agricultural Development Program (NNYADP), funded a 2002 to 29,052 tons of P$_2$O$_5$/year in 2003-2005, a reduction of 4,442 tons or 8.9 million lbs of P$_2$O$_5$/year. In this time period nitrogen (N) sales did not go down (61,877 tons or 123.8 million lbs of N/year over the 6 year period), showing that producers did not reduce fertilizer use, but strategically selected lower P fertilizer blends!
New York On-Farm Research Partnership

2018 New York On-Farm Research Partnership Projects

There is great power in coordinated on-farm research where field data are generated through well designed, repeated and widely implemented trials, with proper data collection and statistically valid analyses. Consider being an on-farm research partner! Our motto is: “Relevant Questions and Sound Science for Agricultural Profitability and Protection of the Environment”.

The On-Farm Research Partnership is a partnership of producers, the Cornell Nutrient Management Spear Program, PRODAIRY, Cornell Cooperative Extension, crop and nutrient management consulting firms, and other farm advisors and agencies. We aim to establish a statewide research partnership that enables us to pose relevant question (farmer and farm advisor driven priorities) and get these questions answered efficiently (large datasets), aiding in development of science-based guidance and implementation of both on-farm and whole-farm nutrient management practices.

NMSP Active Projects:

1. Whole Farm Nutrient Balance Assessment
2. Updating of the New York Corn Yield Database
3. Forage Yield Monitor Data Processing for Accurate Maps
4. Getting the Most out of On-Farm Research
5. Yield Stability Zones for Improved N Management of Corn
6. Active Crop Sensor Use for Corn and Sorghum
7. Drones for Yield Predictions and N Management Decisions
8. Brachytic Dwarf Brown Midrib Forage Sorghum in Double Crop Rotations
9. Winter Cereals as Double Crops in Corn or Sorghum Rotations
10. Phosphorus Index Evaluation in The Northeast
11. Land Application of Acid Whey
12. Corn and Hay Yield, Quality and Soil Health as Impacted by Manure Management

http://nmsp.cals.cornell.edu/NYOnFarmResearchPartnership/index.html
2018 Active Projects

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What about Nitrogen Guidelines?

\[
N \text{ req.} = \frac{(\text{yield potential} \times 1.2) - \text{soil N} - \text{sod N}}{(\text{fertilizer efficiency}/100)}
\]

- past and/or current manure credits
Nitrogen for Corn until 2013

Two options:

1. Corn yield potential for the soil type as per Cornell soil database and recommendations based on the corn N equation (Agronomy Factsheet 35)

2. Actual corn yield measured over a 3-year period under current N guidelines (N management as in approach 1)
Issues

- Some consultants increased N rates with limited or no documentation
  - Risk to farmers and environment
- Limited funds to re-evaluate book values
  - Perception of old data
- Yield potentials per soil type does not capture real variability
- General belief that higher yields means more N is needed
  - Not supported by data
Opportunities

• We needed a means to move forward collectively with the industry
  • Make use of each other’s expertise
• The opening to do so came when NRCS embraced an adaptive management process for nutrient management
• Technology advances (yield monitors and protocols) helped greatly
Adaptive Management NRCS

Agronomy Technical Note No. 6
Adaptive Nutrient Management

Agronomy Technical Note No. 10
Adaptive Management for Conservation Practices
Nitrogen for Corn; Management Options

Although fertility recommendations for corn can vary from state to state, most recognize that accurate yield records are essential to guide nitrogen (N) management decisions. Many farms are striving to refine N rates over time through adaptive management. In New York, the first step is to define a field’s expected yield (yield potential or YP). Here we 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. One thing is clear: a specific amount of N needs to get into the corn plant to support a given yield so there has to be enough N in the right place, time, and form to meet plant needs.

Adaptive Management of Nitrogen for Corn

Accurate yield records and field management information are essential to guide N fertilization decisions for corn. The Cornell yield database offers a starting point, but farms are encouraged to determine actual field yields and document practices over multiple years to fine-tune N management. Currently, certified nutrient management planners can choose to override the Cornell provided yield potential (YP) if the farm has documented

In this equation, YP is the user-selected yield potential in bushels/acre. SoilN is the estimated annual N contribution from the soil organic matter in lbs N/acre, SodN is the expected N release from a decomposing sod in lbs N/acre, and Neff is the soil specific fertilizer N uptake efficiency as a percentage. In step 1, the SoilN, SodN and Neff are not user-selected; the end-of-season evaluations will show if adjustments need to be made over
Adaptive Management in 2013

Added:
3. Findings of two years of on-farm replicated trials with a minimum of four replications and five N rate including a zero-N control treatment.
4. Yield measurements and the results of the corn stalk nitrate test (CSNT), to be managed below 3000 ppm over time.
Adaptive Management in 2013

For more information

Cornell University
Cooperative Extension

Nutrient Management Spear Program
http://nmsp.cals.cornell.edu

Quirine Ketterings, Karl Czymmek, Greg Albrecht (NYSDAM), Dale Gates (NRCS), and Jacqueline Lendrum (NYSDEC)

2013
Adaptive Management in 2018

Adaptive Management and In-Season N Application Update
Expanded End-of-Season Evaluation Options for Corn

6-13-2018

Nutrient Management Spear Program, Cornell University
New York State Department of Agriculture and Markets
Natural Resources Conservation Service
New York State Department of Environmental Conservation

With Input From
The NMSP Internal and External Advisory Committees

http://nmsp.cals.cornell.edu/publications/files/
AdaptiveManagementGuidelinesFor2018.pdf
Adaptive Management in 2018

1. Targeted CSNT from the best areas in the field (top 25% of the field).
2. Comparison strip with control treatment (check strip).
3. Collect 2-3 georeferenced photos of leaf N status within the highest yielding areas in the field; when the 1-3 lowest true leaves are green, a targeted CSNT needs to be taken.

http://nmsp.cals.cornell.edu/guidelines/factsheets.html
4. For crops other than corn, determine and record an individual field N balance per field determined as [total N applied plus N supply by soil and crop rotation credits as defined in the Cornell soils database] minus N removed with harvest.

Adaptive Management in 2018

http://nmsp.cals.cornell.edu/guidelines/factsheets.html
Dairy farms with whole farm N balances of $\leq 105$ lbs/acre, and that maintain a 3-year running average N balance at or below 105 lbs/acre, meet the adaptive management guidelines and do not require additional field-specific evaluations beyond recording yield.
Next Steps

- Continue to build New York On-Farm Research Partnership
- Redo corn grain yield potential database
- Develop separate system for corn silage
- Evaluate yield:CSNT ratio as diagnostic tool
- Evaluate zone-based sampling (and management) making use of 3+ year of yield data per field and farm
- Expand on field balance concept to develop feasible field balances for corn

http://nmsp.cals.cornell.edu/guidelines/factsheets.html
- Drones
- Crop sensors
- Yield monitors
- Precision ag
Technology and Current Projects

Active Sensors

Passive Sensors
Technology and Current Projects

RapidEye

Sentinel 2

May

June

July
Key Ingredients to Success

(1) Farmer and farm advisor involvement in topic selection, trial implementation and data collection
(2) Focus on gaining greater economic sustainability plus protection of environmental resources
(3) Targeted and simple but scientifically sound trials
(4) Follow-up: annual trial summary reports and farm crew meetings to evaluate the results, draw conclusions and make plans for next year
(5) A whole farm monitoring tool to gain confidence that changes made at the field level impact the overall performance of the farm

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