Northern NY Agricultural Development Program
2018 Project Report

Northern New York Dairy Representation in Regional Assessment of a New Phosphorus Index Approach (Phase 2)

Project Leader:
Quirine M. Ketterings, Cornell Nutrient Management Spear Program (NMSP), 323 Morrison Hall, Department of Animal Science, Cornell University, Ithaca, NY

Collaborators:
- Miner Institute: Eric Young.
- Champlain Valley Ag: Eric Bever, Mike Contessa.
- Cornell campus: Mart Ros and Karl Czymmek.
- Five NNY dairy farms, other consulting firms, and Cornell Cooperative Extension

Background:

New York Phosphorus Index

The New York Phosphorus Index (NY-PI) is one of the most important planning tools to protect water quality in New York. It is used to score fields based on their risk of phosphorus (P) loss and identify high-risk areas.

The NY-PI was first released in 2001. Since then, the purchase of P fertilizers declined considerably, soil test P (STP) statewide has leveled off, and P management on NY dairy farms has become more efficient, as shown by a decrease in whole-farm P balances over a ten-year period. However, despite these improvements in P use, ongoing environmental challenges such as surges of algal blooms in major US water bodies and in lakes in NY, along with improved understanding of P movement and management options warrant efforts to improve the effectiveness and accuracy of these tools.

Issues with the current NY-PI including (1) the relatively large weight assigned to STP; (2) the emphasis on STP resulting in relatively unrestrictive manure management on fields with a high transport risk but a low STP; (3) the capping of the transport factor at one (to be between zero and one) diminishes the capacity to distinguish between fields with one predominant pathway versus those with multiple pathways of P transport (and

thus impacts our ability to identify appropriate best management practices (BMP) to reduce P loss; and (4) application rates of manure and fertilizer are incorporated in the source score, while the score determines the amount of P that can be applied, resulting in an iterative and time-consuming approach to find appropriate application rates.

Over the past three years, we have developed a working draft of a new NY-PI based on feedback from planners and consultants, and the evolving body of science of P dynamics and risk of runoff. In the new approach, introduced as a concept in 2017, farm fields are scored based on inherent risk of P transport (derived from individual factors such as soil erosion, soil drainage, field distance to a stream, etc.). It subsequently promotes use of BMPs for manure application on high-risk fields through use of a BMP-crediting system (so transport-based PI scores can be reduced if BMPs are implemented). We call this the ***transport x BMP approach*** (in contrast to the source x transport approach that is currently in place).

In this new approach, STP serves as a classification tool to prevent fields from becoming greatly excessive in soil test P (Table 1). The transport x BMP approach has the advantage of being easily adapted for use across state boundaries.

Table 1. Manure management implications in the proposed NY-PI, based on a transport x BMP score, and Morgan soil test P values.

		Morgan soil test P (lbs/acre)			
Inherent P loss risk	NY-PI score	< 40	40-100	101-160	≥ 160
Low	< 50	N-based	N-based	P-based	Zero
Medium	50 to 74	N-based	P-based	Zero	Zero
High	75 to 99	P-based	P-based	Zero	Zero
Very high	≥ 100	Zero	Zero	Zero	Zero

Whole-farm P balances

In addition to the NY-PI, we have developed the whole-farm nutrient mass balance (NMB) assessment over the past decade. In this assessment, information on nitrogen (N), P, and potassium (K) imports and exports onto and from a farm are collected (Figure 1). The exports are subtracted from the imports and the difference is defined as the balance. This balance can be expressed per tillable acre or per hundredweight (cwt) of milk exported to obtain indicators for sustainability and efficiency.

In 2014 we defined optimal operation zones for N, P, and K, which frame the feasible limits for judicious and sustainable use of these nutrients based on data from NY farms (Figure 2). Conducting NMB assessments and obtaining information on the farm's position relative to peers and to the feasible balance limits can help farms identify the need for and opportunities to adopt source reduction practices as a way to reduce overall farm nutrient inputs.

Integration of the P component in the NMB assessments and the NY-PI would be a logical step towards increasing the P efficiency and sustainability of New York dairy farms. One of our goals for the proposed NY-PI is to avoid penalizing farms that

consistently operate within the range of feasible P balances (≤12 lbs P/acre). These farms show that they manage their P resources responsibly and should be able to spread all the on-farm produced manure on their own land-base, given a reasonable animal density and STP levels.

We, therefore, aim to take NMBs across test farms into account to help set coefficients for the different transport and BMP factors included in the new approach, in addition to evaluating approaches that give farms with NMBs within the range of feasible balances greater flexibility with field-based manure and fertilizer P management.

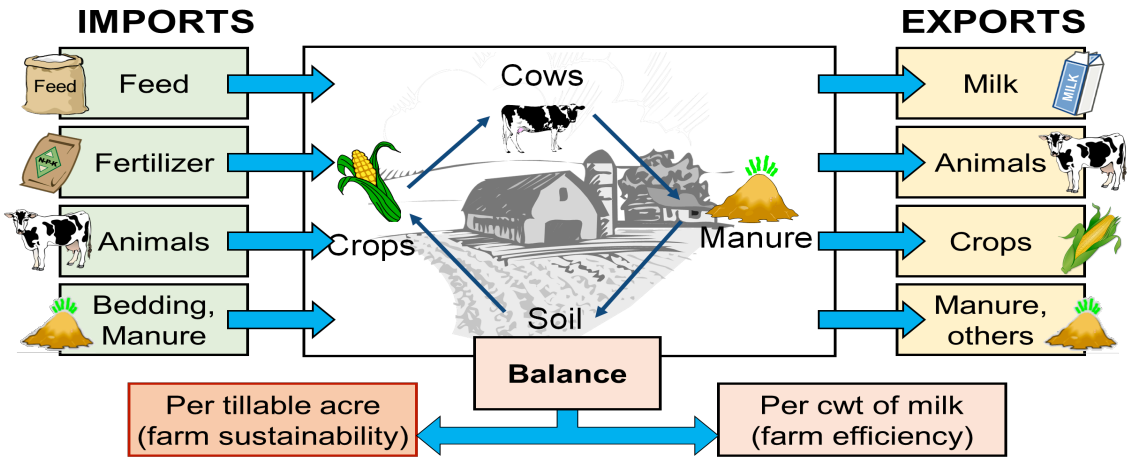

Figure 1. Overview of nutrient imports and exports included in the NMB. The nutrients in the resulting balance either remain on the farm, or are lost to the environment. Farms with feasible P balances per acre (≤11 lbs P/acre) are assumed to operate sustainably.

Methods:

We collected NMB and P index information for five farms (2017 data). Cropware files with P index data were obtained and added to the NY-PI database as well. The five farms were added to the three farm-years already obtained for 2016, and the data for 11 other farms statewide, resulting in a total of 1,300 field records. Per field record, scores for the current NY-PI were calculated.

Management implications of the proposed NY-PI were assessed under a variety of management scenarios (Table 1). To do this, scores were calculated for each BMP option and the relative area with N-based, P-based, and Zero implications for manure applications was calculated (interpretations as in Table 1). In the Cropware files, there was no information on the presence of vegetative buffers on the edge of fields (new transport factor in the proposed NY-PI). For the current analysis, buffers were assumed absent. Buffers can significantly decrease the transport score and thus result in a lower PI score and a different management implication.

Table 2. Various BMP scenarios (combinations for method of application and ground cover) used in the analysis of field distribution over three management categories in the proposed NY-PI (Figure 3). A lower coefficient indicates stronger PI score reduction.

Scenario	Method of application	Ground cover and timing	Coefficient
1	Surface spread without setback	Bare ground outside 2 wk of planting	1.00
2	Surface spread with 100 ft setback	Dormant sod or cover crop after corn harvest	0.64
3	Surface spread with managed setback	Dormant sod or cover crop after corn harvest	0.56
4 (sod)	Surface spread with 100 ft setback	Growing crop	0.48
4 (row)	Incorporation within 24 h and 15 ft setback		0.36
5	Injection	Growing crop	0.30

Results:

Whole-farm P balances

Milk production and whole-farm P balances for farms varied considerably across the regional database (Figure 2). The NNY farms had similar productivity (milk produced per acre) and were close to the average of all database farms. The variety in P balances was higher in 2017 than in 2016, which indicates the importance of using multiple years of data for these assessments. Most NNY P balances were close to or within the feasible limits per acre. Farms that consistently manage to keep annual P balances below this limit and have a reasonable animal density should be allowed to spread all manure on their land-base under the proposed NY-PI, given STP levels below 100 lbs/acre. The animal densities for the NNY farms currently involved ranged from 0.80 to 1.20 animal unit (AU) per acre and were mostly around 1 AU/acre. Earlier research has shown that this is approximately the largest animal density at which feasible P balances are obtainable without the need to export manure.

Phosphorus index scenarios.

Only 1.2% of all fields had STP values >100 lbs P/acre and 6.4% had STPs between 40 and 100 lbs P/acre. A vast majority (> 90%) of the NNY fields had STP values below 40 lbs Morgan-extractable P per acre and would benefit from P fertilization, according to Cornell University guidelines (Figure 3). Thus, based on STP alone, very few fields would be cut-off from manure application, both in the current and the proposed NY-PI.

Under the current NY-PI, more than 90% of the fields of the NNY farms were able to receive N-based manure applications (Figure 4, left bar). However, the current NY-PI likely impacted more fields than the results in Figure 3 may suggest. This is because application rates and methods are taken into account in the source factor of the current NY-PI (adjusted based on scores).

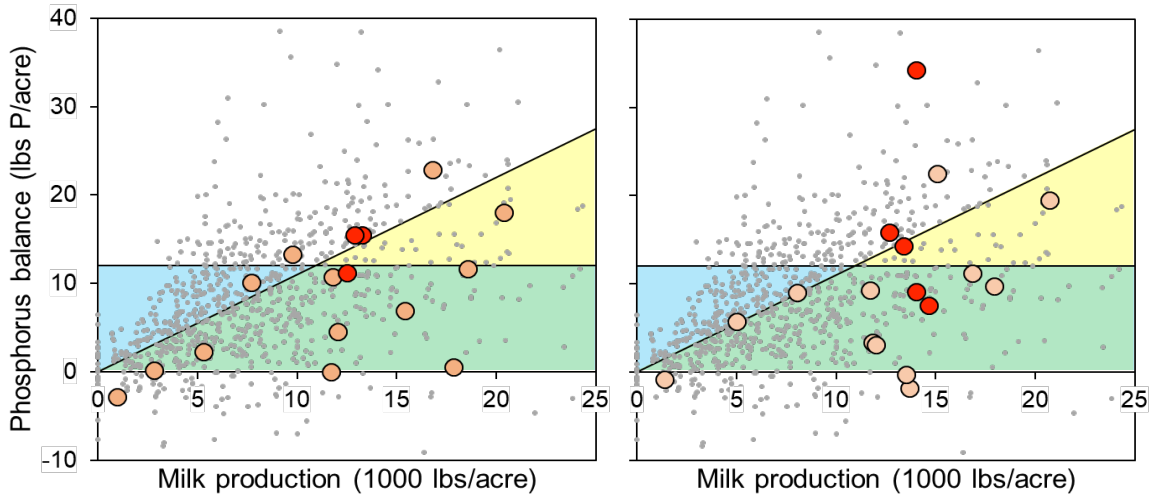

Figure 2. Whole-farm P balances for the farms in the regional NY database (large circles) including those from NNY (red circles) for 2016 (left) and 2017 (right). The small grey dots represent all records of NMB assessments done over the years. The green area represents the optimal operation zone, or 'Green Box' with feasible balances per acre and per hundredweight of milk exported. For the current project, we specificly focus on the feasible balances per acre (≤ 12 lbs P/acre), represented by the blue and green areas.

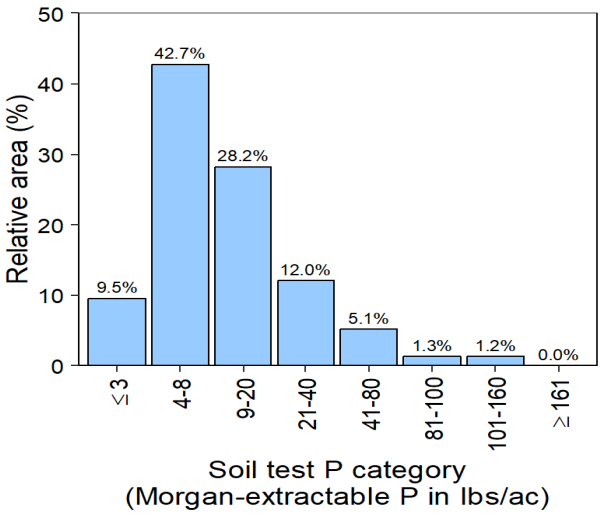

Figure 3. Distribution of the 1300 NNY field records across different STP categories. The categories are based on P fertilization recommendations for corn in New York and on STP categories in the current and proposed (NY-PI).

Compared to other fields in the database, NNY fields had relatively high transport factors. More than 75% of the fields had a transport score that exceeded 0.7 and, over 50% of fields had the maximum transport score of 1. This was mainly a result of fields being in close proximity to a stream, having poor drainage, or the presence of untreated concentrated flow. As the proposed NY-PI relies more firmly on transport scores, manure restrictions for NNY fields would be larger when the current coefficients are applied and when few or no BMPs are applied to counteract the risk of P transport (Figure 3).

With current coefficients, if no BMPs are implemented and manure is surface spread on bare soil outside of the growing season (worst case scenario), only around 10% of the fields could receive N-based fertilization, whereas more than 75% would be cut off from P application altogether (BMP scenario 1 in Figure 3). The number of fields to which manure could be applied can be reduced by adopting BMPs that reduce the risk of P transport (BMP scenarios 2, 3, 4, and 5 in Figure 4), up to a point where almost all fields could receive N-based fertilization if manure is incorporated and injected on a growing crop (Figure 4; Table 2).

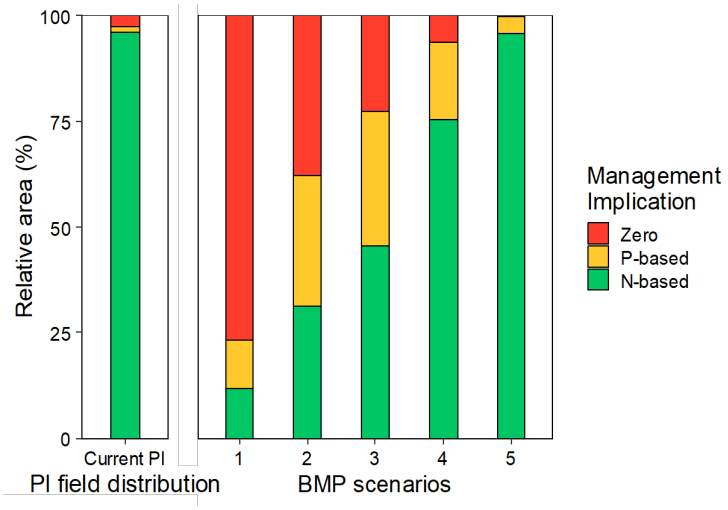

Figure 4. Distribution of the NNY fields over the three manure management implication categories (N-based, P-based, or Zero manure application) for the current NY-PI (left) and the proposed NY-PI given different BMP scenarios (right) defined in Table 1. For all scenarios vegetative buffers were assumed to be absent.

With current setting, BMPs need to be implemented on 60-90% of the acres, depending on the farm, to allow for manure application to those acres. Keep in mind that all scenarios in this study assume no vegetative buffers and that with implementation of vegetative buffers, a larger number of acres per farm can receive manure. These initial simulation results show that a switch from the current to the proposed NY-PI has implications for farms with a large number of fields with relatively high transport risk but also that the BMP structure incentivizes the implementation of relevant BMPs.

Conclusions/Outcomes/Impacts:

The NY-PI data show that for the farm fields in NNY in this study, the STP tends to be low but fields have a relatively high transport score. The current structure and coefficients incentivize BMP implementation for the high risk (high transport score) fields, consistent with the design of a PI.

Furthermore, evaluation of multi-year P balances is needed to evaluate if current settings are consistent with P balances where farms that have a whole farm P balance in the green box should be able to allocate all P in manure to cropland as long as STP levels are not excessive and risk of P transport from the most risky fields is limited by implementation of BMPs. Coefficients and BMPs included in this simulation are not set in stone yet and will be subject to feedback and review in 2019.

Outreach:

Preliminary results were discussed with farmers and planners during on-farm workshops in March of 2018. Nutrient mass balance reports were shared with all participating farms. We are currently (February 2019) working on individual farm NY-PI reports, including a variety of scenarios for transport factors and BMPs, which will be presented and discussed with farmers and planners during on-farm workshops this winter.

Next Steps:

This project will continue with one additional year of acquisition of NMB and NY-PI data (2018 growing season; data collection this winter). We will then finalize the analysis and coefficient setting of the new NY-PI. Over the coming months, a last round of feedback from planners and farmers will be collected.

Acknowledgments:

This study was co-funded by a USDA-Conservation Innovation Grants (69-3A75-17-26).

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

General talks about the NY-PI project and NMB assessment have been given. Information specific to NNY will be put together after the individual farm reports are completed and farms have been visited.

For further information, contact:

- Quirine M. Ketterings, Cornell Nutrient Management Spear Program (NMSP), Dept. of Animal Science, Cornell University, qmk2@cornell.edu, 607-255-3061, http://nmsp.cals.cornell.edu.