Nutrient Management Spear Program – 9/5/2009

College of Agriculture and Life Sciences

Nutrient Management Spear Program

Applied Research, Extension and Teaching in Nutrient Management for Dairy/Cash Grain Farms

Program Update

9/5/2009
Department of Animal Science
Cornell University

Cornell Nutrient Management Spear Program
A collaboration among the Department of Animal Science, Cornell Cooperative Extension and Pro-Dairy.

http://nmsp.css.cornell.edu
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Cornell University Nutrient Management Spear Program

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NSMP Vision:
To assess current knowledge, identify research and educational needs, conduct applied, field- and laboratory-based research, facilitate technology and knowledge transfer, and aid in the on-farm implementation of strategies for field crop nutrient management, including timely application of organic and inorganic nutrient sources to improve profitability and competitiveness of New York State farms while protecting the environment.

Justification:
Agriculture is one of New York State’s largest businesses, and keeping farms sustainable is critical to the economy of the state, particularly in rural areas. Maintaining economic viability, while ensuring environmental quality, is key to sustainability. Sustainability of New York State farms can be improved through applied research to address knowledge gaps and increased application of existing knowledge to create comprehensive nutrient management plans (CNMP’s) for farms of all sizes. The College of Agriculture and Life Sciences’ Nutrient Management Spear Program (NMSP) applied research program focused on improving our understanding of soil and environmental parameters that affect the accuracy of existing nutrient management guidelines and the risk for environmental pollution. Such understanding will allow for refinement of the guidelines. The NMSP extension program aims to improve communication, information exchange, and knowledge transfer between Cornell University’s research programs, extension field staff, agricultural consultants, the fertilizer industry and regulatory agencies and to develop joined applied research projects that address current and future challenges. Further, the NMSP teaching and mentoring program prepares Cornell undergraduates and graduates in animal science and agronomy to better address environmental issues impacting the farming community now and in the future.

NMSP Program Goals:
1. **Extension Program:** Improve grower and agricultural industry awareness of field crop nutrient needs, crop quality, management of organic amendments, environmentally sound nutrient management practices, and overall soil fertility management in New York State, and provide methods and tools to integrate and apply accumulated knowledge about field crop nutrient guidelines to optimize yield and quality while minimizing risk to the environment.

2. **Research Program:** Improve understanding of nutrient dynamics, development of risk identification tools and best management practices that reduce runoff, leaching and volatilization losses from inorganic and organic amendments as affected by soil type, hydrology, time and rate of application, and use of specific soil and fertilizer amendments.

3. **Teaching and Mentoring Program:** Prepare Cornell undergraduates for careers in agriculture focusing on increasing farm income while protecting the environment. Instill upon Cornell graduate students with a major or minor in soil science the skills, attitude and enthusiasm needed to conduct sound science using interdisciplinary and integrated approaches to address environmental issues related to soil science and nutrient management.
To assess current knowledge, identify research and educational needs, conduct applied, field- and laboratory-based research, facilitate technology and knowledge transfer, and aid in the on-farm implementation of strategies for field crop nutrient management, including timely application of organic and inorganic nutrient sources to improve profitability and competitiveness of New York farms while protecting the environment.

**Impact through collaboration and integration of teaching, extension and research.**
**NMSP Extension and Applied Research Projects**

**Nitrogen needs for corn following sods:**
In 2005/2006, we completed 16 first year corn field trials (corn following sods) of which 13 were on-farm trials as part of a project on nitrogen (N) management for corn. This involved 12 CCE educators and consultants. The project showed 1st year corn did not respond to extra N beyond a small (30 lbs N/acre or less) starter application, enabling large N fertilizer savings (http://nmsp.css.cornell.edu/projects/Nitrogenforcorn.asp). The project was lead by a Cornell Soil and Crop Sciences MS student (Joe Lawrence) who joined Cornell Cooperative Extension of Lewis County upon graduation in January of 2008. His results were published in 2008 and 2009 (Agronomy Journal, Soil Science Society of America Journal, and Soil Science).

**Tools for nitrogen management for corn:**
A new N test is under investigation as a possible tool for improved N management in New York. The test (Illinois Soil N Test) was developed in Illinois and modified to reduce test variability in the laboratory. Field trials were conducted in 2002-2008. This project involves many CCE field crops educators and has both research station trials for more controlled treatments and on-farm trials (33 trials in 2002-2005 for development of critical levels, 16 trials to address first year corn sites, and 19 trials for second/third year corn or corn after soybean). Information on the test is accessible at: http://nmsp.css.cornell.edu/projects/Nitrogenforcorn.asp. The project showed great promise for the new soil N tool (ISNT, Illinois Soil N Test) and the Cornell Nutrient Analysis Laboratory is offering the test for use in New York. The results of this study were published in the Soil Science Society of America Journal (2009). We are working with 24 New York farms to conduct whole farm ISNT assessment in 2008/2009, part of the MS degree programs of Anne Place and Sarah Wharton. This project was made possible by grants from the New York Farm Viability Institute (NYFVI), with additional support from the Northern New York Agricultural Development Program (NNYADP) and federal formula funds.

**Whole-farm mass nutrient balances and farm analysis:**
We work with New York State producers (2005-2009) to collect whole farm balance data. This project is conducted in collaboration with CCE extension educators, Soil and Water Conservation District (SWCD) employees, the Waste Management Institute, and agricultural consultants, and has generated a 300-farm database to date. This project will continue and is conducted in collaboration with colleagues in Animal Science (Dr. Larry Chase and Dr. Mike van Amburgh). Funding comes from federal formula funds, a NNYADP grant, and a USDA-CIG grant. NYSDAM sponsors a project on identification of nutrient management efficiency indices in support of performance-based planning of nutrient use on dairy farms.
Too much manure, where to put it?
This project focuses on quantification of soil test P increase with P addition via manure or fertilizer. Basic questions are: (1) How quickly do soil test levels build? (2) What determines the increase in soil test P upon P addition? (3) Can tools be developed that help with site selection if additional P needs to be applied; and (4) Will manure amendments (AlCl$_2$ or alum) change the dynamics? The NYSDAM supplied the initial funding followed by funding comes from the NNYADP. The first publication (SSSAJ) and fact sheet based on findings were published in June 2007 and a second publication is in progress. The project involves CCE educators from 6 Northern NY counties.

Nutrient dynamics upon manure and compost application in a corn-alfalfa rotation:
In this project, we follow nutrient dynamics in compost versus manure or inorganic N based management systems. In the first 5 years, we built P levels through P-based and N-based compost and manure management and now we are following the drawdown via alfalfa harvest. Focal points are: (1) timing of the N release peaks as affected by organic N source, (2) effect of time of sampling on soil test results for pH and Morgan extractable P, K, Ca, Mg, Fe, Mn and Zn; (3) effect of N source on organic N buildup (evaluation of the ISNT); (4) effects of organic based nutrient management on corn silage and grain yield and yield quality.

The project ([http://nmsp.css.cornell.edu/projects/nandpmanagement.asp](http://nmsp.css.cornell.edu/projects/nandpmanagement.asp)) is funded with federal formula funds. Collaborators: Jerry Cherney, Forage Specialist at Cornell University, and Shawn Bossard, Executive Director of Cornell Cooperative Extension of Seneca County.

Manure application methods and runoff versus tile drain losses:
To better understand the role of manure application methods (surface versus aerator treatment on runoff and leaching (tile drain) losses from grasses we established 12 large (60’ x 500’) orchardgrass plots at the Willsboro Research Farm in NNY. These plots were specifically constructed to simultaneously collect runoff and drainage water (central tiles lines empty in monitoring manholes) under controlled conditions. Our main objective for this study was to quantify losses of P and N in tile lines and surface runoff as impacted by manure application method (with and without partial incorporation via an Aerway). Additional measurements include orchardgrass yield, quality and nutrient uptake. The project was funded by the NNYADP with previously also additional funds from NYSDAM. Collaborator: Larry Geohring, Hydrologist, Cornell University and Peter Kleinman, Senior Soil Scientist, USDA-ARS, Pennsylvania. We are pursuing additional funding to conduct intact core lysimeter studies in 2010/2011.
**Manure application methods and N credits:**

This project was initiated by Shawn Bossard, Executive Director of Cornell Cooperative Extension of Seneca County who obtained funding from Altria (1 year) and NYFVI (2 additional years) to compare N credits for corn from partial incorporation with Aerway versus surface application without incorporation and incorporation with a chisel plow. The results of this study were published in Soil Science (2008). Additional funding from NYFVI (2008-2009) allowed us to expand this project to 10 sites throughout the state and to attract a new graduate student (Anne Place). Similar trials are ongoing in the Mid Atlantic region (collaborative effort with the Chesapeake Bay states).

**Starter phosphorus use for corn:**

We united a group of 20 extension educators working in field crops in a 3-year project: New York Starter Phosphorus Project. The project involved research station and on-farm field trials (71 completed trials, 49 producers) aimed to determine starter P needs for corn. Information on the project and its impact is accessible at: [http://nmsp.css.cornell.edu/projects/starterp.asp](http://nmsp.css.cornell.edu/projects/starterp.asp). The approach strengthened our campus – county collaboration, resulted in numerous extension articles, talks, display materials (posters, postcards, etc.) In the final year of the project, a survey of over 350 corn producers showed project convinced 17% of those that replied to reduce starter P application rates. We monitored the fertilizer sales data (New York State Department of Agriculture and Markets, NYSDAM) to assess the true impact of the project. New York statistics on fertilizer sales confirm the changes that farmers have made in P fertilizer use. From 1996 through 1999, average annual New York P fertilizer sales
amounted to 85.1 million lbs of P₂O₅. During the years of the project (2000-2003), sales reduced to an average of 64.1 million pounds of P₂O₅ per year. The decline in P fertilizer use continued beyond the duration of the project; annual P sales were as low as 53.3 million pounds of P₂O₅ in 2006, almost 32 million lbs of P₂O₅ less than the average P fertilizer sales in 1996-1999 and resulting in an accumulate saving of 165 million lbs of P₂O₅ since 2000! In comparison, nitrogen sales fluctuated between 1996 and 1999 but have been fairly constant since 2000 (on average 124 million pounds of N per year), and cropland acres have remained fairly constant as well, so these results show that New York farmers have made a conscious change to low P or P free fertilizers! This project was funded by a research and extension grant from NESARE. Other contributors include NYS Natural Resources Conservation Service (NYS-NRCS), NNYADP, Agway’s Lyon blend plant, Carovail, Pioneer Hi-Bred International Inc., and AgriCulver Seeds.

**Brown midrib (BMR) sorghum sudangrass best management practices:**
Best management practices were developed for brown midrib sorghum sudangrass, a possibly more environmentally sound alternative to corn. Trials were conducted (and will continue) to address fertilizer needs, cutting management, and seeding rates. Information is downloadable from: [http://nmsp.css.cornell.edu/projects/bmr.asp](http://nmsp.css.cornell.edu/projects/bmr.asp). This work resulted in numerous extension articles and talks, an increase in seed sales in the region, and six peer-reviewed journal articles. The collaborative research was led by Tom Kilcer, **CCE of Rensselaer County**, in collaboration with **CCE of Delaware, St Lawrence and Jefferson Counties** and Cornell programs in nutrient management and forages (Jerry Cherney). Funding was obtained from NNYADP and the seed industry. The website for this project is: [http://nmsp.css.cornell.edu/projects/bmr.asp](http://nmsp.css.cornell.edu/projects/bmr.asp).

**Comparison of lime requirement tests for New York**
Currently, lime requirements for New York (NY) soils are derived from the actual soil pH, target pH and exchange acidity (EA) determined by a barium chloride (BaCl₂) titration. The latter analysis is time-consuming and generates toxic waste. Our objective with this study is to compare the accuracy of the Mehlich buffer with half the BaCl₂ replaced with calcium chloride (CaCl₂), the modified Mehlich buffer (CaCl₂ instead of BaCl₂), Shoemaker-McLean-Pratt (SMP) buffer, and Sikora buffer in predicting lime needs for NY agricultural soils. **Cornell Cooperative Extension field crop educators collected 50 soil samples throughout the state.**
Eighteen soils were used to determine lime needs (incubation study) and to calibrate the different lime tests. Once calibrations were completed, lime requirements predicted with the different buffers were compared to those generated based on EA. Of the evaluated lime requirement methods, the EA-based method was the most accurate. The Modified Mehlich buffer-derived lime requirements correlated best with the current EA-derived requirements and this buffer replaced the current method used in CNAL in June of 2009. This project is a collaboration with Dr. Renuka Rao, Director of the Cornell Nutrient Analysis Laboratory and CCE field crops educators.

Conversion equations for phosphorus:
Conversion equations for soil tests from different laboratories were developed in a collaborative effort that included 5 commercial laboratories (including one in Canada) and 5 university laboratories in the Northeast (see http://nmsp.css.cornell.edu/software/morganequivalents.asp). The equations are being used by CAFOs that use laboratories other than the Cornell Nutrient Analysis Laboratory for their regular soil testing. The conversions have been adopted by the Agricultural Environmental Management (AEM) program of the Department of Agriculture and Markets (NYSDAM) and the equations have become an integral part of environmentally sound nutrient management planning in New York. As a result of this project, Mehlich-3 extractable Al is now included in standard Mehlich-3 soil testing packages. Use of conversion equations adds uncertainty to the recommendations. Ongoing work on quantification of the uncertainty shows these equations should only be use for samples taken in the fall after harvest and prior to manure application and verifications should be done prior to use of conversions.

Spatial variability of soil test data; influence on fertility guidelines and P runoff risk
While manure is a commonly used soil amendment in New York State, it is a challenge to distribute its nutrients uniformly across a field. The application of manure will likely increase the spatial variability of soil fertility (P, K, Ca, Mg, OM, pH) within a field. This could have major consequences for soil sampling in support of fertilizer and manure recommendations and environmental risk assessment. The objectives of our study were to (1) determine the impact of manure application on spatial soil fertility patterns, and (2) assess if a change in spatial variability should be accounted for in soil sampling and fertilizer recommendation procedures. Two farmer fields (Aurora Ridge Farm) were extensively sampled...
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in July and November of 2006. Using a combination of traditional and spatial statistics we evaluated spatial patterns for the July sampling. The November samples are being analyzed to determine spatially related changes that occurred as a result of manure spreading in one of the two fields. Two agronomic soil tests are included: Morgan and Mehlich-3. The latter was included to evaluate the impact of spatial variability and time of sampling on the accuracy of Mehlich-3 to Morgan conversion for P fertility guidelines and the P index. Current soil sampling guidelines are to take 10-20 samples per field with field sizes not exceeding 10 acres independent of field history, average expected P status, or time of sampling as related to manure management. Standard practice is to mix all sub samples in the field, creating one composite sample representative of the entire 10 acre field. This project showed (1) 3 samples should be taken per acre for most accurate assessments and (2) timing of sampling impacts the accuracy of conversion equations. This was the honors thesis project of Scott Grandt, double major in Crop and Soil Sciences and Applied Economics and Management at Cornell University. He is the lead author on a journal article that is being considered for publication in the Soil Science Society of America Journal.

**Teff as emergency forage in New York**

Teff is a warm season annual grass native to Ethiopia with great promise as an emergency forage crop in New York. Recent research from the Oregon State University Klamath Experiment Station and collaborative work by the Cornell Cooperative Extension Associations of Jefferson (Mike Hunter), St. Lawrence (Peter Barney) and Rensselaer (Tom Kilcer) Counties, and Jerry Cherney (Department of Crop and Soil Sciences, Cornell) indicate great promise for teff as a forage crop. Potential uses for teff in New York include: (1) Emergency hay, pasture or silage crop that can be planted in mid-summer, (2) Summer annual cover crop for erosion control, (3) Green manure crop, (4) Stand alone annual hay crop for market, and (5) Rotation break crop when renovating a perennial grass or alfalfa stand or pasture. The crop can reduce forage production losses due to “summer slump” when used as an annual pasture. It could follow winter cereal forage, straw or grain crop or spring cereal forage crop in the rotation and an additional advantage is that teff can be grown with conventional forage seeding and harvesting equipment. In 2006 and 2007, nitrogen rate studies were conducted in Northern, Eastern and Central New York. These trials indicated an N application of 50 lb/acre per cut was optimal for teff production. A factsheet was written on teff.
production as part of the MS thesis of Mike Hunter and a journal article was published (2009) in Forages and Grazinglands.

**Sulfur (S) needs for alfalfa**

In 2007, we initiated a new project to: (1) determine the S status and S removal by alfalfa grown in New York; (2) develop tools (critical levels for tissue and soil tests) that enable producers to identify deficiencies before they impact yield and/or quality; (3) stimulate S use where needed for improved alfalfa production, enhanced farm profitability, and protection of the environment. This project is ongoing with 6 on-farm sites, a greenhouse experiment and soil incubation study. A factsheet was developed on the basics of sulfur. The first year of field trials showed a yield response to S addition for four of the eight sites selected for the study. Six soil extraction methods and two detection methods were evaluated for their ability to predict responsiveness. A journal article is currently in preparation and field trials are ongoing.

**Potassium (K) needs for alfalfa**

Potash prices recently reached historic highs ($800-$1,000/ton), and are forecast to remain strong for the foreseeable future. Dairy producers often apply supplemental fertilizer K to alfalfa in rotation with corn because: (1) alfalfa removes large amounts of K; and (2) there are concerns about stand survival through the winter for low K alfalfa. Cornell K guidelines are soil-specific and reflect the strong K supplying capacity of many NYS soils. Consequently, the K guidelines are lower than industry K recommendations. For the reasons listed above, it is however not uncommon for dairy producers to apply 150-250 lbs/acre K₂O ($100-$200/acre in 2008). This is reflected in high whole farm K balances on some dairy farms. Research at the Aurora Farm the past three years has shown no yield response to K for fields testing even low or medium in soil test K, suggesting potential for large fertilizer savings. Crop removal-based applications required $200/acre in K fertilizer costs while the K saturation based approach used on some farms would have resulted in even larger K applications. Field trials and an extension program were needed to evaluate soil test K versus K saturation and crop removal based management for impact on yield, quality, stand survivability, fertilizer costs. We initiated such a project in 2009, to be expanded with funding from NYFVI in January of 2010. Our specific research objectives are to: (1) determine likeliness of a K yield or quality response of alfalfa fields in a corn-alfalfa rotation, with and without manure application in the corn years; (2) evaluate three approaches for K management (soil test K based, percent K saturation based, crop removal based) for their validity as tool for optimizing K management for alfalfa in corn-alfalfa rotation and for predicting economic return to K; (3) assess the impact of each approach on whole farm K balances and return to fertilizer investments. We will also conduct a statewide K status assessment of agricultural soils in New York State using current and past soil test records. Our extension objectives focus on creating awareness for K needs (or lack thereof) for alfalfa in corn-alfalfa rotations, awareness of the three approaches and their benefits and disadvantages, and fine-tuning of our K guidelines taking into account yield, quality and stand survival.
Nutrient Management Spear Program website:
See http://nmsp.css.cornell.edu. This program website lists projects, extension documents, software tools etc. The site contains a link to the official Cornell guidelines for field crops fertility and nutrient management (http://nmsp.css.cornell.edu/nutrient_guidelines/). This page has six major guideline publications: N Guidelines for Field Crops in New York; P Guidelines for Field Crops in New York, K Guidelines for Field Crops in New York, lime Guidelines for Field Crops in New York; the New York State Phosphorus Runoff Index; and Manure Use for Alfalfa-Grass Production. All projects discussed in this program overview are accessible through the Nutrient Management Spear Program website. The website houses our agronomy fact sheet series, Cornell Cropware, the official sites of the N and P indices, soil test conversions and soil test summaries. The site also features farmer and extension impact statement for two major projects and the stories of three NMSP students reflecting on their time as a graduate student in an applied research and extension program (“Student and Extension”).

Nitrogen management on dairy farms (http://www.dairyN.cornell.edu):
This N Management on Dairy Farms web site was developed by researchers and extension educators at Cornell University (Department of Crop and Soil Sciences and Department of Animal Science), the Animal Manure and By-Products Laboratory of the USDA Agricultural Research Service (Beltsville Agricultural Research Center, Maryland), and the University of Vermont (Department of Plant and Soil Science). Funding for the project was provided by the Fund for Rural America. This web site is designed to deliver background information and management guidelines for efficient N use throughout the dairy farm system, including: (1) crop and soil N management; (2) feed storage N management; (3) herd N management; (4) manure storage N management. Project is completed (Funds for Rural America) but given great interest following the USDA-ARS public announcement of release of the website, we are looking for additional funding to maintain and expand the site with greater involvement of other universities.
Cornell fertility and environmental risk management guidelines for field crops:  
As stated above, we fully documented the Cornell fertility guidelines for field crops in collaboration with Stuart Klausner and Shaw Reid, emeritus faculty. The six major documents (N guidelines for field crops in New York; P guidelines for field crops in New York, K guidelines for field crops in New York, Lime guidelines for field crops in New York; and The New York State Phosphorus Runoff Index, and the New York Nitrate Leaching Index) are posted on the official Cornell University website for guidelines for field crops fertility and nutrient management (http://nmsp.css.cornell.edu/nutrient_guidelines/). Also developed were stand-alone calculators accessible via the same website. Guidelines were built into Cornell Cropware and are consistent with recommendations generated by the Cornell Nutrient Analysis Laboratory (CNAL). These documents are referred to within the NRCS 590 standard for nutrient management planning as references for nutrient management planning. The Cornell Guide for Integrated Field Crop Management include fertility guidelines for field crops but for New York CAFO planning, the recommendations outlined in the documents listed above are the basis (more accurate in manure and sod credit assessments than the overall guidelines listed in the Cornell guide). These documents and Cornell Cropware are also the basis for our course in whole farm nutrient management (ANSC/CSS412).

Statewide and county-based phosphorus balances:  
We completed state and county-based summaries of phosphorus (P) balances. The document was published in September 2006 and is downloadable from our website. http://nmsp.css.cornell.edu/publications/articles/extension/PBalance2006.pdf. The assessment showed great improvements in P management in New York over the years. This project was done in consultation with the Mid Atlantic Regional Water Program and funded with Federal Formula Funds and contributions from NYSDAM, NNYADP, and the Upper Susquehanna Coalition. The project supported a Dutch undergraduate (senior) from Larenstein Agricultural College, The Netherlands (thesis project, see picture). In the past couple of month, this assessment was expanded to include (1) an estimate of the relative contribution of herd nutrition improvements on statewide P balances, and (2) to predict 2006 balances. This assessment showed a reduction from +7.2 lb/acre in 2002 without herd nutrition improvement (P excretion of 62 lb/cow per year) to +4.3 lb/acre with herd nutrition (P excretion of 40 lb/cow per year). With a P excretion of 40 lb cow\(^{-1}\) per production period, increased yields in 2006 (reflected in crop P removal of 25,639 tons versus 23,268 in 2002) and reduced P fertilizer sales (11,586 tons versus 14,030 in 2002), the estimated P balance
for 2006 amounted to +1.5 lb ac\textsuperscript{-1}. These assessments illustrate (1) the importance of precision feeding and cropland fertility management for the long-term sustainability of the dairy sector, and (2) the progress made through enhanced agricultural environmental management in NY. This work will be published in the Feb/March 2009 issue of the Journal of Soil and Water Management.

Statewide and county-based soil test summaries:
In total, **56 county summaries** were completed in 2003/2004 and again in 2007. Summaries are downloadable from: [http://nmsp.css.cornell.edu/publications/soil_test_summaries.asp](http://nmsp.css.cornell.edu/publications/soil_test_summaries.asp). Many of the summaries have introductions written by the local extension office. A statewide assessment resulted in a journal article and an extension article on P trends in New York agricultural land. The work set the stage for our current activities (extension and research) in whole farm nutrient balance assessments. This 2001-2006 summary series was conducted in collaboration with **CNAL director Dr. Renuka Rao**.

New York State Phosphorus Runoff Index:
In 2003, with NYSDAM funding, a NYS Phosphorus Index and User’s Guide was written. This document was distributed during trainings with certified nutrient management planners and electronically ([http://nmsp.css.cornell.edu/publications/pindex.asp](http://nmsp.css.cornell.edu/publications/pindex.asp)). The NYS P index was developed by a Cornell based working group under leadership of Karl Czymmek. The tool has become a required assessment tool for environmentally sound nutrient management planning in New York State. Extension materials including calculators and on-line tools were developed and these are accessible from the same P index website. This project was conducted in collaboration with Larry Geohring and the **NYSDAM Agricultural Environmental Management (AEM) program**. Funding was obtained through NYSDAM and NNYADP. A CALS P index committee was established in 2007 and work is currently ongoing to evaluate the initial P index and the need for improvements and extension activities.

Cornell Cropware:
Cornell Cropware 2.0 aids nutrient management planners in the development of NRCS standard compliant nutrient management plans for CAFOs. The software was developed with funding from NYSDAM, NYS-NRCS and the NYS Department of Environmental Conservation (NYSDEC). It is electronically available via the Cropware website: [http://nmsp.css.cornell.edu/software/cropware.asp](http://nmsp.css.cornell.edu/software/cropware.asp). Our team supports the software and works on updates when new science becomes available. We have one person on the staff dedicated to customer support and conducting workshops on Cropware use and general soil fertility and nutrient management principles that guide environmentally sound nutrient management on New York State dairy farms. In 2006, we worked with colleagues at SUNY Buffalo on
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building a mapping component to the software, Mapware, as part of an EPA funded project. We also published a paper on the software and a survey we completed among Cropware users. In 2005, DEC annual updates showed we have 606 medium and large CAFOs in New York. Of these 606 CAFO farm plans 218 (36%) were developed with Cropware (31 planners, 11 from the private sector and 20 from the public sector). Based on a user survey, 73% of the plans developed with Cropware in 2004 were developed for non-CAFO size farms. If we use this percentage for 2005 as well, in 2005 Cropware was used to develop an additional 590 plans for non-CAFO farms. This brings the total number of plans developed with Cropware in 2005 to a little more than 800 farms. Improvements are being mapped and a record-keeping component for manure and fertilizer management is being developed in collaboration with New York nutrient management planners and NYSDAM (with NYSDAM funding).

Agronomy Fact Sheets:
In the summer of 2005, we started a new series of Agronomy Fact Sheets upon request from Cornell Cooperative Extension educators, farmers and nutrient management planners (http://nmsp.css.cornell.edu/publications/factsheets.asp). Fact sheets are developed in collaboration with Cornell undergraduate and graduate students and Cornell Cooperative Extension field crop educators and currently 43 fact sheets have been completed and posted to our website. This project has allowed Cornell students to experience and be part of extension. The latest fact sheets in the series include factsheets developed by SUNY Cobleskill interns Hillary Bundick (enhanced efficiency nitrogen fertilizers) and John Weiss (nitrogen fertilizer sources). The series continue to grow with currently under development fact sheets on boron and teff.

SUNY Cobleskill Internship Program:
In 2007, we initiated our Cobleskill Internship Program in collaboration with Dr. John Kowal (Chair), Dr. Ted Bruetsch, and Dr. Doug Gooddale, of the Plant Science Department at SUNY Cobleskill. The SUNY Cobleskill’s 4-year curriculum requires students do a 15-week internship and students with an interest in applied research and extension in agriculture and environmental management are invited to apply. We were joined by the first student, Wayne Berry, that spring semester and by Chie Miyamoto in 2008. Chie continued to work with us beyond graduation until January of 2009 when she returned to Japan to start her new job at a land reclamation company. Two new interns plan to join us in the summer of 2009. These internships expose students to applied research and the Cornell Cooperative Extension system and allow them to develop team member and leadership skills.

Dr. Bruetsch: “We try to have the students educated with a good practical background and Cornell Cooperative Extension deals with just that - good practical applied agriculture. We've got a good marriage with Cornell. We are preparing our students with the hands-on type of experiences, and Cornell Cooperative Extension and the NSMP offer that.”
Wayne Berry: “The internship showed me the need for the different research that is being done now and the reason why it is being done and how it is being done. I'm more in tune with things. The internship gave me a better understanding of how things are going now, what it all entails.”

Dr. Kowal: “Internships like this help students take the knowledge from the classroom out into the work place. It gives them a greater understanding of what is being taught; it’s a nice evolution of knowledge.”

In the summer of 2009, we enjoined having Hillary Bundick and John Weiss with us and in September of this year, Eun Hong will join us for her internship.

**NMSP Teaching (ANSC/CSS 412)**

We teach “Whole Farm Nutrient Management”, an upper-level, undergraduate course offered through the Departments of Animal Science (ANSC) and Crop and Soil Sciences (CSS) at Cornell University. The course (ANSC/CSS 412) is designed for students interested in agricultural careers and aims to help them develop a working knowledge of agricultural environmental management. Students must enroll in module I (soil and crop nutrient management) and most opt to continue through the second half of the semester in module II (dairy herd nutrient management). The course attracts student in agronomy, natural resources, engineering and animal science. Most students enter ANSC/CSS 412 with a limited background crop and soil sciences so Module I focuses on agricultural environmental policy, the basics of soil and crop nutrient management, and the development of a nutrient management plan for an actual dairy farm. The course attracted 35 students in 2004, 33 in 2005, 28 in 2006, 31 in 2007, 24 in 2008, and 38 in 2009 showing an average annual enrollment of about 30 students over the past 6 years. The course includes five web-based learning modules (basics of fertility management), a group project (development of a nutrient management plan for a commercial farm), a reporting session (in-class) with the producer and a CNMP specialist, and a field trip to the farm. The February 2nd issue of Country Folks featured the course.
Some class responses:

Everything was very well organized, and cooperation between different instructors was obvious. I wasn’t sure if I should take the class, but I’m very glad that I did, it is one of the most hands-on, interactive, applicable classes I’ve taken at Cornell.

I really enjoyed this class a lot. I did not have any background in this area. I deal with the cows all day while everyone else is dealing with crop work. I am currently managing a herd and the farm owner was really excited to hear I was taking this class.

I enjoyed the course and did learn a lot, some things I only got the basics of, some I got all of the details. Gave me a very good understanding of this type of work and now I’m considering furthering my education in this field.

Gives me more of an appreciation for nutrient managers.

I really liked this class as a whole. Very informational. Probably one of the top classes that I took information away from. Very applicable to my farm once I graduate.

I thought the project was the best part, because it was an actual real life situation where we got to apply what we learned.

The project put together everything we had discussed in class and furthered my knowledge a lot. It made things very interesting.

Very practical and hands-on, at least within the world of CAFO/Cropware/CNMP – learned a lot.

By doing this part of the plan, I realized just how involved the process is – as soon as we thought we were finished, we found something else that could be adjusted to make the plan better – I’m sure with more time we could have made more adjustments.

Working in small groups is a very good part of this module, especially combinations of crop and animal science students. It gave a lot of opportunities to share our ideas and interact with each other.

Impact through collaboration and integration of teaching, extension and research.
Peer-reviewed publications (*indicates NMSP staff or student advisees):

2009:

2008:

2007:


2006:


2005:

2004:

2003:

2002:

2001:

2000:

1999:

1997:
Nutrient Management Spear Program – 9/5/2009

Agronomy Fact Sheets:

# 3: Pre-Sidedress Nitrate Test (9/20/2005)
# 4: Nitrogen Credits from Manure (8/19/2005)
# 7: Liming Materials (7/21/2006)
# 8: Starter Phosphorus Fertilizer for Corn (10/22/2005)
# 9: Cornell Cropware (8/18/2005)
#10: Phosphorus Index (12/12/2005)
#11: Nitrogen Leaching Index (2/2/2006)
#12: Phosphorus Basics - The Phosphorus Cycle (1/16/2006)
#13: Phosphorus Runoff (1/16/2006)
#15: Phosphorus Soil Testing Methods (9/30/2006)
#16: Application of Manure to Established Alfalfa (12/18/2006)
#17: Nutrient Management for Pastures (6/28/2006)
#18: Manure Spreader Calibrations (1/19/2007)
#20: Establishment and Management of Switchgrass (12/18/2006)
#21: Nitrogen Needs for First Year Corn (12/18/2006)
#22: Cation Exchange Capacity (3/2/2007)
#24: Teff as Emergency Forage (3/22/2007)
#26: Brown Midrib Sorghum Sudangrass Nitrogen Management (6/30/2007)
#27: How Quickly Will Soil Test P Levels Increase? (7/10/2007)
#28: Phosphorus Removal by Field Crops (7/21/2007)
#29: Soil Texture (8/22/2007)
#30: Soybean Nitrogen Credits (7/18/2007)
#31: Late Season Stalk Nitrate Test (7/21/2007)
#32: Zinc (9/10/2007)
#33: Nutrient Management Planning (10/15/2007)
#34: Sulfur (8/29/2007)
#36: Illinois Soil Nitrogen Test for Corn (1/17/2008)
#37: Nutrient Management Data Collection (2/5/2008)
#38: Manure Sampling, Handling and Analysis (2/5/2008)
#40: Potassium for Corn (6/16/2008)
#41: Organic Matter (5/8/2008)
#42: Manure Use for Alfalfa-Grass Establishment (9/12/2008)
#43: Nitrogen Benefits of Winter Cover Crops (11/26/2008)
#44: Nitrogen Fertilizers for Field Crops (8/23/2009)
#45: Enhanced Efficiency Nitrogen Sources (8/23/2009)
Extension publications (*indicates NMSP staff or student advisees):

2009:

2008:

2007:

2006:


2005:


2004:


2003:


2002:

2001:


