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

Applied Research, Extension and Teaching in Nutrient Management for Dairy/Cash Grain Farms
http://nmsp.css.cornell.edu

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.

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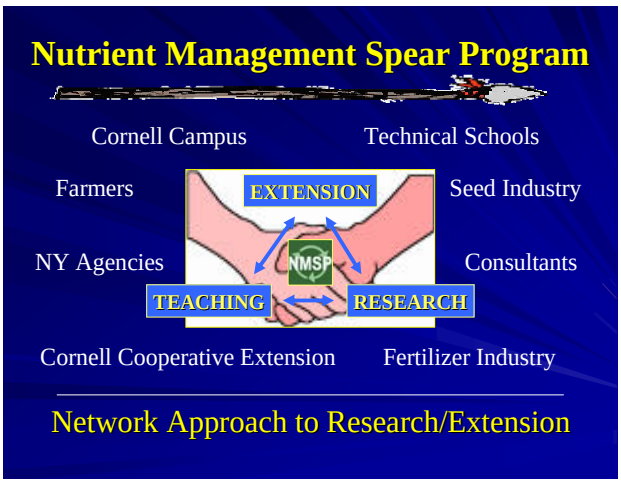
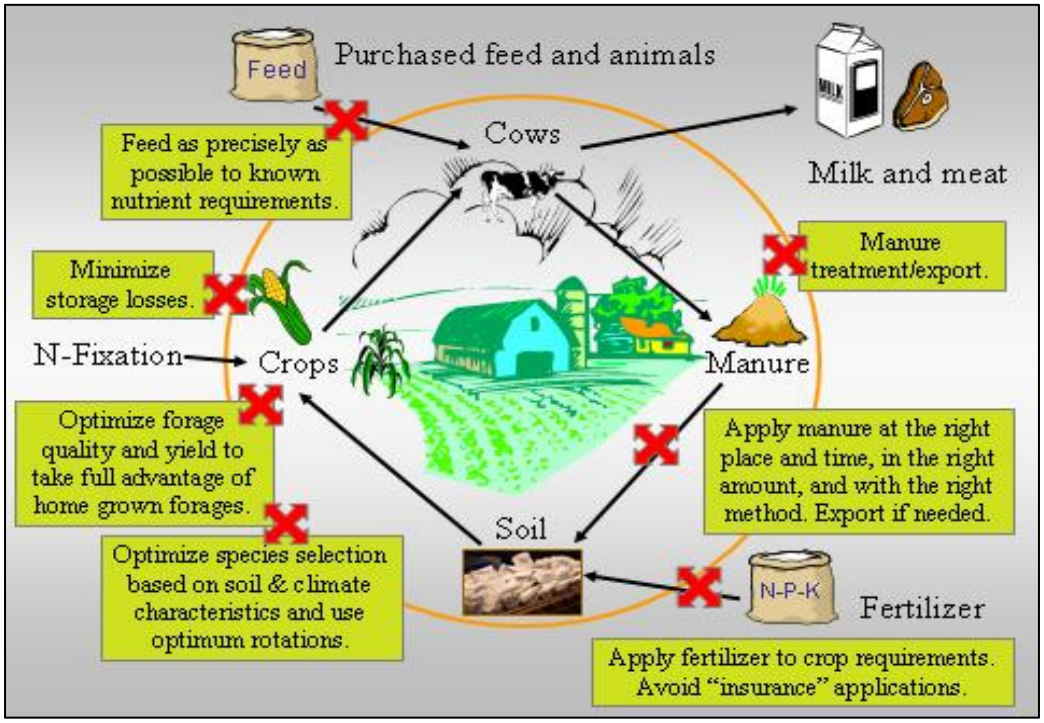




To assess current knowledge, identify research and educational needs, conduct applied, field- and laboratory-based research, facilitate technology and knowledge transfer, and aid in the on-farm implementation of strategies for field crop nutrient management, including timely application of organic and 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:


Cornell University
Cooperative Extension

Nitrogen for Corn Project 1

Dairy Changes N Fertilizer Applications for Corn

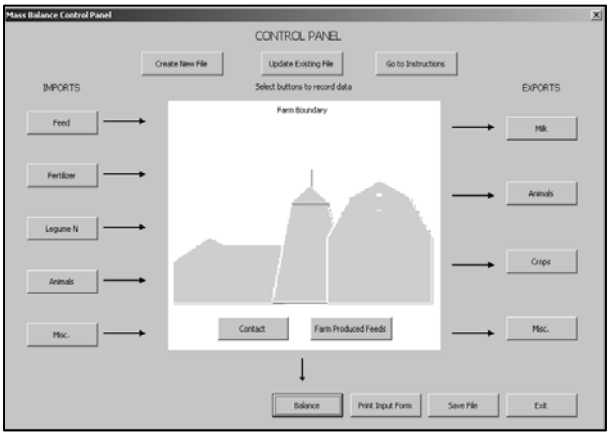
In 2005/2006, we completed 16 first year corn field trials (corn following sods) of which 13 were on-farm trials as part of a project on nitrogen (N) management for corn. This involved **12 CCE educators and consultants**. The project showed 1st year corn did not respond to extra N beyond a small (30 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) 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:

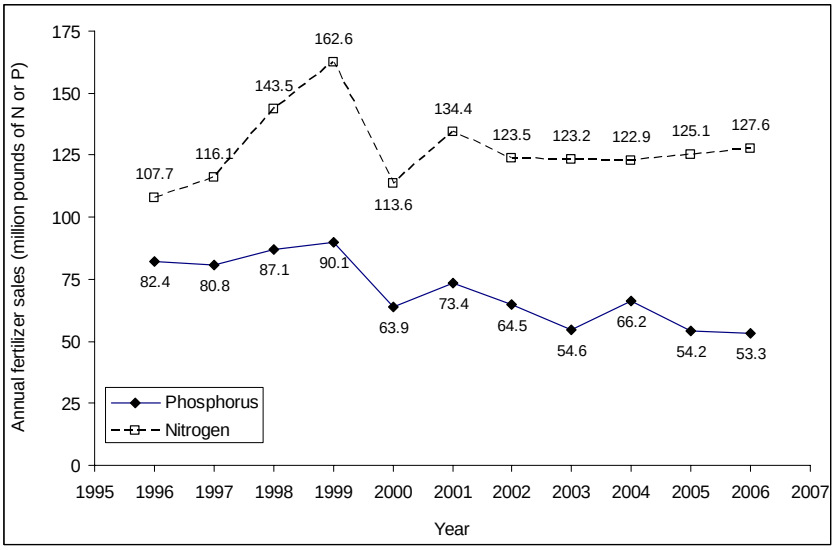
To better understand to role of manure application methods (surface versus aerator treatment on runoff and leaching (tile drain) losses from grasses we established 12 large (60' x 500') orchardgrass plots at the Willsboro Research Farm in NNY. These plots were specifically constructed to simultaneously 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. 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 P_2O_5. During the years of the project (2000-2003), sales reduced to an average of 64.1 million pounds of P_2O_5 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 P_2O_5 in 2006, almost 32 million lbs of P_2O_5 less than the average P fertilizer sales in 1996-1999 and resulting in an accumulate saving of 165 million lbs of P_2O_5 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. 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.

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 ($BaCl_2$) 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 $BaCl_2$ replaced with calcium chloride ($CaCl_2$), the modified Mehlich buffer ($CaCl_2$ instead of $BaCl_2$), 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**.

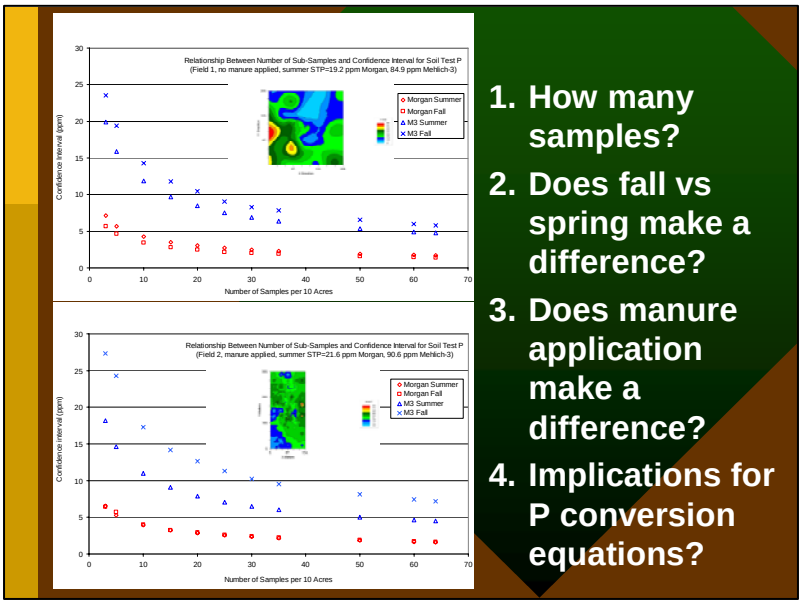
Eighteen soils were used to determine lime needs (incubation study) and to calibrate the different lime tests. Once calibrations were completed, lime requirements predicted with the different buffers were compared to those generated based on EA. Of the evaluated lime requirement methods, the EA-based 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 uncertainly 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



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.

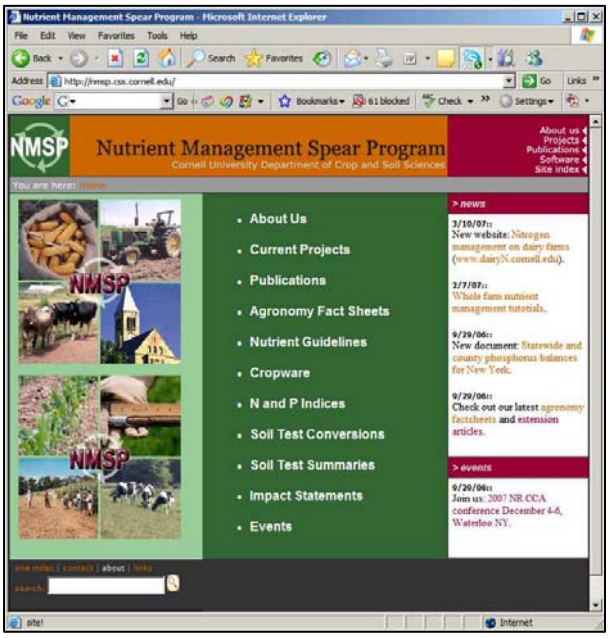
Potassium (K) needs for alfalfa

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 K_2O ($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.

NMSP Extension Materials (websites and major documents)

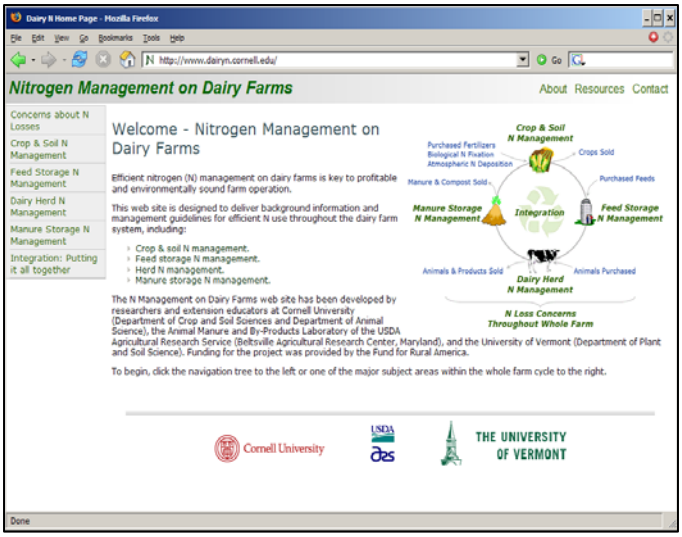
Nutrient Management Spear Program website:

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").



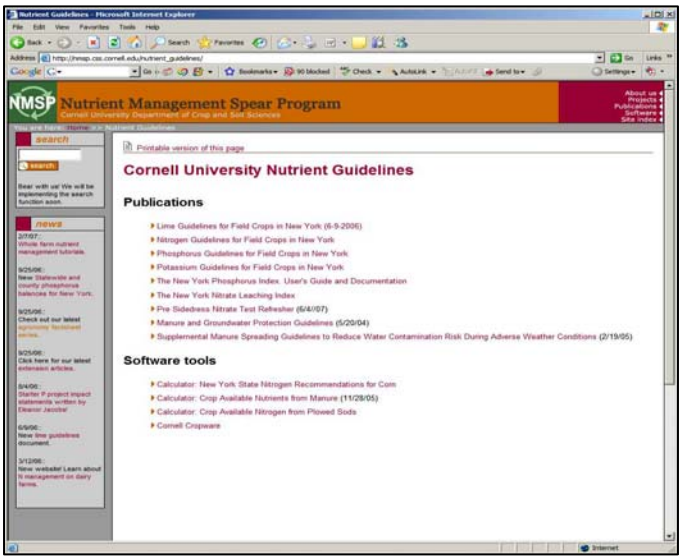
Nitrogen management on dairy farms (http://www.dairyN.cornell.edu):

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.



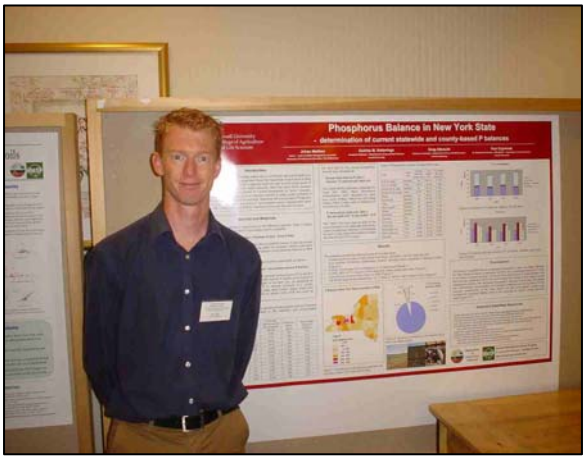
Cornell fertility and environmental risk management guidelines for field crops:

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^{-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. 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). 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:

Mouse Clicks for Enhanced Agricultural Environmental Management on Dairy Farms

In New York State, large- and medium-size dairy farms as well as smaller farms that receive state or federal funds need to develop and implement a Comprehensive Nutrient Management Plan (CNMP). This plan needs to be based on field-specific crop nutrient guidelines developed by the New York Land Grant University (Cornell University). In addition, for each field, the New York Phosphorus Index and the Nitrate Leaching Index need to be determined to guide manure and fertilizer application rate, method, and timing.

Because of the large amount of information that has to be integrated to derive guidelines, risk indices, and management solutions that consider practical constraints and farm-specific challenges/opportunities, computer software tools have become essential.

"The sustainability of the dairy industry in New York State will depend greatly on its ability to protect air and water quality from the effects of excess nutrients while maintaining/improving profitability," says Dr. Quirine Ketterings, Director of the Nutrient Management Spear Program at Cornell University and co-author of a new article in the *Journal of Natural Resources and Life Sciences Education*. "Given the complexity of the farming systems and the need to develop best management practices that can be implemented and have impact on water and air quality, software tools have become essential."

With funding from the Natural Resources Conservation Service, the Department of Environmental Conservation, the Department of Agriculture and Markets, and the Environmental Protection Agency, and with input from New York Certified CNMP Planners and Cornell Cooperative Extension educators, faculty and staff at Cornell University developed Cornell Cropware, a software tool for fertilizer and manure management.

"Our software currently allows over 200 registered users to develop Comprehensive Nutrient Management Plans in accordance with New York regulatory requirements," says Caroline Rasmussen, Research Associate with the Nutrient Management Spear Program at Cornell University.

In addition, Cornell sensors use the software in a course on environmental management of dairy farms.

"The Whole Farm Nutrient Management course, in which Cornell undergraduates learn to use Cropware, provides a key experience for future leaders in agriculture because environmental management will continue to play an increasingly important role in farm sustainability," says Karl Czymmek, Senior Extension Associate with the PRO-DAIRY program and co-author of the article.

A 2005 survey among Cropware users (80 respondents, 34% response rate) showed that the software is used primarily by government agency employees, extension educators, private-sector Certified CNMP Planners, and producers. According to the survey, 579 plans were developed with Cropware in 2004 with 323 additional plans and 561 updates scheduled for 2005. Seventy-three percent of the plans were developed for small- and medium-size animal feeding operations, and 86% were dairy operations.

The software is considered valuable by its users. Specific features considered most useful centered on field data entry and the creation of output database files and reports. Suggestions for further development included improvements in data linkages with other software (e.g., mapping software), user interface, and output reports.

Ketterings, Q.M., G.L. Albrecht, C.N. Rasmussen, and K.J. Czymmek. 2006. Cornell Cropware: Decision support tool for fertilizer and manure nutrient management planning. J. Nat. Resour. Life Sci. Educ. 35:340–351. View the full article online at http://www.jnrlse.org/issues.php

Career & Education

January 2007 V52 N01

CSA News 45

New M.S. Program in Land, Water Conservation

The University of Bologna (Italy) and Washington State University (USA) have created a new program where students can earn an international M.S. in Land and Water Conservation. The program includes the exchange of participating students.

The objective of the program is to develop an integrated multidisciplinary program in Land and Water Conservation. Professors with different backgrounds (physicists, hydrologists, land and water development engineers, experts in informatics, and water and environmental resource managers) will be teaching with a solid in-depth training in their fields of specialization. At the same time, they will work together in an interdisciplinary environment to develop strategies for an integrated approach.

For more information, visit www.dista.agraci.unibo.it/master/index.php.

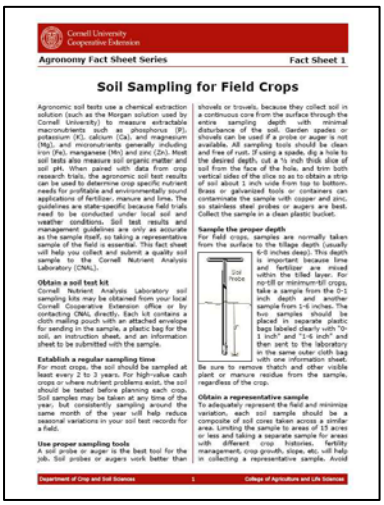
Students in a Cornell University capstone course on whole-farm nutrient management present nutrient management plans developed with Cropware and discuss them with producers.

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 Cropwar website: 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

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.


Cornell University
Cooperative Extension

Agronomy Fact Sheet Series — Fact Sheet 1

Soil Sampling for Field Crops

Agronomic soil tests use a chemical extraction solution (such as the Morgan solution used by Cornell University) to measure extractable macronutrients such as phosphorus (P), potassium (K), calcium (Ca), and magnesium (Mg), and micronutrients generally including iron (Fe), manganese (Mn) and zinc (Zn). Most soil tests also measure soil organic matter and soil pH. When paired with data from crop research trials, the agronomic soil test results can be used to determine crop specific nutrient needs for profitable and environmentally sound applications of fertilizer, manure and lime. The guidelines are state-specific because field trials need to be conducted under local soil and weather conditions. Soil test results and management guidelines are only as accurate as the sample itself, so taking a representative sample of the field is essential. This fact sheet will help you collect and submit a quality soil sample to the Cornell Nutrient Analysis Laboratory (CNAL).

Obtain a soil test kit

Cornell Nutrient Analysis Laboratory soil sampling kits may be obtained from your local Cornell Cooperative Extension office or by contacting CNAL directly. Each kit contains a cloth mailing pouch with an attached envelope for sending in the sample, a plastic bag for the soil, an instruction sheet, and an information sheet to be submitted with the sample.

Establish a regular sampling time

For most crops, the soil should be sampled at least every 2 to 3 years. For high-value cash crops or where nutrient problems exist, the soil should be tested before planning each crop. Soil samples may be taken at any time of the year, but consistently sampling around the same month of the year will help reduce seasonal variations in your soil test records for a field.

Use proper sampling tools

A soil probe or auger is the best tool for the job. Soil probes or augers work better than shovels or trowels, because they collect soil in a continuous core from the surface through the entire sampling depth with minimal disturbance of the soil. Garden spades or shovels can be used if a probe or auger is not available. All sampling tools should be clean and free of rust. If using a spade, dig a hole to the desired depth, cut a ½ inch thick slice of soil from the face of the hole, and trim both vertical sides of the slice so as to obtain a strip of soil about 1 inch wide from top to bottom. Brass or galvanized tools or containers can contaminate the sample with copper and zinc, so stainless steel probes or augers are best. Collect the sample in a clean plastic bucket.

Sample the proper depth

For field crops, samples are normally taken from the surface to the tillage depth (usually 6-8 inches deep). This depth is important because lime and fertilizer are mixed within the tilled layer. For no-till or minimum-till crops, take a sample from the 0-1 inch depth and another sample from 1-6 inches. The two samples should be placed in separate plastic bags labeled clearly with "0-1 inch" and "1-6 inch" and then sent to the laboratory in the same outer cloth bag with one information sheet.

Be sure to remove thatch and other visible plant or manure residue from the sample, regardless of the crop.

Obtain a representative sample

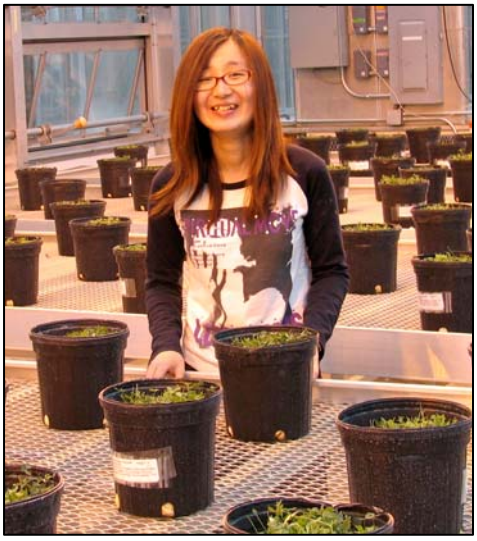
To adequately represent the field and minimize variation, each soil sample should be a composite of soil cores taken across a similar area. Limiting the sample to areas of 15 acres or less and taking a separate sample for areas with different crop histories, fertility management, crop growth, slope, etc. will help in collecting a representative sample. Avoid

Department of Crop and Soil Sciences — 1 — College of Agriculture and Life Sciences

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 1 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:

1. Cherney, J.H., Q.M. Ketterings. M. Davis, and D.J.R. Cherney (**2009**). Split application of nitrogen vs. dairy manure on temperate perennial grasses. Forage and Grazinglands (*accepted pending revisions*).
2. Turan, M., Q. M. Ketterings, A. Gunes, N. Ataoglu, A.V. Bilgili, and Y. Ming Huang (**2009**). Boron fertilization of mediterranean Aridisols improves lucerne (*Medicago sativa* L.) yields and quality. Acta Agriculturae Scandinavica, Section B - Plant Soil Science (*in press*).
3. Medvecky*, B.A., and Q.M. Ketterings (**2009**). Incorporation of legumes residues does not increase productivity of intercropped beans on smallholder farms in Trans-Nzoia District, Kenya. Biological Agriculture and Horticulture 26(4): *(in press)*.
4. Parsons, D., Q.M. Ketterings, J.H. Cherney, R.W. Blake, L. Ramirez-Aviles, C.F. Nicholson. (**2009**). Effects of weed control and manure application on nutrient fluxes in the shifting cultivation milpa system of Yucatan. Archives of Agronomy and Soil Science (*in pres*s).
5. Parsons, D., L. Ramirez-Aviles, J.H. Cherney, Q.M. Ketterings, R.W. Blake, and C.F. Nicholson (**2009**). Managing maize production in shifting cultivation *milpa* systems in Yucatan, through weed control and manure application. Agriculture, Ecosystems and Environment 133: 123-134.
6. Hunter, M., Q.M. Ketterings, J.H. Cherney, P. Barney, T. Kilcer, and G. Godwin (**2009**). Nitrogen needs of teff (*Eragrostis tef* (Zucc. Trotter) managed as forage crop in New York. Forage and Grazinglands doi:10.1094/FG-2009-0612-01-RS.
7. Gunes, A., N. Ataoglu, M. Turan, A. Esitken, and Q.M. Ketterings (**2009**). Effects of phosphate-solubilizing micro-organisms on strawberry yield and nutrient concentrations. Journal of Plant Nutrition and Soil Science DOI:10.1002/jpln.200800121.
8. Swink*, S.N., Q.M. Ketterings, L.E. Chase, and K.J. Czymmek, and J.C. Mekken* (**2009**). Past and future phosphorus balances for agricultural cropland in New York State. Journal of Soil and Water Conservation 64(2):120-133.
9. Dietzel*, K., Q.M. Ketterings, and R. Rao (**2009**). Predictors of lime needs for pH and aluminum management of New York agricultural soils. Soil Science Society of America Journal 74(2): 443-448.
10. Turan, M., F.M., Kiziloglu, and Q.M. Ketterings (**2009**). Phosphorus management of Lucerne grown on calcareous soil in Turkey. Journal of Plant Nutrition 32: 516-535.
11. Lawrence*, J.R., Q.M. Ketterings, M.G. Goler*, J.H. Cherney, W.J. Cox and K.J. Czymmek (**2009**). Accuracy of the Illinois Soil Nitrogen Test (ISNT) in predicting N responsiveness of corn in rotation. Soil Science Society of America J. 73(1): 303-311.
12. Turan, M., A. Dursun, N. Ataoglu, A. Gunes, M. Ekinci, T. Oztas, Q.M. Ketterings, Y. Ming Huang (**2009**). Yield and chemical composition of Brussels sprout (*Brassica oleracea* L. gemmifera) as affected by boron management. HortScience 44(1):176-182.

2008:

13. Soldat*, D., M. Petrovic, and Q.M. Ketterings (**2008**). The effect of soil phosphorus levels on phosphorus runoff concentrations from turfgrass. Water, Air, and Soil Pollution DOI:10.1007/211270-008-9857-y.
14. Lawrence*, J.R., Q.M. Ketterings, J.H. Cherney, S.E. Bossard, G.S. Godwin* (**2008**). Tillage tools for manure incorporation and N conservation. Soil Science 173: 649-658.
15. Lawrence*, J.R., Q.M. Ketterings and J.H. Cherney (**2008**). Effect of nitrogen application on yield and quality of first year corn. Agronomy Journal 100: 73-79.

16. Angin, I., M. Turan, Q.M. Ketterings, and A. Cakici (**2008**). Humic acid addition enhances B and Pb phytoextraction by vetiver grass (*Vetiveria zizanioides l. Nash*). Water, Air and Soil Pollution 188: 335-343.

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18. Ketterings, Q.M., J.H. Cherney, G. Godwin*, T.F. Kilcer, P. Barney, and S. Beer (2007). Nitrogen management of brown midrib sorghum x sudangrass in the Northeastern USA. Agronomy Journal 99: 1345–1351.
19. Haden*, V.R., Q.M. Ketterings, and J.E. Kahabka* (**2007**). Factors affecting the change in soil test P levels following manure and fertilizer application. Soil Science Society of American Journal 71: 1225-1232.
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22. Brock*, E.H., Q.M. Ketterings, and P.J.A. Kleinman (**2007**). Phosphorus leaching through intact soil cores as influenced by type and duration of manure application. Nutrient Cycling and Agroecosystems 77: 269-281. DOI: 10.1007/s10705-006-9065-3.
23. Medvecky*, B.A, Q.M. Ketterings and E.B. Nelson (**2007**). Relationships among soilborne bean seedling diseases, *Lablab purpureus* L. and maize stover residue management, bean insect pests, and soil characteristics in Trans Nzoia district, Kenya. Applied Soil Ecology 35: 107-119.
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26. Ketterings, Q.M., G.L Albrecht*, C.N. Rasmussen*, and K.J. Czymmek (**2006**). Cornell Cropware: Decision support tool for fertilizer and manure nutrient management planning. Journal of Natural Resources and Life Sciences Education 35: 140-151.
27. Klapwyk*, J.H., Q.M. Ketterings, G.S. Godwin*, M. Wang* (**2006**). Response of the Illinois Soil Nitrogen Test to liquid and composted dairy manure application in a corn agroecosystem. Canadian Journal of Soil Science 86(4): 655-663.
28. Brock*, E.H., Q.M. Ketterings, and M. McBride (**2006**). Copper and zinc accumulation in dairy and poultry amended soils. Soil Science 171:388-399.
29. Medvecky*, B.A., Q.M. Ketterings, and F. Vermeylen (**2006**). Bean seedling damage by root-feeding grubs in Kenya as influenced by planting time, cultivar, and crop residue management. DOI: 10.1016/j.apsoil.2006.01.008. Applied Soil Ecology 34(2-3): 240-249.
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Agronomy Fact Sheets:

1: Soil Sampling for Field Crops (6/3/2005)
2: Nitrogen Basics - The Nitrogen Cycle (6/3/2005)
3: Pre-Sidedress Nitrate Test (9/20/2005)
4: Nitrogen Credits from Manure (8/19/2005)
5: Soil pH for Field Crops (11/11/2005)
6: Lime Recommendations (3/4/2006)
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)
14: Brown Midrib Sorghum Sudangrass, Part 1 (11/23/2005)
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)
19: Soil Management Groups (6/13/2006)
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22: Cation Exchange Capacity (3/2/2007)
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