Nutrient Management Spear Program

College of Agriculture and Life Sciences

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

Program Update

1/9/2014
Department of Animal Science
Cornell University

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

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

Quirine M. Ketterings
Professor of Nutrient Management
Nutrient Management Spear Program team leader
323 Morrison Hall, Cornell University, Department of Animal Science, Ithaca NY 14853
qmk2@cornell.edu – (607) 255-3061

Karl Czymmek
Senior Extension Associate, Nutrient Management
PRODAIRY

Staff:
Greg Godwin
Research Support Specialist
Sanjay Gami
Research Associate
Shona Ort
Technician
Sheryl Swink
Research Aid
Melanie Soberon, Sebastian Cela, Pilar Berenguer
Postdoctoral Researchers
Gordana Jacimovski
Temp Staff
Lisa Fields
Free-lance Writer (assignments)
Peter Barney and Tom Kilcer
Consultants (hourly)
Yunchen Zhao
Visiting Professor

Graduate Student:
Emmaline Long
Animal Science

Undergraduate Students:
Rachel Breslauer, Marco Anichini, Lars Demander
Agricultural Sciences
Priya Sathaye
Animal Science
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 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.**
2014 New York On-Farm Research Partnership

In spring of 2012, we launched the “New York On-Farm Research Partnership”.

There is great power in coordinated on-farm research where field data are generated through well designed, repeated and widely implemented trials, with proper data collection and statistically valid analyses. Consider being an on-farm research partner! Our motto is: "Relevant Questions and Sound Science for Agricultural Profitability and Protection of the Environment". The On-Farm Research Partnership is a partnership of producers, the Cornell Nutrient Management Spear Program (NMSP), Agrinetix, and PRODAIRY. We aim to establish a statewide research partnership that enables us to pose relevant question (farmer and farm advisor driven priorities) and get these questions answered efficiently (large datasets), aiding in development of science-based guidance and implementation of both on-farm and whole-farm nutrient management practices.

2014 On-Farm Research Projects (to date)

- Liquid Manure Method and Rate of Application?
- Whole Farm Nutrient Balance Assessment
- Sulfur and Potassium Status of Alfalfa
- Nitrogen Needs of Winter Cereals as Double Crop in Corn Rotations
- Updating of the New York Corn Yield Potential Database
- Calibration of Forage Yield Monitors for Corn Silage and Alfalfa/Grass

If you would like to receive more information, have suggestions for future projects, would like to sponsor a project, or have general questions, contact Quirine Ketterings (qmk2@cornell.edu or 607-255-3061). You can also write to: Quirine Ketterings, Nutrient Management Spear Program, Department of Animal Science, Cornell University, 323 Morrison Hall, Ithaca NY 14853.

http://nmsp.cals.cornell.edu/NYOnFarmResearchPartnership/index.html

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Nutrient Management Spear Program – 1-9-2014

NMSP Extension and Applied Research Projects

------------------------------------------ONGOING PROJECTS------------------------------------------

New York State Phosphorus Runoff Index:
In 2009, as part of their effort to revise the 590 Nutrient Management Standard, the Natural Resources Conservation Service (NRCS) requested that a Working Group of scientists within the Southern Extension-Research Activity Group 17 (SERA-17) make recommendations for ways to evaluate and improve P Indices. Specifically, that group concluded that a rigorous evaluation of P Indices is needed to determine if they are directionally and magnitudinally correct. While use of observed P loss data under various management scenarios is ideal, such data are not widely available. Alternatively, use of a locally relevant and validated water quality model may be the most expedient option to conduct Index assessments in the short time required by the newly revised 590 Standard. As a result of this, three regional consortiums developed and have prepared CIG Projects, which are being considered to evaluate, assess, validate, and refine P Indices in the Heartland, Chesapeake Bay, and Southern Regions. The Chesapeake Bay proposal stems from a national call for P Index advancement and builds upon a long, strong history of collaboration amongst project partners. Members of the project team worked closely in coordinating the development of P Indices in the Chesapeake Bay region. Building upon these efforts, we proposed to further unify nutrient management planning within the region by harmonizing state P Indices within the major physiographic provinces of the Chesapeake Bay watershed. This approach reflects the common conditions and management practices that are found within these regions, consistent with NRCS’s MLRA classification, and provides a model for extrapolating project outcomes outside the bounds of the Chesapeake Bay watershed. The project has four major objectives: (1) Establish a network of 11 watersheds within the four major physiographic provinces of the Bay watershed for foundational evaluation of nutrient management site assessment tools; (2) For each physiographic province, identify site conditions and practices of priority concern and corresponding remedial practices of greatest efficacy and adaptability, (3) Evaluate P site assessment tools in the 11 watersheds by comparing their output with water quality monitoring data and fate-and-transport models (4) Use water quality data (monitored or predicted by model) to refine P Indices, improving their prediction of P loss potential, ensuring consistency across state boundaries and within physiographic provinces, and promoting effective recommendations for P management, and (5) Predict the management impact of P Indices (existing and refined) on nutrient management practices and water quality. We are currently working with our counterparts in the watershed and local stakeholders on the evaluation of performance of the current P index and possible refinements.

Yield monitors for whole farm evaluations and on-farm research
Work with case study farms in central and western New York over the past five years has shown that great improvement can be made in nutrient use efficiency when detailed farm, feed, and field records are kept. Such progress, monitored using annual Nutrient Mass Balance (NMB) assessments, can be made while maintaining or increasing milk production illustrating the potential for a win-win situation for farm profitability and environmental protection. To achieve the desired nutrient reductions and increased efficiencies accurate farm and field yield records are essential. Experience to date has shown that accurate yield records are the major bottleneck on many farms for diagnosing causes of high nutrient balances, identifying solutions, designing rotations that feed the cows in a sustainable way, and confidently managing nutrients on a field by field basis. Because home-grown forage and grain production impact all aspects of the farm
(economics, nutrient use, environmental footprint, risk management, cost of production), without accurate yield records, it is nearly impossible to systematically measure progress at the field level, much less identify where the largest nutrient use efficiency gains can be made. Thus, accurate yield records are needed, not just to evaluate the Cornell yield potential database, but also to help farms to quicker achieve nutrient reductions. Initial funding to work with the three case study farms and corn fields was obtained from an USDA-NRCS Conservation Innovation Grant. Additional funding was obtained recently from NESARE (graduate student grant) to also evaluate alfalfa harvests. This project is conducted in collaboration with Agrinetix and three New York case study farms (more detailed assessments). This is the focus of the MS degree program of Emmaline Long.

**Nitrogen needs for winter cereals grown as double crops (forages)**

Cover crops have received increasing interest from farmers in recent years. The reasons vary from erosion control and nutrient uptake to improved soil quality, increasing organic matter and field trafficability. Due to the drought in 2012, more farmers are interested in growing winter cereals as double crop, benefiting from the protection offered by cover crops and harvesting the cereal as forage in May to increase per acre crop yields. Properly managed, these crops can supply 2-4 tons of dry matter per acre, and in some fields in 2012 we measured up to 5 tons of dry matter of high quality forage from winter cereals planted after corn silage, even with little growth in the fall. Our main question with growing winter cereals for forage is: how much N do we need at green-up for optimal economic yield? On-farm trials are needed this spring of 2013 to quantify crop response to N addition at greenup. Currently we have 40 farm sites committed to the project (four times replicated trials with five N rates per farm site). The project is jointly funding by the Northern New York Agricultural Development Program (NNYADP), Federal Formula Funds, and USDA-NRCS Conservation Innovation Grant (Chesapeake Bay).

**Potassium (K) needs for alfalfa**

Potash prices reached historic highs a couple of years ago ($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\(_2\)O ($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 and are currently working with 6 farms funded by a grant from the New York State Farm Viability Institute (NYFVI) and Federal Formula Funds. 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 are conducting 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. This study resulted in an honor’s theses by Chang Lian, Agricultural Sciences major, and Yike Bing, Animal Science major. The studies are conducted in collaboration with Agricultural Consulting Service, ConsulAg, Miner Institute, and Cornell Cooperative Extension field crop educators. A continuation that combines field validation for findings for K and sulfur (S) management is ongoing, supported by NESARE (see project listed below).

**Nitrogen dynamics following cover crop incorporation in corn silage cropping systems.**

Cornell N guidelines for corn recognize N benefits of alfalfa/grass in the rotation and hence reduced N fertilizer need for first year corn but specific N discount is given to N credits from cover crops. Dairy producers often apply 100-150 pounds or more of actual N to 2nd or higher year corn, especially if no manure is applied. If a cover crop can reduce N use, saving for farmers can be substantial ($20 to $30/acre). A survey is currently being conducted to document cover crop success stories and identify barriers to implementation as well as document farmer input on extension and research related to cover crop use in corn silage systems. Preliminary monitoring of N dynamics following turnover of a cover crop showed that both clover and rye cover crops can accumulate a considerable amount of N. Monitoring of N dynamics following clover cover crops in 2007 and 2008 in the organic cropping systems trial showed large nitrate peaks mid-June and no crop response to additional N while work in NNY indicated no difference in N release from rye versus triticale and equal N release from chemically and mechanical termination of the
cover crop. N release from a 4 ton rye crop rolled in June was limited versus a large N supply following plowdown of 2 ton of rye early May. Laboratory incubations showed the importance of the carbon (C) to N ratio in determining the timing of N release and monitoring of a rye crop on a central NY farm: rye had to be turned over before mid-May for a C:N ratio less than 30 to avoid N immobilization. However, the current research database on N dynamics and potential fertilizer savings is too small to make changes in our Land Grant University guidelines for corn. Additional quantification work is needed on a larger number of soil types and under varying weather conditions and the first on-farm trials are being implemented this fall. The research was completed and report and article writing are in process.

**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 critical levels for tissue and soil testing using a new CaCl\(_2\) method; and (3) stimulate S use where needed for improved alfalfa production, enhanced farm profitability, and protection of the environment. Field work for this project was completed (8 sites in 2008 and 2009) in collaboration with Cornell Cooperative Extension field crop educators, resulting in critical values for a new soil test and documentation of S deficiencies for New York State. A factsheet was developed on the basics of sulfur. Two journal articles were published (Soil Science Society of America Journal, 2011 and 2012). This project was continued as a joint project that combines field validation for potassium and sulfur management, supported by NESARE.

**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 Nitrogen Test or ISNT) 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.cals.cornell.edu/projects/Nitrogenforcorn.asp](http://nmsp.cals.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 now. In addition, we calibrated a corn test (late season corn stalk nitrate test, CSNT) for use in New York as a “post-season” evaluation of N management. The results of the ISNT work were published in the
Soil Science Society of America Journal (2006-2009) and presentations on New York ISNT and CSNT work were given throughout the US. 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. Four journal articles were published for work in the ISNT. A new article on the CSNT is in review. In 2013, two new factsheets were developed to introduce adaptive management for corn as a strategy for nitrogen management: #77: Nitrogen for Corn; Management Options and #78: Adaptive Management of Nitrogen for Corn.

Whole-farm mass nutrient balances and farm analysis:
We work with New York State producers (2005-2012) 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 400+-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 sponsored a project on identification of nutrient management efficiency indices in support of performance-based planning of nutrient use on dairy farms and USDA-NRCS funded our current work on development of a more streamline process. A journal article was published in the Journal of Natural Resources and Life Science Education in 2013 and two new publications are currently being written. Additional mass balances are being collected for the 2013 calendar year in collaboration with the Upper Susquehanna Coalition.
**Whole Farm Agricultural Environmental Indicators Evaluation**

Whole farm mass nutrient balance assessment tells us if there are opportunities for improvements that lead to more sustainable farming systems but do not give us specifics for management changes. In this project, we work with seven case study farms and each farm’s crop and herd consultants to collect and analyze feed, manure, and crop records needed to calculate farm nutrient use efficiency measures. Effective record-keeping requires knowing what records to keep and how to best summarize the records so that conclusions can be drawn and management decision made. Identifying what is most important for determining farm resource use efficiency is one part of this project. In addition, identifying the most effective ways to get the records to “speak” to dairy managers is an important part of the process. The information represented by records kept on hundreds of cows for any number of days, or hundreds of fields cannot be understood until it is summarized in some way. This project is working to identify: (1) indicators for herd, crop and feed management systems that support improved farm efficiencies and reduced Mass Nutrient Balances; (2) records which need to be kept to facilitate annual whole farm analysis and intra-annual milk and crop production efficiency analysis; and (3) reporting formats farm managers find most useful for record summarization. This information will allow us to develop a cohesive farm record-keeping and feedback system that reports on information which farm managers can use to improve farm resource use efficiency. In this system the more frequent records kept from the milk production system can be combined with the seasonal crop records on an annual basis for a comprehensive whole farm performance analysis. In addition, the intra-annual feedback from, and management changes to the milk production or crop production systems allow farm managers to understand the ramifications of decisions on a whole farm balance. The initial project was funded by Northeast Sustainable Agriculture Research and Extension (NESARE). Continued work is focusing on use of the corn stalk nitrate test and yield monitoring with funding from the Northern New York Agriculture Development Program and a USDA-NRCS Conservation Innovation Grant.

**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.cals.cornell.edu/projects/nandpmanagement.asp](http://nmsp.cals.cornell.edu/projects/nandpmanagement.asp)) is funded with Federal Formula Funds and New York Farm Viability Institute funds. Collaborator is Jerry Cherney, Forage Specialist at Cornell University. This will be one of the project sites for a study on the biological buffering capacity of soils.

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**COMPLETED PROJECTS**

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**Can manure replace starter nitrogen fertilizer for corn grown on high fertility sites?**

Cornell guidelines reflect high probability of a starter N response where manure has not been applied recently, but, unlike P, we have not adequately tested the possibility of eliminating starter N fertilizer on manured sites or in other words, replacing the need for fertilizer by applying manure. Elimination of starter N use without yield/quality penalty in fields with fall or spring applied manure can lead to substantial savings in fertilizer as well as labor costs during the already busy planting season. Timely planting is essential in the short growing season of NNY so not having to refill fertilizer boxes during the planting season will have benefits for corn yield and quality. Recognition of the fertilizer value of the manure might further stimulate producers to distribute the manure over a larger acreage.

The results of a pilot project on starter N needs on a western NY dairy farm showed N could be eliminated from the starter without a penalty in corn yield or silage quality (potential milk production per ton of silage), although a first year corn (after alfalfa) field yielded corn silage with a slightly lower protein level when N was eliminated from the starter. In 2007, we also analyzed the silage for feed quality parameters. The data showed eliminating starter N did not impact any of the silage quality parameters in the 4th year corn site in 2007. However, adding 60 lbs N/acre did significantly increase crude protein levels in 1st year corn. Yet, this increase in crude protein did not seem to impact the overall silage quality expressed in tons/acre or milk per acre. Based on these results, we successfully applied for Federal Formula Funds which enabled us to conduct additional trials (2009-2011). The manuscript was published in 2013 (Agronomy Journal).
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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.cals.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).

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 (AlCl₃ 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. The project involved CCE educators from 6 Northern NY counties.

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 an aerator 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. The work indicated a 1-2 ton/acre yield increase with incorporation of manure and no difference in yield or N conservation between the aerator and chisel incorporation technologies. Similar trials are ongoing in the Mid-Atlantic region (collaborative effort with the Chesapeake Bay states). A journal article was published in Agronomy for Sustainable Development in 2013 and extension articles were written as well (see http://nmsp-cals.cornell.edu/projects/Manureapplicationmethods.html).

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.cals.cornell.edu/projects/starterp.asp.

The fully integrated 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, reflecting a 20% decrease from 2000 to 2007! In comparison, nitrogen sales have been fairly constant since 2000 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. One journal article was published and a second one is in press. Three journal articles were published based on this work, including two impact documentation articles.

**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.cals.cornell.edu/projects/bmr.asp](http://nmsp.cals.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.cals.cornell.edu/projects/bmr.asp](http://nmsp.cals.cornell.edu/projects/bmr.asp).
Comparison of lime requirement tests for New York

Until recently 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, led by Dr. Renuka Rao, Director of CNAL, was 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.

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.cals.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. Quantification of the uncertainty (Cornell student Scott Grandt honor’s thesis, see below) showed 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. This work was published in Soil Science in 2002. Since then an assessment of seasonal variability of soil testing parameters and the impact on conversion equations has shown the models to be more reliable when samples were taken in the fall. This study, published in Soil Science in 2010, was a collaboration with Song Chunyu, Research Fellow, Key Laboratory of Mollisols Agroecology, Northeast Institute of Geography and Agroecology, Chinese Academy of Sciences, Harbin, China and with numerous consultants and extension educators who did the soil sampling.
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 was published in the Soil Science Society of America Journal in the fall of 2010.

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.

**NMSP Extension Materials**

(websites and major documents)

*Nutrient Management Spear Program website ([http://nmsp.cals.cornell.edu](http://nmsp.cals.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.cals.cornell.edu/guidelines/nutrientguide.html](http://nmsp.cals.cornell.edu/guidelines/nutrientguide.html)). 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, is the official site for our Land Grant University Guidelines, contains tools for soil test conversions and has listed the soil test summaries. The site also features farmer and extension impact statement for major projects and the stories of students reflecting on their time as an undergraduate or 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.cals.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 4-credit course in whole farm nutrient management (ANSC4120).

**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.cals.cornell.edu/publications/articles/extension/PBalance2006.pdf](http://nmsp.cals.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 was published in the Feb/March 2009 issue of the Journal of Soil and Water Management and a follow-up article was published in the Journal of Environmental Quality in 2012.

**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.cals.cornell.edu/publications/soil_test_summaries.asp](http://nmsp.cals.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 then CNAL director Dr. Renuka Mathur.

**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.cals.cornell.edu/publications/pindex.asp](http://nmsp.cals.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. A new USDA Conservation Innovation Grant in collaboration with partners in the Chesapeake Bay Watershed now enables us to re-evaluation of
the P indices in the region. The project is entitled “Refining and Harmonizing Phosphorus Indices in the Chesapeake Bay Region to Improve Critical Source Area Identification and to Address Nutrient Management Priorities”.

**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 Cropwar website: [http://nmsp.cals.cornell.edu/software/cropware.asp](http://nmsp.cals.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**. In 2011, Cornell Cropware technical support and software development responsibilities were transferred to Farm Information Technologies, LLC. This transfer to the private sector allows for more timely updates than we have been able to supply Cropware users with these past many years. It will also allow us here at the Cornell Nutrient Management Spear Program to focus more on applied research and refining of New York State soil fertility and nutrient management guidelines for field crops. We work with Farm Information Technologies LLC as we work with all other private and public sector organizations who service New York State farmers to ensure full access to the Cornell nutrient management guidelines for field crops and deliver timely updates on those guidelines. Farm Information Technologies, LLC. has a list of the many suggestions Cropware users have offered us over the past five years. They have been working on the most urgent updates. The first release of Cropware Classic was October 2011; the first release of Cropware Plus was January, 2012.

**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.cals.cornell.edu/guidelines/factsheets.html). Most of the fact sheets are developed in collaboration with Cornell undergraduate and graduate students and Cornell Cooperative Extension field crop educators. Currently 53 fact sheets have been completed and posted to our website. This project has allowed Cornell students to experience and be part of extension. Among the latest fact sheets in the series include a factsheet developed by SUNY Cobleskill intern Joe Foster (Web Soil Survey) and factsheets written by Cornell interns from the Agricultural Sciences major. The series continue to grow and is the most popular and appreciated extension format on our website.

**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 Goodale, 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 (Hillary Bundick and John Weiss) followed by Eun Hong in the fall of 2009, and Joe Foster in the summer of 2010. 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.”
We teach “Whole Farm Nutrient Management”, an upper-level, undergraduate course offered through the Department of Animal Science at Cornell University. The course (ANSC4120) is designed for students interested in agricultural careers and aims to help them develop a working knowledge of agricultural environmental management. The course attracts student in agronomy, natural resources, engineering and animal science. Most students enter ANSC4120 with a limited background crop and soil sciences so initially the course 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 enrollment fluctuates between about 20 and 30 students each spring (total enrolment of 285 students in the past 10 years). The course includes five web-based learning modules (basics of fertility management).

The 2009 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.

In addition, two articles were published, one specifically focusing on the class itself, and a second one featuring one specific exercise conducted by the students in the class:


Impact through collaboration and integration of teaching, extension and research.

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

http://nmsp.cals.cornell.edu
Peer-reviewed publications (*indicates NMSP staff or student advisees):

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2013 (7 articles):

2012 (6 articles):


2011 (10 articles):

2010 (5 articles):

2009 (9 articles):

2008 (4 articles):

2007 (8 articles):

2006 (9 articles):

2005 (11 articles):

2004 (2 articles):

2003 (1 article):

2002 (4 articles):

2001 (1 article):

2000 (2 articles):

1999 (2 articles):
1997 (1 article):

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)
# 46: Nitrogen Management of Teff (9/19/2009)
# 47: Boron (12/15/2009)
# 48: Buffer pH to Derive Lime Guidelines (1/8/2010)
# 49: Manganese (4/30/2010)
# 50: Buckwheat Production: Planting (7/7/2010) (by Thomas Bjorkman)
# 51: Buckwheat Production: Harvesting (7/7/2010) (by Thomas Bjorkman)
# 52: Web Soil Survey (8/26/2010)
# 53: Manure Cost, Value and Time Management Calculator (8/26/2010)
# 54: Timing of Lime Applications for Field Crops (9/22/2010)
# 56: Winter Triticale Forage (12/17/2010)
# 57: Subsurface (Tile) Drainage Benefits and Installation Guidance (3/18/2011)
# 59: Magnesium for Field Crops (4/28/2011)
# 60: Nitrogen Credits from Red Clover as Cover Crop between Small Grains and Corn (4/20/2011)
# 62: Maximizing Forage Quality in Bunk Silos (9/8/2011)
# 63: Fine-Tuning Nitrogen Use on Corn (9/8/2011)
# 64: Forage Radishes (12/20/2011)
# 65: Fertility Management of Winter Wheat (12/20/2011)
# 66: Cornell Sulfur Test for Alfalfa (3/17/2012)
# 67: Can Manure Replace the Need for Starter N? (5/2/2012)
# 68: On-Farm Research (7/9/2012)
# 69: Adaptive Nutrient Management Process (7/22/2012)
# 70: Drought and Risk of Nitrate Toxicity in Forages (7/26/2012)
# 71: Measuring Corn Silage Yield (9/15/2012)
# 72: Taking a Corn Stalk Nitrate Test Sample After Corn Silage Harvest (11/21/2012)
# 73: Phosphorus Fertilizers for Field Crops (12/13/2012)
# 74: Soybean Fertility Management (12/13/2012)
# 75: Field Crop Fertilizer Management (12/13/2012)
# 76: Manure Use for Soybeans (12/13/2012)
# 77: Nitrogen for Corn; Management Options (10/2/2013)
# 78: Adaptive Management of Nitrogen for Corn (10/2/2013)
# 79: Zone/Strip Tillage (12/19/2013)
# 80: Urea Fertilizer (12/19/2013)

**Other Extension publications** (*indicates NMSP staff or student advisees):


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