# What's Cropping Up?

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## Where and When is Phosphorus Leaching From Manure Application a Problem?


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Phosphorus losses to our streams and lakes pose a serious environmental concern. P losses through runoff and erosion are a known concern, but little information exists about P getting into surface water by leaching to subsurface drains and then being discharged into surface ditches and streams. Previous studies have shown that considerable leaching losses of P may occur under certain scenarios: Soils that received high historical P applications, especially sands with low P-sorbing clay or iron and aluminum oxides, may readily exceed critical soil P levels and cause excessive P leaching. Drained muck soils may also show high leaching losses from mineralization of organic matter. And concern also exists with fine-textured soils that may not be P-saturated, but allow for rapid movement of fertilizer or manure P through preferential flow paths to the drains.

Management practices appear to affect P leaching losses as well. P applications on perennial forage crops may increase P losses compared to annually cropped lands due to higher number of continuous biopores. Dry antecedent soil conditions and longer periods between application and subsequent rainfall reduce P leaching from liquid manure application on clay soils.

Previous studies have thus shown that soil, crop, and management factors affect the leaching losses of P. Little information exists to separate the effects of these factors to make recommendations on the sound management of manure. We initiated this three-year study to quantify the transport of manure-derived P to drain lines under two crops (maize and orchardgrass) grown on two soil types (clay loam and loamy sand) as affected by timing of manure application.

### Methodology

P leaching studies were conducted at the Cornell University Research Farm in Willsboro, NY for the period 1997 to 2000. They were conducted on two soil type extremes: a Muskellunge clay loam and a Stafford loamy fine sand, each with sixteen subsurface-drained plots. At each site, eight plots were established in orchardgrass and maintained under a three-cut system, and the remaining plots were cropped under corn (Figure 1).

For corn, four different times of liquid manure application were used: Early Fall (target date 1 October), Late Fall (target date 1 November), Early Spring

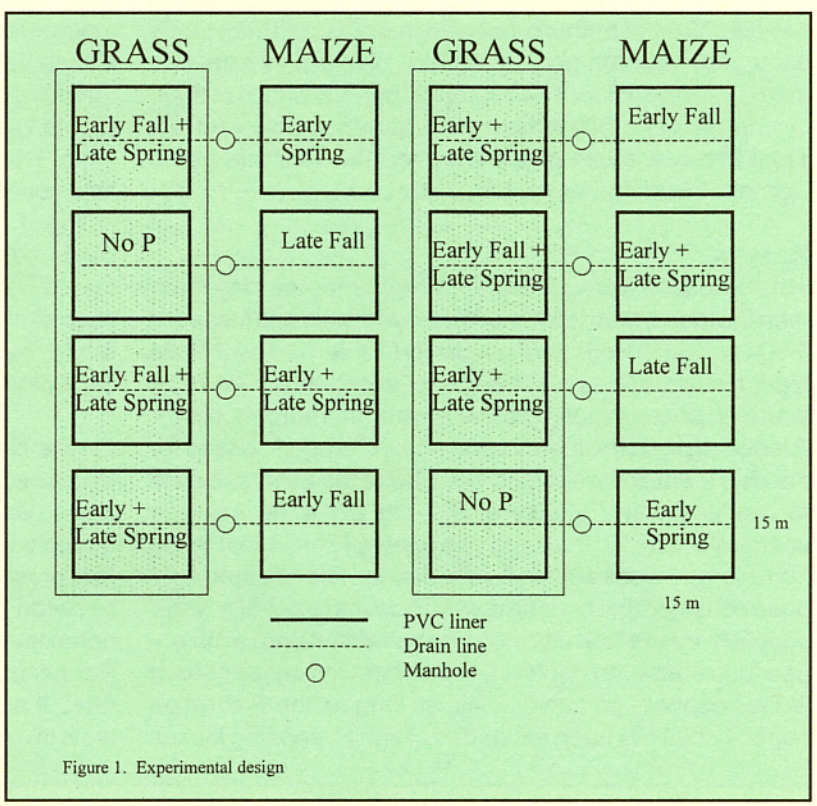


Figure 1. Experimental design

(target date 15 April) and a Split Application with half applied in Early Spring, and the remainder applied as sidedress in Late Spring (target date 15 June). Manure was applied at an annual rate of 10,000 gallons per acre in one application for both Fall and the Early Spring applications. For the springtime split application, two equal amounts of 5,000 gallons per acre were applied. These rates were chosen to supply the maize N requirements from spring manure applications.

Manure applications on corn were disk-incorporated (twice) within 3 hours after application, except for the late-spring sidedress application which utilized a four-unit drop hose system equipped with S-tine cultivators for immediate incorporation of manure between crop rows.

Grass plots received two equal applications of 5,000 gallons per acre, applied with the drop-hose system. Manure applied to grass was not incorporated, but left on the soil surface. One set of three plots on each site received manure applications in the Early Spring (target date 15 April), and after the first cutting in Late Spring (target date 15 June). Another set received manure after the first cutting (Late Spring) and after the third cutting (Early Fall, target date 1 October). Two grass plots at each site did not receive any P fertilizer or manure, but were topdressed three times each year with ammonium nitrate. Drain flow rate was measured and effluent was sampled during periods of drain discharge, generally in the spring, early summer, and fall. Total P content was determined for each sample at the Cornell University Nutrient Analysis Lab.

## Results

Total P losses were consistently higher for the clay loam than the loamy sand soil, with three-year average losses of 0.504 and 0.013 mg $L^{-1}$, respectively (Table 1). The 39-fold higher leaching loss indicates that the well-structured clay loam soil poses a much greater environmental concern for P leaching than the loamy sand soil. Average P losses for the clay loam soil were also well above the EPA guideline for surface water quality of 0.1 mg $L^{-1}$, while average concentrations for the sand site are well below that level. Therefore, regions with artificially-drained fine-textured soils pose considerable concerns with P losses to surface water supplies, even when allowing for spatial dilution in a mixed-use landscape. In contrast, P leaching losses appear of limited concern on sandy soils, as long as the P sorption capacity has not been exceeded. High P leaching losses can be explained by chemical transport through preferential flow paths. This notion is supported by the patterns of leaching losses, which showed short-term peaks in P concentrations, especially in periods following manure applications.

It is noted, however, that the No-P treatment (no manure or P fertilizer applied) under grass on the clay loam soil also shows considerable P leaching losses, with mean values equal to those of all manure application scenarios under maize and grass, except the early fall applications. This suggests that the risk for environmentally-significant P leaching losses in drained clay loam soils is high, even without P applications. The problem may be inherent with such soils if they are artificially-drained, possibly due to organic matter mineralization. The P additions from liquid manure applications did not cause any higher P losses under most management scenarios.

Mean P losses were not different between the corn and grass plots on the sand site, but P losses were significantly higher for the grass plots than the maize plots on the clay loam site (Table 1). This is presumably the result of higher preferential transport when the contaminant is not incorporated and the lack of tillage results in a more continuous macropore network. An analysis of seasonal patterns shows that drain water P levels can vary over orders of magnitude from one season to another for the clay loam soil (Table 1), with variations being especially high for the grass plots. P losses appear to be more related to the precipitation conditions during the season itself, especially the timing of rain events relative to manure applications. In this case, our data suggest that the early fall application resulted in the highest risk for leaching, although a three-year study may have been inadequate to establish this firmly. Seasonal variability was much lower for the loamy sand plots, commensurate with lower mean losses.

On the clay loam plots, high P concentrations were only measured when flow rates were also high, especially on the grass plots. This suggests that most P losses occurred during and immediately following periods of high precipitation, presumably through preferential flow. The relationship between flow rate and P concentration in drain water was nonexistent for the loamy sand plots. In fact, the highest P concentration was measured on a grass plot at a low flow rate. It appears that P transport through the loamy sand plots involved mostly uniform (matrix) flow.

## Conclusions

In a three-year evaluation of P leaching under identical weather conditions, we established that losses of P to drainage systems is strongly affected by soil type and to a lesser extent by timing of manure application. Mean P leaching losses, averaged over cropping systems and seasons of manure application, were 39 times higher for the clay loam than the loamy sand soil. This large discrepancy is attributed to rapid preferential flow in the clay loam. In real terms, the P losses to drain lines in the clay loam soil were well above the level of concern (0.1 mg $L^{-1}$) under all management scenarios, while those for the loamy sand soil were well below it. Early fall applications showed the highest P losses. Other studies have demonstrated further elevated manure leaching losses to drains in well-structured soils when application is followed by heavy precipitation on wet soils, but much of this can be avoided with careful scheduling.

Perhaps the most intriguing result of this study is that plots without any P application had the same P leaching losses as those with manure application (on the clay loam). It appears that P leaching through drained fine-textured soils inevitably poses environmental concerns, but risks are possibly augmented through manure applications (especially in the fall and on sods). Extensive drainage projects in P-sensitive watersheds with fine-textured soils should therefore be considered with caution. We finally note that the *nitrate* leaching losses measured in this study were higher for the loamy sand than the clay (see Czymmek et al. (2001), Vol. 11, No. 5), and fall application on corn was the greatest risk factor. The allocation of manure to fields, and the timing of application therefore needs to be linked to the water quality concern in the watershed, N vs. P.

For more detailed information on this experiment, contact Harold van Es at hmv1@cornell.edu or 607/255-5629 or visit www.css.cornell.edu/research/precisionag/.

This research was in part funded through the Northern New York Agricultural Development Program.

Table 1. Flow-weighted mean Total P losses for drain flow periods at the Clay Loam and Loamy Sand sites.

| Treatment | Winter 97-98 | Growing Season 98 | Winter 98-99 | Growing Season 99 | Winter 99-00 | Growing Season 00 | 3-yr Mean |
|---|---|---|---|---|---|---|---|
| **Clay Loam** | | | | | | | |
| Maize | mg $L^{-1}$ | | | | | | |
| Early Fall | 0.750 a† | 0.030 | 1.857 b | No Flow | 0.615 bc | 0.480 a | 0.609 b |
| Late Fall | 0.395 b | 0.032 | 0.121 c | No Flow | 0.092 c | 0.386 a | 0.266 c |
| Early Spring | 0.000 d | 0.093 | 0.189 c | No Flow | 0.309 c | 0.417 a | 0.284 c |
| Early + Late Spring | 0.000 d | 0.107 | 0.387 | No Flow | 0.191 c | 0.390 a | 0.289 c |
| *Mean* | *0.286* | *0.065* | *0.639* | No Flow | *0.302* | *0.418* | *0.362* |
| Grass | | | | | | | |
| Early Fall + Late Spring | 0.152 c | 0.012 | 5.866 a | No Flow | 2.883 a | 0.018 b | 1.441 a |
| Early + Late Spring | 0.000 d | 0.012 | 0.256 c | No Flow | 0.920 b | 0.178 ab | 0.194 c |
| No P | 0.000 d | 0.009 | 0.611c | No Flow | 0.805 b | 0.185 ab | 0.304 c |
| *Mean* | *0.051* | *0.011* | *2.244* | No Flow | *1.536* | *0.127* | *0.646* |
| *Site Mean* | *0.169* | *0.038* | *1.441* | No Flow | *0.919* | *0.273* | *0.504* |
| **Loamy Sand** | | | | | | | |
| Maize | mg $L^{-1}$ | | | | | | |
| Early Fall | 0.000 | 0.020 | 0.000 | No Flow | 0.000 | 0.000 | 0.004 |
| Late Fall | 0.000 | 0.010 | 0.000 | No Flow | 0.001 | 0.090 | 0.044 |
| Early Spring | 0.000 | 0.016 | 0.000 | No Flow | 0.000 | 0.011 | 0.009 |
| Early + Late Spring | 0.000 | 0.010 | 0.000 | No Flow | 0.001 | 0.000 | 0.002 |
| *Mean* | *0.000* | *0.014* | *0.000* | No Flow | *0.001* | *0.025* | *0.015* |
| Grass | | | | | | | |
| Early Fall + Late Spring | 0.000 | 0.019 | 0.000 | No Flow | 0.000 | 0.000 | 0.005 |
| Early + Late Spring | 0.000 | 0.012 | 0.000 | No Flow | 0.009 | 0.054 | 0.029 |
| No P | 0.000 | 0.001 | 0.000 | No Flow | 0.000 | 0.000 | 0.000 |
| *Mean* | *0.000* | *0.010* | *0.000* | No Flow | *0.003* | *0.018* | *0.011* |
| *Site Mean* | *0.000* | *0.012* | *0.000* | No Flow | *0.002* | *0.022* | *0.013* |
| Precipitation (mm) | 426 | 347 | 249 | 123 | 267 | 396 | Total 1808 |

Pest Management

# Section 18 Emergency Exemption Granted for Warrior on Alfalfa -- Grass Mixed Seedings

**E. J. Shields, Dept. of Entomology, Cornell University**

A section 18 emergency exemption has been granted by EPA for Warrior to control Potato Leafhopper in alfalfa-grass mixed seedings. The specifics for the exemption are listed below. Please become familiar with the specifics of the exemption before recommending use.

The Environmental Protection Agency hereby grants a specific exemption under the provision of section 18 of the Federal Insecticide, Fungicide, and Rodenticide Act, as amended to the New York Department of Environmental Conservation for the use of lambda-cyhalothrin formulated as Warrior with Zeon Technology, on alfalfa/clover/grass mixed stands to control the potato leafhopper. This specific exemption is subject to the condition and restrictions set forth in your request, as well as the following:

1. The New York Department of Environmental Conservation is responsible for ensuring that all provisions of this specific exemption are met. It is also responsible for providing information in accordance with 40 CFR 166.32. This information must be submitted to EPA Headquarters and to the EPA Regional Office.

2. The product, Warrior with Zeon Technology (EPA Reg. NO. 100-1112) manufactured by Syngenta Crop Protection, Inc. may be applied. All applicable directions, restrictions, and precautions on the federal label and section 18 use directions submitted with your application must be followed.

3. Apply 1.92 - 3.2 fl.oz. (0.015 - 0.025 lbs ai) per acre of Warrior with Zeon Technology to control potato leafhoppers. Apply as required by scouting and when populations reach determined economic thresholds. A maximum of 0.24 pints (0.03 lbs ai) per acre may be applied per cutting; a total of 0.96 pints (0.12 lbs a.i.) per acre may be applied per season. **(Less than label rates are not permitted)**

4. A maximum of 560,000 acres of alfalfa/clover/grass missed stands may be treated in New York State.

5. Time-limited tolerances have been established for residues of lambda-cyhalothrin on grass forage at 5.0 ppm and grass hay at 6.0 ppm. These time-limited tolerances are scheduled to expire on December 31, 2005.

6. Minimal adverse effects are expected for terrestrial animals, but that significant direct negative effects are expected for aquatic animals if lambda-cyhalothrin habitats via spray drift or run-off. Aquatic animals are extremely sensitive to this pyrethroid. The use directions had the following restrictions to mitigate concerns regarding bees and aquatic environments.

- Avoid applications when bees are actively foraging by applying during the early morning or during the evening hours.

- Do not apply by ground equipment within 25 feet, or by air within 150 feet of lakes, reservoirs, rivers, permanent streams, marshes, pot holds, or natural ponds. A 25 foot vegetated non-cropped buffer strip untraversed by drainage tiles must be maintained between a treated field and a coastal salt marsh or stream that drains into a coastal salt marsh for both aerial and ground application.

In addition, lambda-cyhalothrin is classified as a restricted use pesticide due to its toxicity to fish and aquatic organisms. It is for retail sale to and use only be Certified Applicators, or persons under their direct supervision, and only for those uses covered by the Certified Applicator's certification.

7. EPA shall be immediately informed of any adverse effects resulting from the use of this pesticide in connection with t his exemption.

8. This specific exemption expires on August 31, 2003.

9. A report summarizing the results of this program must be submitted by February 28, 2004.

10. Any future correspondence in connection with this exemption should refer to file symbol 03-NY-06.

This is the second year this use has been requested by New York for this chemical under section 18 of FIFRA. The regulations governing section 18 require the Agency to consider the progress which has been made toward registration of the proposed use if a repeated specific exemption is sought. Under the regulations, it shall be presumed that reasonable progress has not been made if a complete application for registration of a use, which has been under a specific exemption for any 3 previous years, has not been submitted. Similarly, the Agency applies a 5 year-year standard to IR-4 supported usses. Any future requests should fully address the topic of progress towards registration.

# Soybeans: Add the Inoculum but Forget the Starter N

**Bill Cox and Quirine Ketterings**
**Dept. of Crop and Soil Sciences, Cornell University**

Crop & Nutrient Management

Soybean acreage in New York increased from 20,000 acres in 1985 to 130,000 acres in 1999, but has remained about the same during the last 4 years. Consequently, most soybean growers in New York have produced the crop for at least 4 years so most of their fields have been planted to soybeans at least twice. Most growers routinely apply inoculum to soybean seed at planting, despite a field history of soybeans. A significant number of growers also apply a small amount of starter N fertilizer at planting to provide available N to soybeans in June before soybeans begin fixing their own N at the onset of flowering in early July. We conducted a 4-year study on fields that had been planted to soybeans previously at least 3 times to evaluate the response of soybeans to inoculum and starter N fertilizer.

When averaged across the 4 years, soybeans did not respond to inoculum or starter N fertilizer (Table 1). Soybeans, however, responded to inoculum in 2000 and 2001, years when significant drought did not occur. Soybeans did not respond to the inoculum in 1999 and 2002, low-yielding years because of severe drought. The cost of inoculum is less than $2/acre so growers should apply inoculum at all times to reap the yield benefit in years of no severe drought.

Soybeans did not respond to starter N fertilizer in any year of the study, including the cool and wet 2000 growing season (Table 1). Soybeans that received the starter N fertilizer were deeper green in color in June but this green color response did not translate into a yield response at harvest. These results suggest that soybeans do not require starter N fertilizer under New York growing conditions.

We recommend that soybean growers in New York apply inoculum to the seed at planting even in fields with a soybean history because of the likelihood of a response in years when there is no severe drought. Soybean growers in New York should not apply starter N fertilizer at planting because of the likelihood of no response even in cool wet years. Soybeans look greener in June but that does not justify the cost and time of applying starter N fertilizer.

Table 1. Soybean yields with and without inoculum and starter N fertilizer in 1999, 2000, 2001, and 2002 at the Aurora Research Farm.

| Treatment | 1999 | 2000 | 2001 | 2002 | Mean |
|---|---|---|---|---|---|
| | | ----------bu/acre---------- | | | |
| Inoculum† & Starter‡ | 32 | 45 | 42 | 24 | 36 |
| Inoculum | 31 | 44 | 42 | 26 | 36 |
| Starter | 31 | 43 | 40 | 25 | 35 |
| Check | 32 | 42 | 39 | 27 | 35 |
| LSD 0.05 | NS | 2 | 3 | NS | NS |

† Hi-Stick inoculant
‡ A liquid starter fertilizer was applied at 15 lbs N and 55 lbs $P_2O_5$/acre.

Nutrient Management

# Coming Attraction: Cornell Cropware v2.0

**Greg Albrecht[1], Caroline Rasmussen[1], Quirine Ketterings[1], Karl Czymmek[2] and Vajesh Durbal[3], [1]Department of Crop and Soil Sciences; [2]PRO-DAIRY, [3]Animal Science; Cornell University**

Many farms are following nutrient management plans to satisfy regulatory requirements as well as make more efficient use of manure and fertilizer. To be effective, this calls for integrating a number of crop production and environmental considerations. Cornell Cropware (Figure 1) is a software package that enables producers and their advisors to integrate Cornell's crop nutrient guidelines, the New York Phosphorus Runoff Index and the Nitrate Leaching Index. It contains equations that allow for conversion of soil test results from participating commercial laboratories to Cornell equivalents and allows for the integration of on-farm logistics to develop plans that fuel productive cropping programs and minimize losses to the environment in accordance with the Natural Resources Conservation Service Nutrient Management Standard (NRCS NY590).

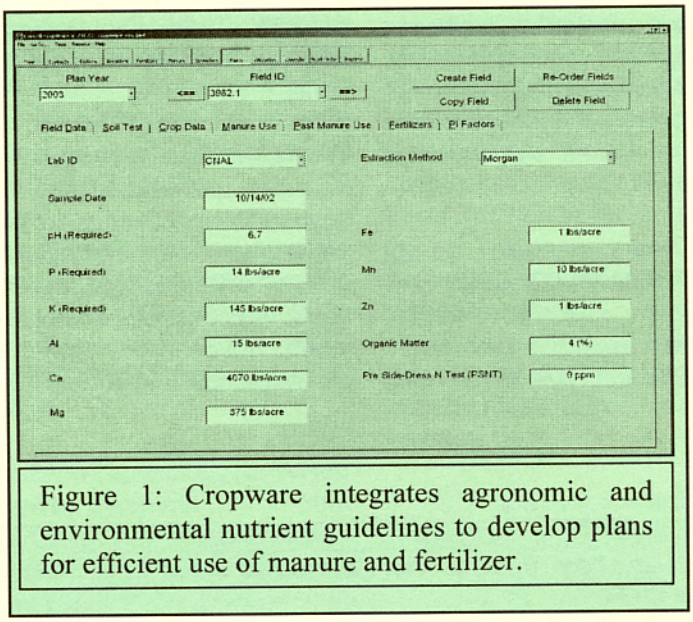


Figure 1: Cropware integrates agronomic and environmental nutrient guidelines to develop plans for efficient use of manure and fertilizer.

With support from NRCS, the NYS Department of Agriculture and Markets, and the NYS Department of Environmental Conservation, staff members of the Nutrient Management Spear Program (NMSP) at Cornell developed Cornell Cropware version 1.0 and released it to New York nutrient management planners in August of 2001. Currently, our staff supports over 250 registered copies and the software is being used to develop and maintain approximately 500 plans throughout New York State.

Combining research updates and user feedback from version 1.0, Cropware version 2.0 has been developed and is scheduled to be released for download from the Spear Program website (http://nmsp.css.cornell.edu) in mid-June. Funding for Cornell Cropware 2.0 was provided by USDA-NRCS.

Cropware version 2.0 contains the following enhancements:

- The Nitrate Leaching Index is now based on township-level precipitation data, thanks to Steve DeGloria, Quirine Ketterings, and Harold van Es of Crop and Soil Sciences, Karl Czymmek of Pro-Dairy, and Arthur Degaetano of Earth and Atmospheric Sciences. The result is a more site-specific tool for gauging leaching risk. The Nitrate Leaching Index manual has also been created and is available from the Spear Program website and in the Cropware Help section.

- Nutrient guidelines for a broad range of vegetable crops have been included thanks to help from Steve Reiners (Department of Horticulture at the Geneva campus), Don Halseth, Roy Ellerbrock, and Anu Rangarajan of the Department of Horticulture at the Ithaca campus.

- Soil test conversion equations have been added to translate University of Vermont Modified Morgan soil test values into Cornell Morgan equivalents. This addition builds on the list of laboratories for which conversion equations are available: Brookside Laboratories Inc., Spectrum Analytic Inc., and A&L Eastern Laboratories Inc. It is expected that more laboratories will be added in future versions of Cropware.

- Flexibility to plan up to two manure applications per field. Such a change better reflects field conditions and allows for a more accurate assessment with the New York Phosphorus Runoff Index.

- Plan data is housed in a Microsoft Access® compatible database form rather than in a text file; this facilitates information exchanges with other databases used by planners as well as with Geographic Information Systems for nutrient management plan map creation.

- Many additional improvements in data entry, organization, and report generation.

Cropware version 2.0 will be available to download free of charge from the Spear Program website, but a fast internet connection is recommended (e.g. cable modem, T1, DSL, etc.) as the installation package is 30 MB in size. Alternatively, a Cropware CD is also available free of charge. If interested in receiving a CD, contact Michelle Cole (607-255-7712 or mlc44@cornell.edu).

Training sessions for Cropware version 2.0 will be held later this summer. If you are interested in taking part in or hosting a training session in your area, please contact Greg Albrecht (607-255-1723 or gla1@cornell.edu) or Caroline Rasmussen (607-255-2875 or cnr2@cornell.edu). You are also welcome to contact Caroline and Greg for telephone and email support of Cropware version 2.0. The Nutrient Management Spear Program website (http://nmsp.css.cornell.edu) is regularly updated to offer relevant nutrient management information integrated into Cropware.

# Nutrient Management Spear Program Website

## Access to Nutrient Management Research and Extension for NY

Quirine Ketterings, Karl Czymmek, Greg Albrecht, Caroline Rasmussen, & Barb Dybwad, Department of Crop & Soil Sciences, Cornell University

Nutrient Management

The Nutrient Management Spear Program provides leadership for the crop and manure nutrient management extension program of the College of Agriculture and Life Sciences. The Spear Program aims to improve grower and agricultural industry awareness of crop nutrient needs, crop quality, management of organic wastes, and sound nutrient management practices to improve profitability and competitiveness of New York farms while protecting the environment. Research, extension and teaching programming involve collaborations across disciplines with faculty and staff in several academic departments at Cornell University, staff of the Pro-Dairy program, Cornell Cooperative Extension educators, New York State and federal government agency staff, agricultural industry partners and New York growers as well as counterparts in other states.

Spear Program staff and collaborators are involved in numerous research projects and in integration and extension of research findings through a capstone course in whole farm nutrient management, field days, workshops, extension articles, software development (see the announcement of the release of Cropware 2.0), and on-farm demonstration trials. Information on the Spear Program's mission, current research projects, extension events, publications and tools for nutrient management can be found at the program's website (Figure 1). Available from this site are manuals for the Nitrate Leaching Index, the NY Phosphorus Runoff Index, a web-based calculator and a spreadsheet for learning the basics of the NY P Index, documents on crop nutrient guidelines for nitrogen, phosphorus, and potassium, a growing list of county soil test summaries for 1995-2001, and a spreadsheet and web-based tool with equations that allow for the conversion of soil test results from three commercial laboratories and the analytical laboratories of the Land Grant universities of Vermont, Massachusetts, and New Hampshire. In addition, there are many other downloadable publications, including all "What's Cropping Up?" articles co-authored by program staff and collaborators in the past 3 years covering topics from brown mid rib sorghum sudangrass research to the New York Phosphorus Runoff Index.


Figure 1: The Nutrient Management Spear Program website (http://nmsp.css.cornell.edu/)

## Calendar of Events

| | |
|---|---|
| June 5 | Small Grains Management Field Day, Musgrave Research Farm, Aurora, NY |
| June 29-July 2 | Northeastern Branch American Society of Agronomy Meeting, Burlington, VT |
| July 8 | Seed Grower's Field Day, NYSIP Foundation Seed Barn, Ithaca, NY (791 Dryden Rd, Rte 366) |
| July 8 | Weed Science Field Day, Valatie, NY |
| July 15 | Weed Science Field Day, Aurora, NY |
| July 16 | Weed Science Field Day, Freeville, NY |
| August 1 | Aurora Farm Field Day, Musgrave Research Farm, Aurora, NY |
| October 21 | Field Crop Dealer Meeting, Comfort Suites, Clifton Park, NY |
| October 22 | Field Crop Dealer Meeting, Ramada Inn, New Hartford, NY |
| October 23 | Field Crop Dealer Meeting, Batavia Party House, Batavia, NY |
| October 24 | Field Crop Dealer Meeting, Holiday Inn, Waterloo, NY |
| November 2-6 | American Society of Agronomy Annual Meeting, Denver, CO |

*What's Cropping Up?* is a bimonthly newsletter distributed by the Crop and Soil Sciences Department at Cornell University. The purpose of the newsletter is to provide timely information on field crop production and environmental issues as it relates to New York agriculture. Articles are regularly contributed by the following Departments at Cornell University: Crop and Soil Sciences, Plant Breeding, Plant Pathology, and Entomology. **To get on the mailing list, send your name and address to Pam Kline, 234 Emerson Hall, Cornell University, Ithaca, NY 14853.**

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