

Cover Page

1. **Project Number:** LNE02-173
2. **Project Title:** Reducing Phosphorus Fertilizer Inputs for Field Corn Production
3. **Project Coordinator (PI):**

Quirine Ketterings, Assistant Professor
Nutrient Management Spear Program (NMSP)
Cornell University
817 Bradfield Hall
Ithaca, NY 14853
Phone: 607 255-3061
Fax: 607 255-7656
E-mail: qmk2@cornell.edu
Website: <http://nmssp.css.cornell.edu/>

4. Team Members

Coordination, research trial management, and extension

Karl Czymmek, Senior Extension Associate: Pro Dairy, Cornell University
Greg Godwin, Research Support Specialist: NMSP, Cornell University
Sheryl Swink, Program Support Specialist: NMSP, Cornell University
Greg Albrecht, Extension Associate: NMSP, Cornell University

On-farm experiments

Cornell Cooperative Extension (CCE) Educators that coordinated on-farm trials

1. Carl Albers, Agriculture/Natural Resources Program Leader: CCE Steuben Co.
2. Peter Barney, Sr. Extension Resource Educator: CCE St. Lawrence Co.
3. Shawn Bossard, Field Crops Extension Educator: CCE Cayuga Co.
4. Peter Carey, Agriculture Extension Educator: CCE Sullivan Co.
5. Janice Degni, Dairy & Field Crops, Area Extension Team Leader: CCE South Central NY
6. Maxwell Dayton, (formerly) Field Crops Extension Educator, CCE Saratoga Co.
7. Mike Dennis, Agriculture Resource Educator: CCE Seneca Co. (formerly in Oneida Co).
8. Dale Dewing, Field Crops/Water Quality, Sr. Resource Educator: CCE Delaware Co.
9. Aaron Gabriel, Crop and Soils, Extension Resource Educator: CCE Washington Co.
10. Kevin Ganoë, Area Field Crops Extension Educator: CCE Herkimer Co.
11. Nancy Glazier, NWNYS Dairy, Livestock & Field Crops Team: CCE Livingston Co.
12. Nate Herendeen, NWNYS Extension Field Crops Specialist: CCE Niagara Co.
13. Mike Hunter, Program Leader, Agronomy: CCE Jefferson Co.
14. Jeff Miller, Assistant Director, CCE Oneida Co.

15. Mike Stanyard, NWNV Dairy, Livestock & Field Crops Team Leader: CCE Wayne Co.

Other non-CCE participants:

1. Elaine Dalrymple, Schuyler Co Soil and Water Conservation District
2. Mike Davis, Research Associate, E. V. Baker Research Farm (Willsboro, NY)
3. Dr. Adam Khan, Chair, Department of Agricultural Science: Morrisville State College
4. Ralph Lott, Empire Farm (Empire Farm Days, Seneca Falls)
5. Mark Ochs, Consultant: Ochs Consulting
6. Dr. Gregory W. Roth, Professor of Agronomy: The Pennsylvania State University
7. Ronald D. Stutzman, Research Agronomist: Stutzman's Research Farm
8. Ev Thomas, W. H. Miner Agricultural Research Institute

Producers:

- | | |
|---|---|
| 1. Jerry Blumer (Weedsport) | 25. Kevin McCollum (Canton) |
| 2. Randy Brouillette (Waterville) | 26. Mike McMahon (Homer) |
| 3. Bill Brown (Hammondsport) | 27. Tom Moskin (Ava) |
| 4. Ken Burr (Trumansburg) | 28. Steve and Gary Natali, Natali Farms (East Springfield) |
| 5. Timothy Cantwell (Richfield Springs) | 29. Steven Nemeec, Grandview Farms (Moravia) |
| 6. Greg Coller (DeKalb) | 30. Ken Pemberton (Lisbon) |
| 7. Clark Decker (Stockholm) | 31. David Post (Hobart) |
| 8. William Elsworth (Greenwich Central School) | 32. Charlie Roberts (Fort Jackson) |
| 9. Dave Fisher and Lou Ann King (Madrid) | 33. Dave Schieferstine (Rome) |
| 10. Dudley French (Chemung) | 34. Joe and Kirk Schwasnick (Little Falls) |
| 11. Gary Gaike (Mecklenburg) | 35. Maurice Stoughton (Newark Valley) |
| 12. Jon Greenwood (Canton) | 36. Robert Sykes, Sykes Dairy Farms (N Branch) |
| 13. Mark Grocott (Edmeston) | 37. Richard and Steve Talcott, Ashland Dairy (Poplar Ridge) |
| 14. Les Hargrave (Depeyster) | 38. Glenn and Larry Taylor (Cassville) |
| 15. Tim and Mark Heiden (Madrid) | 39. Gary Teel (W. Barneveld) |
| 16. Sam Hendee, Hendee Homestead Farm (Hornell) | 40. Gary Tiernan (Chase Mills) |
| 17. Rick Holdridge (Bloomville) | 41. John Williams (Carthage) |
| 18. John Hourigan (Elbridge) | 42. Robert O. Williams (Waterville) |
| 19. Wilfred Hughson (Jeffersonville) | 43. Wayne Wood (Schuylerville) |
| 20. Mark Jahnke (Cooperstown) | 44. Marty Young (Cuyler) |
| 21. Bill Kilcer (Genoa) | 45. one additional producer who wished to remain unnamed |
| 22. David and Andrew Kross (Earlville) | |
| 23. Frank Lamport (Hobart) | |
| 24. John Maxwell (Geneseo) | |

Other CCE Educators that participated in the on-farm research workshop and project outreach activities:

1. Anita Deming, Executive Director, CCE Essex Co.
2. Kathe Evans, Extension Community Educator: CCE Madison Co.
3. Tom Kilcer, Agriculture Program Leader: CCE Rensselaer Co.
4. Dean Sprague, Field & Forage Crops Educator: CCE Cattaraugus Co.
5. Bruce Tillapaugh, Agriculture Program Leader/Field Crops: CCE Wyoming Co.

On-farm research instructors:

1. Francoise Vermeylen, Statistical Consultant: Cornell University
2. Chris Reberg-Horton, Sustainable Agriculture Specialist: University of Maine Cooperative Extension
3. Dr. Sjoerd Duiker, Assistant Professor of Soil Management and Applied Soil Physics, The Pennsylvania State University
4. Harold van Es, Professor, Crop and Soil Sciences: Cornell University

5. Funding

SARE Grant: \$118,485

Matching Non-Federal Funds: \$ 69,906

6. Project Duration

Three years (Official dates: August 1, 2002 - July 31, 2005 – project planning and implementation for first year trials started in spring 2002 in anticipation of contract establishment).

Narrative

Reducing Phosphorus Fertilizer Inputs for Field Corn Production

(LNE02-173)

1. Summary 5

2. Introduction..... 5

3. Objectives/Performance Targets..... 7

4. Materials and Methods..... 12

5. Results and Discussion/Milestones..... 17

6. Impact on Use of Starter Phosphorus for Corn – Starter P Survey Results..... 21

7. Economic Analysis 27

8. Publications and Outreach 2001-2005 29

9. Farmer Adoption..... 34

10. Areas Needing Additional Studies..... 34

1. Summary

Phosphorus accumulation on farms has led to high soil test P levels and increased P runoff and leaching from agricultural fields in many Northeastern states. Dairy producers have been facing increasing pressure to reduce phosphorus (P) inputs in the form of feed and fertilizer. However, many producers are concerned about sacrificing corn yield and quality if starter P fertilizer applications are reduced or eliminated for fields testing beyond the agronomic critical level. The central element of this project consisted of on-farm demonstration and research trials that evaluated the need for P addition in the starter band for optimum corn yield and quality. The aim of the NY Starter P Project was to reduce over-application of P fertilizer for corn on fields that test high or very high in P. In addition, we aimed to establish and strengthen research/extension collaboration among producers, extension, universities, agribusiness and agencies on issues of importance for the sustainability of agriculture (crop production and phosphorus loss to the environment in this case). We proposed to achieve these goals through the establishment of on-farm trials covering major agricultural production areas of New York State, through field days, extension meetings and documentation, and by working with a collaborative network of producers, agribusiness, university faculty and staff and regulatory agencies on on-farm field trials, dissemination of project results and impact assessment.

2. Introduction

In 2000, requests by and discussions with Cornell Cooperative Extension Educators and producers concerned about crop production and phosphorus losses from agricultural fields led to the establishment of the first ten on-farm trials on phosphorus needs for optimum yield and

quality of corn grown on high or very high P soils. In the following years, this initiative grew into a large collaborative network of on-farm demonstration trials focusing on testing starter P needs for corn. The 2001 New York Starter P Project involved 14 collaborators (Cornell Cooperative Extension, SWCD, consultants, and research/teaching farm managers), 24 participating producers and 27 on-farm trials. At several locations, a “no starter” treatment and a comparison with the producer’s blend and rate were added to the original starter with no P (200 lbs 10-0-10) and with P (200 lbs 10-10-10) treatments. Assistance of the NESARE grant allowed us to build on the enthusiasm and curiosity of our field crops extension educators, producers and other collaborators. Our on-farm trials were improved over earlier ones by providing extra training in research methodology to the cooperating extension field staff. As a result of the workshop, participation in the project by extension educators doubled and we established 65 on-farm trials (two or more replicates) and 13 research station trials (4 replicates) in those years, held field days and winter extension meetings and documented results through a collaborative network of producers, agribusiness, university faculty and staff, and regulatory agencies. Based on the trial results, we concluded that on sites that test high in P and have no manure applications planned for the season, no yield penalty are expected when P starter levels are reduced below 25 lbs P₂O₅/acre. On sites that test very high in P or when manure is applied to high testing sites, there is a low probability of a starter P response and P could be eliminated from the starter without a yield or quality penalty. Corn responded to N in the starter band more often than P and we continue to recommend 20-30 lbs of banded starter N, even where P is eliminated.

To increase producer, consultant and fertilizer dealer awareness about starter P, project results were extended through on-farm field days and farmer-attended events such as Empire Farm Days and the New York Farm Show, through a high presence at farmer

meetings, and backed up by a large number of articles in a variety of publications highly visible to the farming and dairy community. Surveys of the general corn producer population, interviews with Field Crops Extension Educators across New York State, and a survey of cooperating corn growers were carried out at the end of the project to evaluate its impact. Establishment and strengthening of the network approach we took with this project was essential for *timely implementation* of management practices that contributed to overall agricultural sustainability. As described in this report, it allowed the project to have major impact during project duration.

3. Objectives/Performance Targets

Performance Target 1: 30 corn growers in 2002 and 2003 will conduct on-farm replicated trials, and they will show increased interest in on-farm experimentation following the termination of the project. Of the producers, 25 will reduce starter P use to <20 lbs P₂O₅/acre following the termination of the project.

A total of 38 on-farm trials were completed in growing seasons 2002-2003 through the efforts of 12 extension cooperators and 30 corn producers. Nine of the producers participated both years. A few additional trials by other producers could not be used in the final analysis due to incorrect site selection (too low P) and a couple of trials were lost because of the weather (inability to plant in time – something that can never be avoided when doing field-based projects).

Participating farmers showed increased interest in on-farm experimentation even before termination of the project: at least 6 project participants conducted trials in other on-

farm projects between 2002 and 2004 in cooperation with their county field crop extension educator and the Nutrient Management Spear Program. In 2004, four participants also conducted trials for our Aminosugar N Project and/or implemented BMR sorghum trials with us. Several of the participants have indicated interest in cooperating with on-farm N rate studies in 2005.

In late March of 2005, a survey was sent to 44 producers who participated with on-farm Starter P trials in the period from 2000 to 2003. With 21 of the surveys returned so far, 10 (48%) reported increased interest in on-farm experimentation (4 have already participated in other on-farm experiments since termination of the Starter P project), and 11 respondents (52%) maintained the same level of interest (4 of those have participated in other on-farm experiments since termination of the Starter P project). Five respondents made suggestions for future on-farm research projects.

Reductions in starter P to <20 lbs P₂O₅/acre

In the March 2005 survey of 44 producers who participated in the Starter P on-farm trials, we requested information about their 2004 corn starter applications to help us evaluate changes in starter P applications since the end of the trials in 2003. Of the 20 cooperating producers who returned surveys with complete information on their starter P applications in 2004, 18 were dairies growing mainly forage corn and 2 were 100% grain corn producers. Thirteen (65%) of the responding participants, all dairy producers, applied no more than 20 lbs P₂O₅/acre to High to Very High soil test P fields in 2004, a year after the last on-farm trials. Two others, both dairy producers, were still applying more than 20 lbs/acre, but had made significant reductions (25-50% of their pre-project levels) and a third dairy producer made a small reduction (5%) but reported planting 2004 corn on Medium soil test P soils and at 27

lbs P₂O₅/acre was in line with Cornell phosphorus fertilizer guidelines for corn. Nine (45%) of the responding participants had reduced their starter P fertilizer applications and an additional 7 (35%) of the respondents started with and maintained P application rates at or below 20 lbs P₂O₅/acre. Overall, 80% of participants (89% of dairy producers) reduced starter P rates or are now using 20 lbs P₂O₅/acre or less with reductions ranging from 5 to 100%. Five (25%) respondents reported 2004 starter P rates of less than 10 lbs P₂O₅/acre.

Starter P application rates for 4 of the cooperating producers who responded to the survey actually increased. Three of these were growing mainly grain corn (2 grew only grain corn and were the only two non-dairies responding to the survey). In fact, those applying the highest rates of P (85 and 108 lbs P₂O₅/acre), were 100% grain producers with no dairy component or manure applications. By 2004, 83% of the dairy producers responding to the survey were applying starter P within the recommended range for the soil test P level of their fields as compared to 0% of participating grain corn producers. Thus it appears that dairy farmers have been the most responsive to reducing starter P fertilizer. This may be because they have become more aware of the phosphorus fertilizer value of the manure spread on their fields and the need to reduce P imports onto the farm.

Performance Target 2: 75% of New York corn silage and grain corn growers will be aware that starter P on high P soils and soils that receive manure is rarely needed.

Widespread dissemination of project results (see appendix with lists of articles written about the project and extension events that featured the study) resulted in a large audience awareness of the results of the project (although not all may know the actual source of information). Surveys showed that many were aware of the project and/or its findings; 72%

of 259 survey respondents at the Field Crop meetings (January-March 2004) and 90% of 30 respondents from the NY Corn Growers Association (largely grain growers) indicated they were aware that starter P is rarely needed on high P soils and soils that receive manure. It is anticipated that continued exposure to the results of the on-farm trials through extension events, farmer stories featured in farm magazines, and training sessions for consultants throughout 2005 as well as farmer to farmer sharing results in an even greater number of corn growers becoming aware that little or no starter P is needed on high P soils and soils receiving manure.

Performance Target 3: 30% of the registered farmer participants in field days and extension meetings will re-evaluate starter P use for corn within the duration of the project and reduce starter P use by 50% or more.

Since there was no practical way to follow up with participants of field days and extension meetings, we passed out postcard-like surveys to farmers who attended winter field crop extension meetings in early 2004 (Jan-Mar) to help us determine the impact of the project. We based our evaluation of objective 3 on responses of the survey respondents who indicated they were aware of the results of the starter P trials. We found that 51% had reduced the amount of starter P used on their corn as compared to five years earlier, before initiation of the very first on-farm pilot trials in 2000. However, only 21 (22%) of respondents that were aware of the Starter P trial results had reduced starter P use by the targeted 50% or more. Eleven (11%) respondents aware of the Starter P trial results were already using 20 lbs P₂O₅/acre 5 years ago and were still using the same rate at the time of the survey. Another 18 (19%) had reduced P in the corn starter by at least 25%.

Performance Target 4: Twenty extension field staff will be trained in on-farm experiment management, generate more reliable results with on-farm trials, and establish working relationships with producers that lead to continuation of on-farm experimentation following the termination of this project.

An on-farm research workshop was held on April 1 and 2, 2003 and attended by 16 Cornell Cooperative Extension Field Crop educators from around the state, 5 Cornell research staff, 2 extension researchers from the Cornell Waste Management Institute, and 2 guest presenters/participants from other Northeastern states. As a result of the workshop, participation in the project by extension educators doubled from 6 educators in 2002 to 12 in 2003. The quality and completeness of field data submitted from on-farm trials improved greatly. In 2003, there was only one 2-treatment trial (4%) as compared to 4-6 (22-25%) in earlier years, with the vast majority of the trials having 3 (42%) to 4 (54%) treatments and all with two or more replications.

When Field Crop educators who attended the workshop were interviewed at the end of 2004, their responses indicated the following:

- 92% found their understanding of trial design and data collection had been improved by the workshop, ranking it 3 to 5 on a scale of 1=no change to 5=greatly improved;
- 61% felt that the workshop had moderately to greatly improved the reliability of results from on-farm trials conducted afterwards;
- more than 50% have been involved in on-farm research with farmers who cooperated in the Starter P trials as well as with other farmers since the end of the Starter P Project.

4. Materials and Methods

On-farm trials

In 2001, 25 on-farm trials were conducted. Treatments included: (1) no starter, (2) no P in the starter (200 lbs of 10-0-10 in most cases), (3) 10-25 lbs of P₂O₅/acre in the starter (200 lbs of 10-10-10 in most cases), and (4) >25 lbs P₂O₅/acre. The latter category consisted of the producer's fertilizer blends and rates with actual P applications varying from just over 25 to 104 lbs P₂O₅/acre. The trials were conducted as strip trials in which each plot was at a minimum 4 rows wide and 100 feet long with many of the trials having greater plot sizes. We targeted fields with ≥ 7 lbs P/acre (Cornell Morgan test) where the P recommendations would have been 25 lbs P₂O₅/acre or less. Where needed, K was applied and extra N was broadcast and/or side-dressed.

In 2002, the wet, cold spring reduced the number of on-farm trials to 16 trials while in 2003, 22 trials were established. Each trial was conducted in 2 to 4 replicates per treatment and, as in 2001, the 2002/2003 plots were at a minimum 4 rows wide and 100 feet long. Corn varieties were determined by the producers and varied from 81-day to 109-day varieties. Regular (0-8 inch depth) soil samples were taken at planting (i.e. after any spring manure application). Analysis of these samples was limited to Morgan soil test P for 2001 on-farm trials (due to funding limitations) while in 2002 and 2003, a complete soil fertility assessment including pH_{water}, organic matter by loss on ignition, and Morgan extractable P, K, Ca, Mg, Fe, Mn, Zn, was completed. Pre-sidedress nitrogen tests were done at all sites in 2002 and 2003 when the corn was between 6 and 12 inches tall. All soil analyses were done at the Cornell Nutrient Analyses Laboratory using standard procedures.

Research Station Trials

In addition to the on-farm trials, studies were conducted on Cornell research stations and on the farm of Morrisville State College (Eastern NY) using a complete randomized block design in 4 replicates. In 2001, trials were established at the Aurora Research Farm (Central NY) and the Batavia Research Facility (Western NY). These trials included three treatments: (1) 200 lbs 10-0-10, (2) 200 lbs 10-10-10, and (3) 200 lbs 10-20-10. Plots were 8 rows wide and 50 feet long. In 2002, research station trials were established at the Mt Pleasant Farm (high elevation Central NY), Empire Farm Days (Central NY), the Aurora Research Farm, and Morrisville State College. At the request of participating extension educators, we added a no-starter treatment to the research trials. In 2003, trials were repeated at the Mt Pleasant Farm, the Aurora Research Farm, and Morrisville State College. All trials were planted using Pioneer 37M34, a 99 day variety. Trials were side-dressed with 100 lbs N/acre when the corn was between 6 and 12 inches tall. Harvests were determined and soil samples were taken and analyzed as for the 2002 and 2003 on-farm trials. None of the research station sites with the exception of the Morrisville location had a recent manure history.

Harvest Protocols and Quality Analyses

Most trials were harvested for silage. For grain trials, harvest data in bu/acre were converted to a silage equivalent assuming that 5.9 bu/acre of grain at 15% moisture equals 1 ton of silage at 35% dry matter. Silage harvest protocols were identical for all three years: where machine harvest of larger areas was not feasible given farm constraints, two rows (on-farm trials) or 4 rows (research station trials) of 40 feet were hand-harvested per treatment and replicate. Harvest was initiated when whole plant moisture content was between 60 and 70%. Fresh weights were noted and 5-plant subsamples were taken for moisture content

determination and forage quality analysis. The number of plants per harvest area was determined to allow for assessment of stand density at harvest. In 2001, forage quality analyses were done only for the research station trials (limited funds) while all trials were analyzed in 2002 and 2003. Subsamples were analyzed at the DairyOne Forage Testing Laboratory, Ithaca, NY for dry matter (DM), P, K, crude protein (CP), neutral detergent fiber (NDF), starch and 48 hours in vitro true digestibility (IVTD).

On-farm Research Workshop

The On-Farm Research Workshop held in April of 2003 was organized around needs expressed by the Cornell Cooperative Extension Field Crops Educators in preceding seasons. They were especially interested in gaining a better understanding of experimental design, statistical analysis of data and what factors are critical to obtaining reliable data from the field trials. Interactive presentations were made on experimental design for working farms with easily understood analogies used to illustrate concepts of field variability, noise and the value of replication within and across farms to validate results. Pros and cons of various trial designs were discussed from statistical and farmer implementation perspectives. Participants received hands-on experience with data analysis and processing using SPSS software. All participants also received a notebook to take home containing session notes and related handouts, protocols for the Starter P Project and two other initiatives, information on on-farm research funding available through Northeast Region SARE, and an annotated list of basic on-farm research resources.

Outreach Efforts

Timely and widespread communication of the results of each year's on-farm and experimental station trials through a variety of means was a key element in our strategy to increase producer, consultant and fertilizer dealer awareness about starter P. This was accomplished through the following means:

- Timely flow of material summarizing each year's trials to all County Field Crop Educators to use in newsletters, at their events, and as handouts (e.g., posters, What's Cropping Up? articles, Starter P Postcard). Many of the Field Crop Educators took advantage of these, publishing more than 18 newsletter articles on the starter phosphorus project results, hanging posters at several county fairs and other events, and distributing more than 700 Starter P Postcards (described below).
- Presentations by County Field Crop Educators and Cornell Nutrient Management Spear Program staff at more than 20 local and regional field days, crop meetings, and other farmer events. Farmers participating in the project were encouraged to share their experience at these meetings and field day events.
- In 2003, demonstration plots were set up at the Empire Farm Days location for viewing in August by farmers attending that event. Though it is a well-attended event drawing farmers from across the state and even Canada, we found that few of them ventured out to the demonstration fields and switched to a booth with posters in one of the dairy tents in 2003. This was much more effective, resulting in conversations with more than 100 farmers as compared to about 15 out in the demonstration site in 2002.
- Presentations and poster displays at 4 experimental farm field days, 4 statewide and northeast regional meetings, and 12 multi-county winter field crop extension meetings attended by farmers, consultants, feed and fertilizer dealers, and soil and water conservation professionals.

- Booths with poster displays at farm shows that are widely attended by farmers. In August 2003, we had a booth at Empire Farm Days in the Dairy Tent and in February 2004 at the New York Farm Show. These events draw thousands of visitors from throughout New York State and beyond and have many competing exhibits. At these events we held a daily drawing for donated prizes (certificate for a bag of seed, soil test kits) relevant to our target audience that was useful in attracting the attention of corn growers passing by. The drawing caused them to pause a moment, take note of the topic of the display and motivated them to fill out our brief starter P survey. They then took a closer look at our posters and asked questions about the project.
- Postcard handout summarizing findings. We designed a simple “Starter P Postcard” summarizing the results of the project along with basic starter phosphorus fertilizer guidelines that could be handed out at events such as Empire Farm Days or local field days and tucked into a farmer’s pocket for easy reference. Some of the county extension educators also included them in mailings to their newsletter subscribers. They have also been shared with local and regional policy makers. More than 2800 have been distributed to date.
- Connecting journalists with participating producers and extension educators for stories in farm magazines, submission of write-ups on the project by Cornell staff to ProDairy magazine and other farm periodicals targeting dairy and field crop producers, consultants and educators. This has been a very pro-active strategy for sharing the experience with the starter phosphorus trials in a variety of ways in order to catch the attention of a diverse audience and has resulted in the publication of 10 articles to date. A number of personalized Starter P stories based on interviews with cooperating producers and extension educators are in preparation for publication this summer.

- Incorporation of results into Certified Crop Advisor training materials and presentation of results at the 2004 National SARE conference in Burlington, Vermont.

It is our observation that of all approaches taken with regards to dissemination of results, the active participation of farmers in on-farm trials, the field days with tests where the audience was asked to identify the corn that had not received P fertilizer, and the postcard with results of the project seemed most effective.

5. Results and Discussion/Milestones

Milestones for Performance Target 1: Extension agents and corn producers will establish 25-30 on-farm corn field trials in 2002 and 2003. Of these trials, 75% will have a complete set of treatments.

A total of 38 on-farm trials were completed in 2002-2003 through the efforts of 12 extension cooperators and 30 corn producers. Nine of the producers participated both years. A few (additional) trials were lost due to incorrect site selection (too low P) and weather (inability to plant in time). The trials were conducted in 2-4 replicates per treatment as compared to single replications in 2000 and 2001. In 2003 96% of the trials had at least 3 treatments and of those, 54% were complete sets of 4 treatments. In 2003, a number of the trials with 3 treatments (7 or 29% of the trials) actually included 4 plots per repetition: the no starter, starter without P (200 lbs 10-0-10), starter with P (200 lbs 10-10-10), and a producer blend, but the producer blend was the same as one of the other treatments resulting in only 3 treatments for the purposes of analysis. If the producer blends had been different from all the other treatments, cooperators would have surpassed the target of 75% as 83% of the trials were laid out with 4 plots per rep.

Milestones for Performance Target 2: Results will be presented at the Field Crop Dealer meetings, CCA trainings, and winter meetings held by extension educators to reach 400 corn producers, dealers and consultants. Results will be documented as extension articles in newsletters, field handouts and web documents to reach 200 corn producers, dealers and consultants. Four replicated trials will be established at Willsboro, Aurora, Mt. Pleasant and Morrisville in 2002 and 2003, which will reach 100 corn producers, dealers and consultants. Trials will be established at Seneca Falls (Empire Farm Days) and Stutzman's in both years, which will be seen by 500 corn producers, dealers and consultants.

Results of the New York Starter Phosphorus on-farm trials and experimental field trials were presented at 12 Field Crop Dealer meetings, at CCA trainings, and more than 25 winter extension meetings, reaching more than 1200 corn producers, dealers and consultants. From 2002 through 2004, more than 26 articles were published in extension newsletters serving 22 counties and in What's Cropping Up?, the Cornell field crops newsletter, reaching a combined circulation over 6,800. In 2002, replicated trials were established at Empire Farm Days (Seneca Falls) and Stutzman's Research Farm. Due to low visitation (only 15 visitors) at Empire Farm Days in 2002, no trials were established at that site in 2003; instead we rented a booth for 3 days each at the August 2003 Empire Farm Days and the February 2004 New York Farm Show (Syracuse) in high traffic dairy-focused display tents to present the project and its results. The 2 booths drew over 200 farmers into discussion about the project. Although the field day at Stutzman's was well-attended in 2002, trials were not repeated there in 2003 because of a shift to liquid fertilizer, a lack of interest in holding a field day and a different research focus taken by Stutzman's that year.

Milestones for Performance Target 3: 500 corn producers, dealers and consultants will participate in field days and extension meetings. 100 corn producers will evaluate their starter P program. 60 corn producers will test a low-P program on their farm. 40 corn growers will adopt reduced or zero starter P as standard practice within the duration of the project.

Over 1,380 corn producers, dealers and consultants participated in field days and extension meetings over the term of the project, nearly 3 times our target of 500 participants which was met by the end of 2002. When interviewed at the end of 2004, field crops extension educators estimates indicate that 300-400 corn producers across the state had tested a low-P program on their farm and adopted reduced or zero starter P as a standard practice by the end of the 2004 growing season. Of the corn producers who filled out starter P survey cards at winter meetings in 2003 and indicated awareness of the results of the Starter P Project, 49 (51%) of the 97 producers who provided P use information had reduced starter P since 5 years ago. More than 39 (40%) of these producers had reduced P in their starter by 25% or more. In comparison, 20 (36%) of the 56 producers who provided P use information and indicated no awareness of the results of the Starter P project, had reduced P in their starter since 5 years ago. However, their reductions were less. Only 12 (22%) had reduced P in their starter by 25% or more.

Milestones for Performance Target 4: A workshop on on-farm research training for extension agents will be held in the late winter of 2002. All field crop extension agents and collaborators (25 people) will be invited, 20 will attend, 15 will actively participate in on-farm trials within the duration of the project (3 years).

The on-farm research workshop took place April 1-2, 2003 attended by 16 field crop agents and 7 staff members and collaborators. Some of the field crop agents are also administrators for their county extension program and were unable to get away for the workshop. Following the workshop, 12 field crop extension agents were motivated to participate in on-farm trials, twice as many as in the preceding year. Reasons given by other extension agents for not participating in on-farm trials in 2003 were basically related to work load and a feeling that they didn't have time to do it correctly. Thirteen people turned in evaluations at the end of the workshop –11 rated it “very useful,” one person rated it “somewhat useful”, and one wrote in “*Excellent – covered the items I really wanted.*” Comments about what was found useful in the workshop included:

“Statistics and experimental design were terrific (focus on skills needed for doing our job better.”

“Very good explanations of statistics.”

“The whole workshop was good. A good mix of presentation, hands-on and networking/social time.”

“Great background to experiment design.”

“Field design and plot layout info.”

Post project interviews with cooperating extension agents generated the following comments about the on-farm workshop:

“It (the workshop) gave me a lot more background to get started.”

“I know now how to set up the plots better and how to collect the data better.”

The workshop brought everyone together and helped them understand the value of contributing trials to a large, statewide data set:

“It was nice to be part of the big group doing it [Starter P Project]. I liked the guidance on it although whenever you do something for the first time you learn lots of things.”

“Enough cooperators around the state that essentially had replicates.”

Adherence to soil sample collection, site information collection, and harvest protocol in 2003 following the workshop was greatly improved over the previous seasons.

6. Impact on Use of Starter Phosphorus for Corn – Starter P Survey Results

Impact to date

The advantage of on-farm trials to making real management change is outstanding. Participants often made changes very rapidly after seeing the results in their own fields. This effect was amplified by holding field meetings in plots and having the neighbors take a look too. Additional measures have been taken to measure impact of this information. Over 350 corn producers were surveyed and according to this survey, the project convinced 17% of the corn producers surveyed to reduce starter P application. The actual reduction in P imports for farms that reduced starter P use in the past 5 years amounted to 377 tons of P₂O₅ (on almost 30,000 acres of corn land). Full impact of our activities on statewide fertilizer sales in New York can only be assessed once the NYS Department of Agriculture and Markets completes its annual fertilizer sales assessment for 2004 and onwards.

Do we expect further changes in the future?

Lack of awareness and lack of soil test P information may be holding many producers back from making reductions. More than 80% of producers that heard about the project and its

findings indicated that they are now likely to soil test regularly and change starter P rates as a result the project. In addition, a large percentage of those producers who had little or no familiarity with the project prior to exposure at the time they received the survey indicated an increased willingness to change P starter management. Twenty-eight percent of all survey respondents indicated that they did not soil test regularly (at least once every 3 years). It is expected that many of these producers and others who are becoming aware of the results of the New York Starter Phosphorus Project due to greater extension outreach since completion of the study and a possible new initiative in 2005 (First Year Corn Project) will now have their soil tested and make changes to their application rates based on the results. So, do we expect further changes in the future? Yes! It is expected from the results of this survey that at least 18-50% of those newly aware of the New York Starter P Project results will make some reduction in their application of starter P based on this awareness, levels of manure use and the results of soil tests. Just how much more change occurs will likely depend on the ease and economics of applying different starter blends and/or adjusting rates for fields with different P levels. In a recent survey of the producers who cooperated in the Starter P Project, we learned that some of them believe they could reduce the amount of P in the starter for their high or very high soil test P fields, but currently find it unfeasible for the following reasons:

“Do not have the ability to have 2 or 3 fertilizer wagons for different rates because of too small of total acres of corn.”

“Difficulty[in] timing and application of different fertilizer blends during planting.”

“Price of a specific mix is \$60-70 a ton more.”

“19-19-19 still seems to be my best buy and I need a simple plan with one blend.”

Comments like these, indicating that practicalities of implementation rather than disbelief are holding some producers back from reducing the use of starter P where it would be

appropriate led us to do an economic analysis of several reduced phosphorus scenarios (summarized later in this narrative).

Comments from Extension agents on what worked with this project and its impact on them and cooperating producers:

Learning and creating relationships by getting field research out on farms and in collaboration with producers was highly valued as shown by comments from extension educators:

“The idea of doing this type of research on farm is win-win for everybody. It gets me out on farms. Gets me involved in what they’re doing in the field, so from a base standpoint, it makes a huge difference. – The other thing is that the learning model that goes with this is one that works. You can’t make behavioral change by simply talking about it. – We have county specific research now. And we’re able to produce impacts far quicker than we’ve been able to do with traditional research.”

“The other valuable thing about doing demonstrations, that we haven’t mastered yet, is just getting in the field. It’s the relationships you build with those cooperating farmers. Our relationship grew because we spent that time together working on the project. I know them better. I spent some time on their farm. Now I understand their individual challenges better. I think, however knowledgeable somebody is, you only build knowledge by being in the field operating equipment, helping to do those things, experience it, all the things that go wrong. That just builds your capacity to relate to farmers to help them with other problems. It’s extremely valuable for an agent to grow their knowledge and skills as well as build credibility with the farmers.”

“It [the Starter P Project] was something easy to follow, put into practice with the farmer. For us, it made more opportunities to connect with farmers, get them involved. Working with them on projects like this gives them a chance to see results on their own farms. It is that much more believable to their neighbors. Lends more credibility to the recommendations we give.”

The value of an interactive, collaborative approach was shown too:

“I was very proud of this project. This was a project that to me brought field staff and department people together to the degree where each group respected the other group and what their abilities were and it showed that when we can drop barriers of field staff and university people and just attack a problem, the expertise is there and we can get a lot of work done in a hurry. I was very proud of working on this project because so many people pitched in.”

“The Cornell end was very helpful. And just to see the results as it progressed, not just the final report, to be involved with more input. It is really the data collection and reading the drafts and that part of it and then hearing it on campus with meaning, with discussion and progress. I liked that.”

“It was good to talk with everybody and hear what they were doing with their research trials. It was nice to be able to share equipment with somebody nearby.”

“To be honest, having the accountability of a commitment with someone else that is relying on the data makes sure that it gets done. Those things are important. Knowing at the end there’s going to be a meaningful analysis helps motivate to do it well.”

“Right from the very beginning it was a team approach. Everybody was doing a good job of communicating and things that needed to be done were done in a timely fashion. And that you feel a sense of accomplishment across the whole state because everyone got engaged to get this project done. And the outcome was the result of a very good collaboration.”

Impact on producers in their own words

Producers expressed what they liked about the Project:

“It showed me that you can grow corn with less phosphorus in the starter and still get a good yield and spend a little less and be more environmentally friendly.”

“Am concerned about P levels. Under CAFO we’re already unable to use manure on some fields. This project has shown starter P isn’t needed for good yields.”

How their farm benefited from participation in the Project was shown in the following comments:

“I use less P on high P soils.”

“We will be able to reduce pollution from excess phosphorus and save some money on starter by reduced phosphorus levels.”

“By raising the awareness of manure application rates with regard to nutrient (P) loading and how we may take steps to mitigate this issue by use of a manure storage facility.”

“I was willing to drop P from most of my corn starter.”

“It helped us to better understand starter phosphorus needs of the corn plant and cut down on our fertilizer cost.”

“Have confidence in reduced P use in corn.”

“Saved money on fertilizer and reduced P run-off.”

Impact on consultants

In the interviews with Cooperative Extension Field Crops Educators, 74% of them observed that crop consultants were aware of the Starter P trial results and are reducing P in management plans. Most of the other Field Crops Educators interviewed felt that they did not have enough contact with consultants in their region to comment.

Impact on availability of low P fertilizer blends

Impact of the results of the starter P trials on the fertilizer industry has been slow and this is one of the factors affecting producer adoption of low P starter on high P soils. In our interviews with Cooperative Extension Field Crops Educators across New York State, we found that although 74% of them feel that the fertilizer industry is getting the message that little or no starter P is needed on soils testing high in P, only 37% of them report that the fertilizer industry in their area has begun to change or add blends for high P soils. So far this seems to be offered through custom blending and bulk fertilizer grades, mostly used by larger corn producers. Last year, for instance, FS Gromark made two new bulk fertilizer grades available: 12-6-18 and 12-6-6.

7. Economic Analysis

At the 2003 Empire Farm Days, 75 producers from 30 New York counties filled out a survey on starter P use in corn. Of these producers, 37% grew more than 200 acres of corn, 25% had 100-200 acres in corn production while 37% had less than 100 corn acres. That winter, 274 producers (24 different New York State counties) answered the same survey questions during Cornell Cooperative Extension meetings. Of the latter group, 26% grew more than 200 acres of corn, 32% had 100-200 acres, and 42% had less than 100 corn acres. The combined groups represented over 72,000 acres of corn. The surveys indicated that the three most common starter blends were 19-19-19, 15-15-15, and 10-20-20 and that the average application rate was 250 lbs/acre (the equivalent of 48 lbs of P_2O_5 /acre). Based on these observations, we analyzed 30 complete dairy farm plans to answer the question: how many pounds of P_2O_5 can a dairy farm save by shifting from a standard starter application of 250 lbs of 19-19-19 (48 lbs P_2O_5 /acre) to soil-test based management for corn?

The acres of corn per farm ranged from 41 to 1,488 acres. The percentage of acres testing high or very high in P varied from 18% (corn acreage basis) on the farm with 41.3 acres of corn to 92% on a farm with 982.6 acres of corn. On average 50% of all corn acres tested high or very high in P (48% on total farm acreage basis – i.e. including non-corn fields). This is similar to distributions observed in the database of the Cornell Nutrient Analyses Laboratory (see *What's Cropping Up?* 14(5): 3-6). We analyzed four scenarios, comparing a standard application rate of 19-19-19 with 3 different approaches to reducing starter P: (1) all corn fields receive 250 lbs of 19-19-19, independent of soil test P level; (2) the application rate is reduced to 125 lbs of 19-19-19; (3) soil test based management following Cornell

recommendations (which implies a P-free starter and implementation of three rates of 19-19-19); and (4) a more producer friendly farm option with a P-free fertilizer for all fields that receive manure and/or test high or very high in P and 250 lbs of 19-19-19 for all other fields.

If we assume that all corn fields on the farm received 250 lbs of 19-19-19 per acre (scenario 1), P fertilizer imports onto the farms would have varied from 1,982 lbs P_2O_5 on the farm with approximately 41 acres of corn to 71,443 lbs P_2O_5 for the farm with 1,488 corn acres. Implementing a reduction in P application without shifting to two application rates (i.e. scenario 2; 125 lbs of 19-19-19 per acre for all corn fields) would reduce the average annual P imports by 11,244 lbs P_2O_5 per farm. Scenario 2 would not meet the P guidelines for all fields, and this could possibly impact corn yields on low P fields. Following Cornell guidelines (scenario 3) would have allowed for substantial reductions in P fertilizer imports. However, this scenario implies the use of two blends (a P-free blend and a P-containing blend) and 3 rates (125, 250 and 300 lbs of 19-19-19 in our example) for the P-containing blend and may not be practical on many farms. On 15 of the 30 farms, all high P fields were scheduled to receive manure. Shifting to a more practical management option of 250 lbs of 19-19-19 per acre for low and medium P corn fields that do not get manure and P-free fertilizer for all other corn fields (scenario 4), would have eliminated the use of P containing starter on 12 of the farms and reduced the average annual P fertilizer imports on the other 18 farms from 1,982-71,443 lbs of P_2O_5 under scenario 1 to 144-10,992 lbs of P_2O_5 under scenario 4. As shown by the results of the New York Starter P Project, in most years, this shift to scenario 4 is not likely to negatively impact yield or quality of the forage. However, regular soil testing is needed to monitor soil test P levels over time.

This analysis showed that soil test based management for corn starters can save dairy producers money without sacrificing yield or quality. Let's take a look at a few cost saving

examples. If we assume that 19-19-19 costs about \$270 per ton, shifting from scenario 1 (250 lbs of 19-19-19) to a reduced rate of 125 lbs 19-19-19 per acre the producer would save almost \$17 per acre for each field that did not need the extra P for optimum yield. If a producer is using 250 lbs of 19-19-19 per acre on fields testing high and very high in P and K, a shift to 115 lbs of ammonium sulfate per acre (approximately \$200 per ton of 21-0-0) would result in a \$22 per acre savings, while still providing a responsive amount of N in the starter fertilizer band (20-30 lbs N). A shift from 125 lbs 19-19-19 to 115 lbs of ammonium sulfate per acre (i.e. without altering the N application rate), would save the producer about \$5.50 per acre. Corn fields that are very high in P tend to be high in K as well. Soil test results will indicate if extra K (as well as lime) is needed. If we assume testing fields on a regularly scheduled basis (at least once in three years) with a minimum of one sample per 10 acres, savings in fertilizer expenses easily exceed the cost of collecting and analyzing soil samples. The economics of a reduction in P use were commented upon in a number of other local newsletter articles (see list of publications).

8. Publications and Outreach 2001-2005

The impact of the publications, presentations and extension events are described in the survey results and impact assessments discussed above. The Starter P Postcard mentioned above proved to be a very effective and versatile tool especially appreciated by the Extension educators as commented upon by one of the CCE participants:

“Change doesn’t happen instantaneously. It builds over time, so it’s maybe going up, more farms going that way this year after we’ve had several years of (a) farm

experience and (b) publicizing the research. When we sent the newsletter out this spring, we used those Starter P Postcards. It was a follow-up to earlier research plus this is a local farmer that has results. They were really effective – putting a quick summary out to the people. You got us a bunch – we put them right in the newsletters ... supporting that whole [starter P trial] concept – here they can flip that card over and see for themselves.”

The following is a list of the activities and written materials that were generated in the past 3 years.

New York Starter Phosphorus Project Presentations and Outreach Activities 2001-2005

Farm Shows:	Participants
Aug 5-7, 2003	113 Empire Farm Days – Starter P Project booth
Feb 26-28, 2004	100 NY Farm Show – Starter P Project booth
Aurora and Willsboro Field Days:	Participants
8/03/01	n/a Willsboro Field Day
8/15/01	80 Aurora Field Day
8/01/02	120 Aurora Field Day
8/01/03	85 Aurora Field Day
Starter P Presentations:	Participants
1/25/01	n/a Winter Crop Meeting 2001. Janice Degni. Ithaca, NY
11/6 and 11/7, 2001	n/a Field Days in Oneida County. Mike Dennis.
1/10/02	n/a CCE Schoharie’s Dairy Day 2002, poster presented by Lisa Field. SUNY Cobleskill.
3/01/02	15 Presentation 2001 Starter P results. Mike Dennis. Waterville, NY
2/02 and 12/02	76 Nutrient Management Workshops. Dale Dewing. Trout Creek, Delhi, Hobart, Prattsville, and Margaretville, NY

3/22/01	n/a	NY Starter P Project: results of the 2001 trials. CCTTS Nutrient Management Meeting. Quirine Ketterings. Ithaca, NY.
9/18/02	10	Summer's End Corn Plot Meeting at Teel Farm. Mike Dennis. Barneveld, NY
9/26/02	25	Feed/Fertilizer Meeting – Starter P update. Mike Dennis. Vernon, NY
11/18/02	n/a	Field Days in Oneida County. Mike Dennis.
2/25/03	n/a	Steuben County Crop Symposium. Bath, NY
3/11/03	22	Oneida County Crop Congress. Remsen, NY
3/12/03	n/a	2003 NRCS Water Quality Symposium. Binghamton, NY
6/17/03	n/a	NYS Soil and Water Conservation Committee Meeting. Starter P poster presentation. Ithaca, NY.
7/11-14, 2004	n/a	2004 NE ASA/SSSA meetings. NY Starter P poster presentation. Bordentown, New Jersey.
10/19-21, 2004	n/a	NE SARE 2004 Conference. NY Starter P poster presentation by Quirine Ketterings. Burlington, VT.

Written Publications

Published journal articles

1. Ketterings, Q.M., S.N. Swink, G. Godwin, K.J. Czymmek, and G.L. Albrecht. (2005) Maize silage yield and quality response to starter phosphorus fertilizer in high phosphorus soils in New York. *Journal of Food, Agriculture & Environment*. Vol. 3 (2): 237-242. (www.world-food.net)

Extension articles in *What's Cropping Up?* (Cornell field crops newsletter – direct circulation 325 but articles are often distributed more widely)

1. Ketterings, Q.M., G. Albrecht, M. Hunter, P. Carey, S.N. Swink, and K.J. Czymmek (2004). Whole farm starter phosphorus fertilizer imports. *What's Cropping Up?* 14(6): 3-5.
2. Ketterings, Q.M., S.N. Swink, G. Godwin, K.J. Czymmek, G. Albrecht (2004). New York Starter Phosphorus Project – Does starter P fertilizer impact silage quality? *What's Cropping Up?* 14(5): 1-2.
3. Ketterings, Q.M., S.N. Swink, G. Godwin, K.J. Czymmek, A. Durow, and G.L. Albrecht (2004). New York Starter Phosphorus Project – Results of the 2003 growing season. *What's Cropping Up?* 14(1): 1-3.
4. Ketterings, Q.M., T. Byron, G. Godwin and K.J. Czymmek (2003). Phosphorus Starter Project – Results of the 2002 growing season. *What's Cropping Up?* 13(1): 4-6.
5. Byron, T.M., Q.M. Ketterings, and K.J. Czymmek (2002). Phosphorus starter demonstration project. Results of the 2001 growing season. *What's Cropping Up?* 12 (2): 4-5.

6. Czymmek, K.J., J. Degni and Q.M. Ketterings (2001). Phosphorus starter demonstration project. Results of the 2000 Growing Season. What's Cropping Up? 11(3): 4-6.

Extension Materials for Field Crop Dealer Meetings

1. Ketterings, Q.M., K.J. Czymmek, S. Swink, G. Albrecht, G. Godwin, and A. Durow (2003). New York State Starter Phosphorus Project. In: Field Crop Dealer Meetings. Department of Crop and Soil Sciences Extension Series E03-25. Pages 11-12.
2. Ketterings, Q.M., T. Byron, and K.J. Czymmek (2001). P starter demonstration/research project – 2001. In: Field Crop Dealer Meetings. Department of Crop and Soil Sciences Extension Series E01-7. Pages 3-6.

Additional Publicity

Farm Journals and Magazines (combined circulation: more than 118,000)

1. Country Folks. "Are you throwing away fertilizer?" Tom Kilcer. May 2, 2005, P. 11. (circulation ~15,000)
2. Small Farm Quarterly. "Dairy Producers: Is it time to take a look at your phosphorus fertilizer rates for corn?" Karl Czymmek, Quirine Ketterings and Greg Albrecht. April 11, 2005, p. 8. (circulation 26,000)
3. Northeast Dairy Business. "Control your fertilizer bill." Susan Harlow. April 2005, p. 14. (circulation 16,560)
4. Northeast Dairy Business. "How much P is enough?" Quirine Ketterings and Karl Czymmek. April 2005, p. 37. (circulation 16,560)
5. Clearwaters. "The New York CAFO Program: Successfully Connecting Science, Policy, Regulation, and Implementation." Karl Czymmek, Quirine Ketterings, Jeff Ten Eyck, and Tibor Horvath. Spring 2005, Vol. 35, No. 1, pp. 27-28. (circulation: over 2,500)
6. Farming – The Journal of Northeast Agriculture. "Forages: What's new in field crops for 2005." Ev Thomas. January 2005, p. 24-26. (circulation 25,000)
7. Country Folks. "New York State Starter Phosphorus Project". Submitted by Dean Sprague. March 22, 2004. Section A – Page 6. (circulation: ~15,000)
8. American Agriculturalist. "Save on corn starter: Farm-based New York trials show where starter phosphorus fertilizer can be reduced or eliminated." John Vogel. March 2004, p. 26. (circulation: 33,000)
9. Farming – The Journal of Northeast Agriculture. "Forages: What's new in field crops for 2004." Ev Thomas. January 2004, p. 26. (circulation 25,000)
10. Northeast Dairy Business. "P restraint won't shrink yields". Susan Harlow. December 2003, p. 69. (circulation 16,560)

County Extension Newsletters (combined circulation is over 5,600)

1. Farm Flashes (Oneida Co). "Crop Shorts: Have you sampled your soil, do you need to apply P?" Jeff Miller and Kristen Stockin. November/December 2004, p. 4. (circulation: 505)
2. Jefferson County's Extension Connection - Agriculture and Natural Resources. "NYS Starter P Project results." Mike Hunter. April 2004. (circulation: 900)
3. Farm Flashes (Oneida Co). "Can you save \$\$\$\$ by reducing or omitting Phosphorus (P) fertilizer in the band for corn?". April 2004, p. 10. (circulation: 505)
4. Lewis County AG Digest. "Phosphorus Starter Project – results of the 2003 growing season." March 2004.
5. Crop-Soil News (Rensselaer, Albany, Schenectady, and Columbia Counties). Insert: NMSP Postcard "Does your corn need starter phosphorus?". February 2004. (circulation: 325)
6. AgFocus (Genesee, Livingston, Monroe, Niagara, Ontario, Orleans, Seneca, Wayne, and Yates Counties). "Small investments in nutrient planning yield dividends!" Nate Herendeen. Vol 13, No. 1. January 2004. (circulation: ~900)
7. Farm Flashes (Oneida Co). "Crop shorts: Effect of starter P on corn yields in fields with high or very high soil test P." Jeff Miller. December 2003/January 2004, p. 1. (circulation: 505)
8. Farm and Garden News (Sullivan Co). Various short articles on Starter P by Pete Carey in 2003. (circulation: 1600)
9. Ag Viewpoint (Cayuga, Onondaga, Oswego Counties). Various short articles on Starter P by Shawn Bossard in 2003. (circulation: 500)
10. Jefferson County's Extension Connection - Agriculture and Natural Resources. Vol. 5, Issue 6. October, 2003. Included Starter P Project article. (circulation: 900)
11. Crop-Soil News (Rensselaer, Albany, Schenectady, and Columbia Counties). Thomas Kilcer. February 2003. (circulation: 325)
12. Steuben County Agricultural News. Article on 2002 Starter P results. Vol. 85, No. 2. February 2003.
13. The Ag Program News (Schoharie Co). "Nutrient management: Phosphorus Starter Project – results of the 2002 growing season." Vol. 10, No. 2. April 2003, pp. 4-6.
14. The Ag Program News (Schoharie Co). "Clippings from the Miner Agricultural Institute Farm Report, Oct. & Dec. 2002: Starter P trial results." Vol. 10, No. 1. February 2003, p. 8.
15. Farm Flashes (Oneida Co). Title? (Starter P highlighted in fertilizer recommendation article. Mike Dennis. May 2002. (circulation: 505)
16. Crop-Soil News (Rensselaer, Albany, Schenectady, and Columbia Counties). Thomas Kilcer. February 2002. (circulation: 325)
17. Farm Flashes (Oneida Co). "Starter fertilizer preliminary results are in...". Mike Dennis. January 2002, pp. 6-7. (circulation: 505)
18. Crop-Soil News (Rensselaer, Albany, Schenectady, and Columbia Counties). "Are you limiting corn yields with your starter fertilizer?" Thomas Kilcer. March 2001. (circulation: 325)

9. Farmer Adoption

See our discussion under Milestones for Performance Target 3.

10. Areas Needing Additional Studies

The improved collaboration generated a list of priority areas to be considered for research/extension including: (1) N needs for first year corn driven greatly by high N prices but also by environmental issues (2005 NESARE funds will be requested for a project with a similar networked approach and substantial impact potential among all audiences, small-large, organic-conventional); (2) assessment of whole farm nutrient balances (initiated in 2005 and currently ongoing).