NORTHERN NEW YORK AGRICULTURAL DEVELOPMENT PROGRAM

Final Report
April 1, 2006 to December 31, 2008

(NYS Department of Agriculture Contracts #C200138 & #C200166)

February 15, 2009

New York State College of Agriculture and Life Sciences
A Statutory College of the State University
Cornell University
Ithaca, New York

The Northern NY Agricultural Development Program
Its Purpose and Background

In NYS, no area is more economically dependent on agriculture and more challenged in terms of the profitability and long term vitality of its farm businesses than the North Country. These challenges are exacerbated by factors that include, but are not limited to, the regions climatic constraints, its soil resources, and its distance from markets

In 2006-2007, the Northern New York Agricultural Development Program (NNYADP) continued to support agricultural research projects, demonstrations, and outreach in Jefferson, Lewis, St. Lawrence, Franklin, Clinton and Essex counties to help improve agricultural productivity and farm profitability. This report documents findings, results and impacts of the projects that were conducted in the time period covering April 1, 2005-December 31, 2006. Eighteen (18) projects were conducted in the following areas:

- Dairy herd management
- Agricultural environmental management
- Integrated pest management
- Grass-based agriculture
- Field crop production and improvement
- Maple production
- Fruit production

The program is supported by funding from the NYS Senate though the long term sponsorship of Northern NY's state senators and assemblypersons. The program also receives support (funds, land, staff and expertise) from Cornell University's College of Agriculture and Life Sciences, the Cornell University Agricultural Experiment Station, the NYS Agricultural Experiment Station in Geneva, Cornell Cooperative Extension at Cornell and in each of the six NNY counties, the W.H. Miner Institute, the U.S. Department of Agriculture, cooperating farmers and agri-service businesses.

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Don Holman, Beef producer
Janet Schrader, Sheep producer
Dwight Greene, Dairy farmer
Doug Shelmidine, Dairy farmer

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Jon Greenwood, Dairy farmer and Co-Chair
David Fisher, Dairy farmer
Bob Andrews, Dairy farmer
Mary Kelly, Dairy farmer
Bob Zufall, Dairy farmer
Sandy von Allmen, Livestock farmer
Dan Chambers, Dairy farmer

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Steve Ledoux, Livestock farmer
Steve Nortz, Dairy farmer
John Williams, Dairy farmer

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NNY Agricultural Development Program
2006-2008 Project Report

Project Title: The effect of copper sulfate, formaldehyde, and tetracycline on mini pit manure slurry ecology and nutrient composition, and forage grass and alfalfa yield and composition.

Project Leader(s). Sally A. Flis, Everett D. Thomas, Catherine S. Ballard; *The William H. Miner Agricultural Research Institute, P.O. Box 90, Chazy, NY 12921.*

Background: Non-antibiotic and antibiotic treatments have been employed by dairy producers in footbaths to combat papillomatous digital dermatitis (hairy heel warts), which causes lameness in dairy cows. Waste material from footbaths is generally disposed of in manure slurry systems. McBride and Spires (2001) tested manure Cu concentrations from 20 farms in New York State and found that the concentrations of Cu in the manure samples were above that which could be explained by poor absorption of excess Cu in the ration. The mean Cu concentration was 139 ppm (SD = 242), with a minimum of 18 and a maximum of 1100 ppm. Manure test values for Miner Institute have been as high as 2.09 lbs per 1000 gallons (209 ppm). Since 1998 there has been a trend for increasing Cu concentrations in manure tested at the University of Vermont Agricultural and Environmental Testing Laboratory.

In general, given a soil pH range of 5 to 7, Cu is not mobile in the soil and is bound as Cu^{2+} to clay minerals, soil organic matter (**SOM**), or mineral oxides, making it unavailable for crop uptake or leaching. Increasing the pH of the soil through liming practices also decreases the availability of Cu by increasing the binding of Cu^{2+} to both SOM and clay particles (Schulte and Kelling, 1999). However, as the application rates of Cu increase there is potential for a larger fraction of Cu to be in a plant-available form that may effect crop growth.

Research with warm season forage grasses has been conducted with the objective of determining the best species for yield and nutrient removal from land receiving high application rates of nutrient-rich swine manures (McLaughlin et al., 2004a; McLaughlin et al., 2004b). These studies were conducted in the Blackland Prairie resource area of Mississippi, and yields were compared between species, not to Cu concentration. Research has been conducted to evaluate the effects of Cu application as $CuSO_4$ and Cu-enriched poultry and swine manures on alfalfa and other forage legume growth and Cu concentration (Fageria, 2001; Mantovi et al., 2003; Pederson et al., 2002). Studies with alfalfa and other forage legumes have shown that alfalfa has higher Cu tissue concentrations (Lloveras et al., 2004; Mantovi et al., 2003; Pederson et al., 2002). Alfalfa and other forage legume species appear not to be negatively affected by high Cu concentrations from swine manure application and tend to accumulate more Cu in the plant than grasses or small grains. The higher concentrations of Cu in legumes are likely due to the association of uptake and movement of Cu with N-based compounds. No similar testing has been done using high-Cu dairy manure.

Given the flow of Cu from footbaths to manure storage and then to field application, a multi-year study evaluating the effect of high Cu applications on dairy farms was commenced in the fall of 2007 and will carry through 2009. The effects of applying high levels of Cu in dairy manure in the fall of 2007, and after first and third cutting in 2008 on the soil fractions of Cu and growth of cool season forage grasses and alfalfa were evaluated.

Methods:

Manure Collection and Analysis

In the fall of 2007, and after 1st cutting (June 17, 2008) and 3rd cutting (September 3, 2008), twelve 70-gallon black plastic tubs were used to mimic manure pit storage facilities. Tanks were placed in the Cornell University Plot area at the W. H. Miner Agricultural Research Institute, arranged in 3 rows of 4 tubs. Mini pits were filled with approximately 45 gallons of manure collected from the free-stall alleys of the W. H. Miner Agricultural Research Institute dairy barn to ensure a low initial concentration of Cu. Copper sulfate was added to mini-pits to achieve concentrations of 0, 1, 2, and 3 lbs Cu/1000 gallons of manure. There were 3 replications per treatment for a total of 12 mini-pits. Mini-pits were covered with plywood and left undisturbed for 10-14 days. After two weeks of storage, mini-pits were emptied and contents were applied to established orchardgrass, timothy, reed canarygrass, and alfalfa plots (15' x 6'). Four treatments with 3 replications were applied: 0, 5, 10, and 15 lbs Cu/acre, simulating the wide range of Cu being applied on farms in New York State where Cu sulfate footbaths are employed (average manure application rate of Cu = ~8 lbs/acre; Flis et al., 2008). These treatments were achieved by applying 10.3 gallons of manure per plot of the 0, 1, 2, or 3 lbs/1000 gallon manure treatments to the 0, 5, 10, and 15 lbs/acre plots, respectively. While mini-pits were being emptied 4 random samples of manure from different depths were taken, composited, and analyzed for pH, dry matter (DM), total bacterial count, N, S, Fe, and Cu concentrations.

Grass Harvest and Analysis

Due to late application of manure in 2007, plots were harvested for yield determination in June of 2008 for 1st cutting, July for 2nd cutting and early September for 3rd cutting. Plots were harvested by species at the boot to heading stage of maturity for grasses and mid-bud for alfalfa. At each cutting, three, 1' x 2' areas were harvested from each individual treatment plot. Total sample dry weight and total sample area were used to calculate yield in pounds/acre. In addition, samples were pooled by plot and analyzed for DM, NDF, ADF, lignin, crude protein, ash, and Cu concentration.

Soil Analysis

After all 4 species were harvested for 1st cutting in 2008, and prior to manure application, six 6" depth soil samples were taken from each individual plot, mixed, and air dried. Soils were analyzed for total Cu, using the EPA 3051 nitric acid digestion method (William H. Miner Agricultural Research Institute Laboratory, Chazy, NY) and available Cu using the Melich-3 method (Penn State Agricultural Analytical Services Laboratory (University Park, PA). Following the 2nd cutting of the plots, soil samples were taken at 0-1" and 1-8" depths to examine the vertical movement of Cu after two applications of manure (in the fall of 2007 and after the 1st cutting in 2008). Soils were analyzed for available Cu using the Melich-3 method.

Statistical Analysis

The nutrient composition, available Cu, and bacterial counts of manure samples were analyzed using ANOVA for the effect of treatment only. Forage quality, tissue and soil Cu concentrations were analyzed using ANOVA by each species for effect of Cu treatment. All analyses used Proc GLM procedure of SAS v. 9.1.3 (SAS Institute, 2003) and mean separation using the PDIFF option of the LSMEANS statement at $P < 0.05$ when the F test was significant. Differences were significant at $P \leq 0.05$ and tendencies at $P \leq 0.10$.

Results:

Effect of Copper Sulfate on Manure Ecology

The measured Cu concentration in the mini-pits was slightly lower than the planned treatments (Table 1). All treatments were significantly higher than the control (0) and the 3 lbs/1000 gal manure was the highest concentration of total Cu in the manure. The measure of total Cu in the mini-pits being lower than the proposed treatments is likely due to the method of incorporating the $CuSO_4$ and water mixture with the manure and the sampling of the mini-pits. Some of the Cu may have remained near the surface not well incorporated with the manure lowering the concentration of the sample that was taken as the mini-pit was emptied.

There were no significant effects of Cu treatment level on the characteristics or the mineral concentration of the samples. Further, there was no significant effect of Cu treatment on the number of bacteria counted in the manure sampled (Table 1). It was expected that the higher Cu concentrations in the manure would decrease the number of bacteria in the manure due to the antibacterial properties of Cu. The measure of bacteria count done in this project was not selective, so it is not clear if there is a change in the profile of the community due to the addition of Cu. While not statistically different, there was a slight increase in the concentration of S in the manure as the Cu treatment increased (Table 1). This would indicate less use of S by bacteria and less loss of S in gas forms like hydrogen sulfide (H_2S). Further research is needed to investigate the effects of higher manure Cu concentration on the loss of S from manure storage and possible changes in bacterial population profile that might influence this despite similar total numbers.

Grass Plot Yield and Composition Results – Summer 2008

First cut yield, NDF, ADF, lignin, CP, ash, and Cu were not significantly affected by the increased Cu application rates in any species (Table 2, 3, 4, and 5). The Cu tissue concentration of the alfalfa appeared to be higher than for the other three species.

At second cutting, yield, forage quality measurements, and Cu concentration of orchardgrass, reed canarygrass, and alfalfa were not affected by Cu applications that occurred in the fall of 2007 and after 1st cutting in 2008 (Tables 2, 3, and 5). Timothy yield was higher at the 5 lb/acre application rate than all other application rates (Table 4). For timothy, CP (% DM) was lowest at the 15 lb/acre Cu application rate (Table 4). In timothy at the second cutting there was also a tendency for the Cu concentration to increase as the Cu application rate increased (Table 4).

At third cutting, yield and forage quality in the orchardgrass and timothy were not affected by Cu applications from the fall of 2007 and the 1st cutting of 2008 (Table 2 and 4). Only the yield measurement for the reed canarygrass was affected by the Cu application, with the 5 lb/acre application rate having the highest yield (Table 5). There was a decrease in the ADF concentration of the reed canarygrass as Cu application rate increased at 3rd cutting, however this increase was only 2.2% and is likely not to significantly impact animal nutrition. In contrast, ADF was highest for alfalfa with Cu application rate of 15 lb/acre (Table 5). For the alfalfa, lignin was higher for the 0 and 15 lb/acre application rates (Table 5). Again these were small differences and are not likely to be biologically significant for animal feeding considerations. Finally, the Cu concentration of the plant tissue after 3rd cutting was affected by application rate for the orchardgrass and the alfalfa (Tables 2 and 5). Orchardgrass had the higher Cu concentration when it received the 5 and 10 lb/acre application rates (Table 2). In alfalfa the Cu concentration was highest at the 15 lb/acre application rate (Table 5).

Soil Analysis

For soil sampled after the 1st cutting, the total Cu levels for the orchardgrass plots increased with the increased Cu application rates (Table 6). The total Cu analysis was highest in the soils from the orchardgrass plots when compared to the other species. The higher total Cu in the orchardgrass plots is not reflected in the tissue analysis of the orchardgrass. Available Cu levels were significantly higher as Cu application rates increased for all the grass species and tended to be higher for alfalfa as application rates increased (Table 6).

After 2nd cutting, soil sampled in the top 0-1 inches and 1-8 inches had significantly higher available concentration of Cu as Cu application rates increased. Understandably, the top 0-1 inches of soil contained higher levels of available Cu than the lower 1-8 inches (Table 7).

<u>Conclusions/Outcomes/Impacts:</u>

The addition of $CuSO_4$ to a mini-pit of dairy manure did not appear to affect the manure ecology. However, higher manure Cu concentration did result in loss of S from manure storage which may change the bacterial population profile. Unfortunately that information was not collected in this trial. A single application of high Cu manure did not affect the yield or quality of orchardgrass, timothy, reed canarygrass, or alfalfa. As reported in other research, the Cu concentration of alfalfa was higher than that of the grasses. Results after a second application of high Cu manure and 2 cuttings were variable for some of the species. Orchardgrass was the only species to not be affected by Cu application rates at any cutting. The differences in the soil analysis by depth are due to the application of the high Cu dairy manure on the surface of the soil with no incorporation. The lack of effect of the Cu treatments on the forages may also be partially explained by these soil test results, as the majority of the roots are not actively growing in the top 1 inch of the soil. Results for the second cutting timothy may be related to the soil test results at that cutting, while the results for the soil test in the 3rd cutting may be related to the yield and forage quality results for reed canarygrass and alfalfa. Total soil Cu increased significantly in the orchardgrass plots only while available Cu increased for all grass species as Cu application rates increased. The concentration of Cu in the top 1 inch of the soil was higher than in the lower 1 to 8 inches.

<u>Future Investigations:</u>

In the fall of 2008, manure was applied to the plots with the respective Cu application rates. This study will continue to evaluate soil and tissue samples through the 2009 growing season with Cu application rates being re-applied after each cutting to simulate farm practices of applying manure. At the end of the 2009 growing season, total manure application to each plot will be assessed and data summarized to reflect the impact of soil loading of Cu through repeated application rates of varying Cu-levels in manure on yield and nutrient parameters of grass species and alfalfa.

Outreach:

Data will be summarized and presented at local meetings (Miner Institute Corn Congress and/or Dairy Day). In addition, articles summarizing the results will be published in Miner Institute's *Farm Report* and other popular press publications.

Reports and/or articles in which the results of this project have already been published:

The results of this project were presented and published as an abstract for the Joint Meeting of the Geological Society of America, and the ASA-CSSA-SSSA in Houston, Texas. Effects of excess copper in dairy manure applied to cool season forage grasses. *S. A. Flis, S. C. Bosworth, E. D. Thomas, C. S. Ballard, and J. W. Darrah*.

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Table 1. Manure characteristics, total mineral analysis, and bacterial counts of manure from $CuSO_4$ treated mini-pits.

Item	Treatment (lbs Cu/1000 gal manure)				SE	*P*
	0	1	2	3		
pH	7.2	7.1	7.1	7.2	0.11	0.86
Total Solids, %	13.0	13.4	13.2	12.6	0.42	0.62
Density, lbs/gal	8.0	7.9	7.9	8.0	0.09	0.64
DM, %	12.8	13.2	12.7	12.7	0.43	0.79
Total N, lbs/1000 gal	32.9	31.8	31.4	31.8	0.71	0.50
Ammonia N, lbs/1000 gal	13.5	13.8	13.2	13.6	0.49	0.89
Organic N, lbs/1000 gal	19.4	18.0	18.1	18.2	0.70	0.52
P, lbs/1000 gal	5.0	4.8	4.8	4.8	0.07	0.36
K, lbs/1000 gal	19.4	19.0	19.2	19.8	0.33	0.46
Mg, lbs/1000 gal	9.2	9.1	8.8	8.8	0.22	0.57
S, lbs/1000 gal	3.9	4.3	5.8	4.7	0.66	0.30
Cu, lbs/1000 gal	0.07^{b}	$0.89^{a,b}$	1.63^{a}	2.58^{a}	0.32	**0.004**
Ash, %	13.0	12.7	13.3	13.4	0.31	0.39
Bacterial Count, x 10^5	68.8	70.3	50.3	63.7	1.31	0.70

[a,b]Means in the same row with different superscripts are different at $P<0.05$.

Table 2. Yield, Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF), lignin, Crude Protein (CP), ash, and Cu concentration for **orchardgrass** that received Cu from dairy manure at rates of 0, 5, 10 and 15 lbs/acre.

	Cu application rate (lbs/acre)					
Item	**0**	**5**	**10**	**15**	**SE**	***P***
1st Cutting						
Dry matter yield, t/acre	2.71	3.64	3.18	2.84	0.28	0.09
NDF, % DM	54.5	56.3	54.2	55.8	1.12	0.53
ADF, % DM	30.0	30.8	29.6	30.2	0.68	0.69
Lignin, % DM	3.37	3.44	3.60	3.37	0.10	0.43
CP, % DM	17.2	14.8	16.8	14.9	0.99	0.30
Ash, % DM	6.69	6.54	6.96	6.59	0.20	0.30
Cu, ppm	5.67	7.67	7.0	7.33	0.52	0.13
2nd Cutting						
Dry matter yield, t/acre	1.44	1.65	1.58	1.50	0.16	0.81
NDF, % DM	59.1	58.9	58.0	58.8	0.39	0.32
ADF, % DM	36.5	36.1	35.4	36.1	0.28	0.13
Lignin, % DM	5.04	4.88	4.79	4.99	0.12	0.54
CP, % DM	16.4	17.4	17.0	17.7	0.86	0.74
Ash, % DM	11.2	11.5	11.6	11.5	0.23	0.69
Cu, ppm	5.33	8.33	8.67	10.33	1.71	0.31
3rd Cutting						
Dry matter yield, t/acre	1.26	1.16	1.10	1.17	0.11	0.77
NDF, % DM	56.9	55.1	56.3	54.8	0.93	0.40
ADF, % DM	34.8	32.4	33.5	32.8	0.50	0.06
Lignin, % DM	7.88	5.23	4.62	4.87	1.08	0.22
CP, % DM	17.5	20.0	19.3	20.7	0.85	0.15
Ash, % DM	12.5	12.1	12.4	12.1	0.31	0.79
Cu, ppm	6.33[b,c]	10.0[a]	11.0[a]	8.67[a,c]	0.88	**0.04**

[a,b,c] Means in the same row with different superscripts are different at $P < 0.05$.

Table 3. Yield, Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF), lignin, Crude Protein (CP), ash, and Cu concentration for **reed canarygrass** that received Cu from dairy manure at rates of 0, 5, 10, and 15 lbs/acre.

	Cu application rate (lbs/acre)					
Item	**0**	**5**	**10**	**15**	**SE**	***P***
1st Cutting						
Dry matter yield, t/acre	3.39	3.51	3.94	3.16	0.29	0.35
NDF, % DM	65.6	64.8	65.0	64.4	0.64	0.64
ADF, % DM	36.9	37.5	37.4	37.3	0.53	0.90
Lignin, % DM	5.08	5.38	5.25	5.20	0.12	0.41
CP, % DM	16.3	1.9	15.3	14.8	1.09	0.55
Ash, % DM	6.48	6.84	6.78	7.12	0.18	0.20
Cu, ppm	7.00	6.67	7.67	7.00	0.39	0.39
2nd Cutting						
Dry matter yield, t/acre	1.46	1.63	1.37	1.45	0.13	0.57
NDF, % DM	63.0	62.0	63.1	63.2	0.46	0.35
ADF, % DM	39.1	38.2	39.1	38.8	0.31	0.22
Lignin, % DM	5.95	5.82	5.99	5.99	0.08	0.44
CP, % DM	14.9	16.3	13.8	14.4	0.88	0.32
Ash, % DM	10.2	10.4	9.9	10.2	0.20	0.42
Cu, ppm	7.33	8.67	9.67	11.3	1.06	0.15
3rd Cutting						
Dry matter yield, t/acre	0.87	1.15	0.81	0.93	0.07	0.05
NDF, % DM	49.4	48.0	48.2	47.2	0.44	0.06
ADF, % DM	30.5^{a}	29.1^{b}	29.1^{b}	28.3^{b}	0.36	**0.03**
Lignin, % DM	4.97	4.56	4.83	4.64	0.27	0.71
CP, % DM	21.4	23.6	21.6	23.2	0.99	0.38
Ash, % DM	11.4	11.1	11.5	11.3	0.11	0.12
Cu, ppm	8.66	9.67	10.7	11.3	0.80	0.20

[a,b,c] Means in the same row with different superscripts are different at $P < 0.05$.

Table 4. Yield, Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF), lignin, Crude Protein (CP), ash, and Cu concentration for **timothy** that received Cu from dairy manure at rates of 0, 5, 10, and 15 lbs/acre.

	Cu application rate (lbs/acre)					
Item	**0**	**5**	**10**	**15**	**SE**	***P***
1st Cutting						
Dry matter yield, t/acre	4.86	4.51	4.72	4.55	0.34	0.88
NDF, % DM	65.1	65.9	64.4	65.6	0.64	0.47
ADF, % DM	37.9	38.6	38.6	38.5	0.35	0.48
Lignin, % DM	5.07	6.12	5.26	5.35	0.44	0.41
CP, % DM	11.3	10.7	11.6	10.2	0.38	0.13
Ash, % DM	5.36	5.31	4.96	5.10	0.23	0.60
Cu, ppm	5.00	7.00	5.67	6.33	0.46	0.09
2nd Cutting						
Dry matter yield, t/acre	1.02[b]	1.29[a]	1.05[b]	0.97[b]	0.03	**0.003**
NDF, % DM	59.5	60.2	60.1	60.0	0.60	0.82
ADF, % DM	36.4	36.6	37.1	37.1	0.41	0.53
Lignin, % DM	5.00	4.93	5.63	5.23	0.29	0.38
CP, % DM	16.4[a]	17.0[a]	17.6[a]	14.0[b]	0.61	**0.02**
Ash, % DM	7.74	7.80	8.22	8.00	0.32	0.73
Cu, ppm	7.00	9.33	13.7	22.7	3.76	0.10
3rd Cutting						
Dry matter yield, t/acre	0.75	0.62	0.82	0.72	0.10	0.54
NDF, % DM	50.2	51.1	51.4	50.7	0.62	0.57
ADF, % DM	30.2	30.9	30.6	30.6	0.52	0.78
Lignin, % DM	4.41	5.37	4.62	4.35	0.32	0.19
CP, % DM	20.1	17.4	17.8	18.4	1.55	0.64
Ash, % DM	9.08	8.89	8.68	8.59	0.34	0.75
Cu, ppm	6.67	8.33	9.33	15.3	3.00	0.29

[a,b,c] Means in the same row with different superscripts are different at $P < 0.05$.

Table 5. Yield, Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF), lignin, Crude Protein (CP), ash, and Cu concentration for **alfalfa** that received Cu from dairy manure at rates of 0, 5, 10, and 15 lbs/acre.

	Cu application rate (lbs/acre)					
Item	**0**	**5**	**10**	**15**	**SE**	***P***
1st Cutting						
Dry matter yield, t/acre	3.77	3.18	3.29	3.53	0.34	0.66
NDF, % DM	44.1	43.9	43.2	43.9	0.86	0.89
ADF, % DM	35.6	35.2	35.2	35.7	0.60	0.91
Lignin, % DM	8.13	7.84	7.99	7.97	0.12	0.45
CP, % DM	17.0	17.2	17.5	17.8	0.25	0.24
Ash, % DM	6.03	6.31	6.01	6.09	0.11	0.26
Cu, ppm	10.3	10.3	10.1	11.0	0.26	0.17
2nd Cutting						
Dry matter yield, t/acre	1.03	0.95	0.93	1.04	0.10	0.82
NDF, % DM	39.0	36.7	37.9	39.6	1.11	0.35
ADF, % DM	32.4	31.5	32.5	33.2	1.31	0.85
Lignin, % DM	7.23	6.87	7.08	7.27	0.32	0.81
CP, % DM	21.1	21.5	19.3	21.4	1.11	0.51
Ash, % DM	7.50	7.86	7.79	7.65	0.20	0.61
Cu, ppm	11.0	14.3	14.3	23.3	4.79	0.38
3rd Cutting						
Dry matter yield, t/acre	0.91	0.88	0.97	0.96	0.06	0.75
NDF, % DM	31.8	33.0	34.4	35.5	1.21	0.24
ADF, % DM	29.8[b]	28.4[c]	29.9[b]	31.4[a]	0.35	**0.01**
Lignin, % DM	8.41[a]	6.32[b]	6.95[b]	8.25[a]	0.22	**0.002**
CP, % DM	24.7	24.7	24.8	24.0	0.39	0.49
Ash, % DM	8.19	8.18	8.40	8.28	0.30	0.95
Cu, ppm	10.7[b]	10.0[b]	10.3[b]	12.7[a]	0.46	**0.02**

[a,b,c] Means in the same row with different superscripts are different at $P < 0.05$.

Table 6. Total Cu and Available Cu (ppm) in soil at 6” depth after 1st cutting from plots that received Cu from dairy manure at rates of 0, 5, 10, and 15 lbs/acre.

	Cu application rate (lbs/acre)					
	0	**5**	**10**	**15**	**SE**	***P***
Orchardgrass						
Total Cu, ppm	10.0^{c}	$12.4^{b,c}$	$14.1^{a,b}$	17.3^{a}	1.07	**0.02**
Available Cu, ppm	1.61^{b}	2.59^{b}	$4.39^{a,b}$	6.13^{a}	0.78	**0.02**
Reed Canarygrass						
Total Cu, ppm	8.00	9.58	10.6	9.08	0.69	0.16
Available Cu, ppm	1.61^{b}	3.06^{a}	4.18^{a}	3.45^{a}	0.48	**0.03**
Timothy						
Total Cu, ppm	7.91	9.88	10.5	11.1	0.97	0.21
Available Cu, ppm	1.59^{b}	$3.02^{a,b}$	3.38^{a}	4.12^{a}	0.45	**0.02**
Alfalfa						
Total Cu, ppm	6.68	9.44	10.2	11.8	1.23	0.12
Available Cu, ppm	1.64	3.43	3.86	5.12	0.74	0.06

^{a,b,c} Means in the same row with different superscripts are different at $P < 0.05$.

Table 7. Available Cu (ppm) in soil samples taken after the 2nd cutting at 0-1" and 1-8" depths from plots that received Cu from dairy manure at rates of 0, 5, 10, and 15 lbs/acre.

	Cu application rate (lbs/acre)					
	0	**5**	**10**	**15**	**SE**	***P***
Orchardgrass						
0-1	2.74[b]	10.1[a,b]	15.7[a]	17.3[a]	3.04	**0.03**
1-8	2.14[b]	2.50[a,b]	3.41[a]	3.34[a]	0.34	**0.05**
Reed Canarygrass						
0-1	2.30[c]	10.1[b]	18.8[a]	17.3[a]	1.98	**0.004**
1-8	2.21[c]	3.02[b]	3.00[b]	3.73[a]	0.18	**0.01**
Timothy						
0-1	2.12[c]	8.95[b,c]	16.0[a,b]	24.2[a]	2.42	**0.003**
1-8	2.09[c]	2.61[b]	3.45[a]	3.78[a]	0.14	**0.001**
Alfalfa						
0-1	2.24[b]	8.38[b]	19.1[a]	19.0[a]	2.06	**0.003**
1-8	2.16[c]	2.70[b]	3.11[b]	3.69[a]	0.15	**0.002**

[a,b,c] Means in the same row with different superscripts are different at $P < 0.05$.

NNY Agricultural Development Program
2006-2008 Project Report

Project Title: Factors Affecting Milk Component Production in NNY Dairy Herds

Project Leaders: L. E. Chase, Department. of Animal Science, Cornell University

Collaborators: C. M. Ryan – Field Research Technician – Cornell University
J. Tauzel – CCE summer student intern - Cornell University
Cooperative Extension Educators – Extension educators in all 6 Counties participated in this project. They are listed in Table 1 in the Appendix document.
Cooperating feed industry professionals – A total of 29 feed representatives from 16 feed companies were involved in this project. These individuals cooperated by providing detailed ration formulation information for participating dairy herds. Table 2 in the Appendix document contains a list of these individuals and companies.
Cooperating milk processing plants – Bulk tank milk composition data for the participating dairy herds was obtained from 10 milk processors. A list of these plants is in Table 3 in the Appendix document.

Cooperating Producers:

A total of 52 cooperating dairy producers from the 6-county region were involved in this project. Farms from all 6 counties were included in this project. The participation of these herds and their willingness to share data was essential to the completion of this project. The specific farms are in Table 4 of the Appendix document.

Background:

Milk components (fat, true protein) are key determinants of the price received for each 100 lbs. of milk produced on NNY dairy farms. On the majority of these farms, milk sales are the primary source of income. The multiple component pricing (MCP) system uses prices for each component in milk to determine the total milk price. These individual component values are set monthly by the Federal Milk Marketing Order administrator based on use levels of milk for the various products such as fluid milk, butter, cheese and soft dairy products. The December 2007 component prices for the Northeast Marketing Order (Federal Milk Order No. 1) are:

- Protein = $4.7061/lb.
- Butterfat = $1.4348/lb
- Other solids = $0..2637/lb

Table 1 contains the calculated milk price for a 100-cow dairy herd selling 70 lbs. of milk per cow. This herd would be shipping 7,000 pounds of milk per day. Using the milk prices in Table 1, an increase of 0.1% in both milk fat and protein represents an increased monthly income of $1,290 for this herd. This is equal to an additional $15,480 milk income per year. Since milk component prices are adjusted monthly, these differences in prices and income with varying milk component levels could be larger or smaller than the numbers in this example. However, small changes in milk component levels do have a measureable effect on farm milk income a constant level of milk production.

Table 1. Milk price and milk income for a dairy herd with varying milk component levels

Milk fat,%	Milk True Protein, %	Milk Price, $/100 lbs.	Daily Milk Income, $	Monthly Milk Income, $
3.4	2.9	20.06	1404	42120
3.5	3.0	20.67	1447	43410
3.6	3.1	21.28	1490	44700
3.7	3.2	21.90	1533	45990

Milk fat and protein levels in a specific herd are determined by a large number of factors rather than 1 or 2 key determinants. They can be broadly divided into genetic and environmental factors. Heritability estimates indicate that genetics accounts for 50-55% of the difference between cows in terms of milk fat or protein percent. The remainder of the variation is due to environmental factors that include nutrition, age, season and stage of lactation. The nutrition program is one management area that can be controlled to change the percent fat and protein in milk. Milk fat can be altered up to 1 percentage point while milk protein can only be changed by about 0.2 – 0.4 points by nutritional management. Thus, the objective of this study was to examine nutritional and management factors that might be related to differences in milk fat and protein levels in NNY dairy herds.

Methods:

Dairy herds in NNY with varying levels of milk fat and protein were selected for this study. One method of selection was to use published DHI records to identify herds. In addition, Cooperative Extension educators and feed industry professionals were asked to assist in identifying herds for this project. The following base criteria were used in selecting potential herds:

- Holstein herds that are on DHI.
- Herds had to be feeding a total mixed ration (TMR)
- A daily milk production average of > 65 lbs. of milk/cow/day or a rolling herd average of >21,000 lbs. of milk/cow.
- Herd milk fat and protein levels. In an attempt to obtain herds across a spectrum of milk component levels, milk fat % was the main measure used to select herds.

Once a herd was selected, arrangements were made with the herd owner for a farm visit to collect samples and information. When possible, Extension educators were involved in the farm visit component of this project. The following information was obtained at the farm visit:

- Release forms, signed by the herd owner, to permit access to DHI and milk plant component records.
- A survey for housing and management practices used on the farm
- Cows in the herd were visually scored for body condition, hock scores, lameness and rumination activity.
- A bulk milk tank sample was obtained for milk fatty acid analysis.
- Samples of the current forages and TMR being fed were collected.
- Ration information and ingredient composition of the grain mix being fed.
- A water sample was taken for each herd.

Forage, TMR and water samples were sent to Dairy One for analysis. Milk samples were analyzed for fatty acids in the Department of Animal Science. Forage and TMR particle size were determined using the Penn State Particle Separator and the Z-Box developed at the Miner Institute. All rations were evaluated using the CPM-Dairy (Cornell – University of Pennsylvania – Miner Institute) ration model.

The statistical approach used in analyzing the trial results were a combination of regression analysis and analysis of variance (ANOVA). The regression technique provides a method to assess the proportion of the total variation that can be accounted for by one or more variables. The ANOVA approach provides a method to test statistical differences between means.

Results:

The herds used in this project were from herds averaging 326 cows/herd and 75.9 lbs. of milk/cow/day. There were 16 herds with < 100 cows, 19 herds with 100 to 300 cows, 7 herds with 300 to 600 cows and 10 herds with >600 cows. Seventeen herds were housed in tie-stall barns while 35 were housed in free-stalls. There were 24 herds that milked cows twice a day while 28 herds milked three times a day.

Average milk fat in these herds was 3.47 with a range of 2.7 to 4.2%. Twenty-one herds had <3.4% milk fat. Nineteen herds had milk fat of 3.5 or 3.6%. Twelve herds had >3.6% milk fat. Average milk true protein was 3% with a range of 2.8 to 3.3%. Four herds had <2.9% milk protein while 32 herds had milk protein of 2.9 or 3%. There were 16 herds with a milk protein content of >3%.

All herds in this study fed some type of haycrop silage while there were 4 herds that fed no corn silage. Thirty of the herds fed some type of dry forage. A variety of concentrate energy sources were fed with corn grain being predominant. Corn meal was fed in 36 herds while 19 herds fed high moisture corn. Some level of soybean meal was fed to all 52 herds. A rumen buffer was fed in 42 herds.

There were no significant relationships between number of cow per herd or herd average daily milk production and milk fat content in this study. There were only a few factors that had a statistically significant relationship with milk fat content. These were included corn silage particle size as determined with the Z-box, starch content of corn silage and the NDF content of the corn silage. The only significant relationships found with milk protein were the ration starch or NFC levels. A significant relationship was also detected between milk fat content and milk C18:1 t10 levels. Herds with lower milk fat levels had higher levels of the C18:1 t10 fatty acid in milk. This finding confirms that the lower milk fat in these herds was related to alterations in fatty acid metabolism in the rumen.

The lack of finding a single nutritional factor that was responsible for lower milk fat in these herds is disappointing but not surprising. Since milk fat and milk protein are the end result of many interacting factors, it is unlikely that a single factor would be defined as the cause of lower milk component levels. There are a number of feed management factors that could also be involved but it was not possible to measure them as part of this study. The relationships listed above regarding corn silage are interesting and need additional investigation.

Conclusions/0utcomes/Impacts:

The basic conclusion from this study is that one nutritional factor could not be elucidated as the cause of lower milk component levels in the 52 herds in this study. There were some components related to corn silage that appear interesting and need some additional examination.

Outreach:

The outreach component of this project is just starting since the last data was collected in late November. Reports with individual farm data have been provided to some farms. The outreach effort will include providing an individual report to each farm with their specific information. Copies of a final report publication will be provided to each farm, Extension educators and feed industry professionals that participated in this project. A short summary and presentation will be put together and used as a basis for dairy producer meetings in the individual counties. The results of this project will also be presented to feed industry professionals at the 2008 NY Feed Dealer Seminars.

Next Steps:

1. Some additional statistical procedures need to performed with this data examining the potential of multi-factor relationships that might be related to milk component levels.
2. The individual farm reports need to be completed and provided to the cooperating dairy producers.
3. An Animal Science mimeo will be written as the final report for this project.
4. Short, executive summary type information pieces need to be written and made available.
5. Dairy producer meetings in Northern NY need to be organized in conjunction with our Extension educators.
6. A presentation needs to be placed on the agenda for the 2008 Feed Dealer seminar series in New York.
7. The information gained from this study will be used to assist in developing an approach for on-farm investigation of herds with low milk components and will be used as a guide for designing future field studies investigating this problem.

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Northern NY Agricultural Development Program
2006-2007 Project Report

Project Title: ***Klebsiella* Mastitis in Dairy Cows: Sources, Transmission and Control Points.**

Project Leader(s):

Ruth N. Zadoks, DVM, and Gary J. Bennett; DVM; Quality Milk Production Services, Cornell University

Collaborator(s):

Everett D. Thomas; William H. Miner Agricultural Research Institute, Chazy, NY

Cooperating Producers:

John Kingston, Maple View Farms, Canton, NY
Vincent Bilow, Bilow Dairy Farm, Malone, NY
Steve Coutier, Dairy Farm Manager, Miner Institute, Chazy, NY

Background: Mastitis is the most common and costly disease of dairy cattle. Losses due to mastitis have been estimated at $200 per cow per year in the USA. The magnitude of losses depends in part on the organism causing mastitis. Judging by producer testimonials and culture results from our diagnostic laboratory, *Klebsiella* is an increasingly important cause of mastitis in New York. Its economic impact can be devastating because vaccines and antimicrobial treatment have limited impact on severity of mastitis, milk loss, death and culling due to *Klebsiella*. Prevention is the main control strategy for *Klebsiella* mastitis. For many years, sawdust and shavings were considered the most important sources of *Klebsiella* and use of *Klebsiella*-free bedding was thought to be adequate for prevention of mastitis. In recent years, however, *Klebsiella* mastitis has become an issue in herds that use other bedding materials such as recycled manure or even sand bedding. In previous work, we showed that on average 80% of healthy adult dairy cattle shed *Klebsiella* in their feces during the summer. Fecal contamination of the farm environment, feed, water and animals is common, and it seems likely that exposure to *Klebsiella* could result from contact with sources other than bedding.

In this project, sources and transmission routes of *Klebsiella* mastitis on dairy farms were determined, so that critical control points for prevention could be identified. Initially, the presence of *Klebsiella* in feed and water, manure and bedding was evaluated. Early results suggested that animal hygiene may be an important indicator of the risk of exposure to *Klebsiella*. In the second half of the project, we specifically measured the association between hygiene scores and the presence of *Klebsiella* on the animals' legs and teats. We also evaluated the potential role of feed crops as source of *Klebsiella*. This work enabled us to pinpoint sources that harbor disease-causing *Klebsiella* species and that are critical points in the control of *Klebsiella* mastitis. The second goal of this project was to educate dairy producers and farm advisors about sources, transmission and control of *Klebsiella* mastitis. Using the research results, we produced a fact sheet on *Klebsiella* mastitis control for distribution to dairy producers, veterinarians and other farm advisors in Northern New York. In addition, information was and will continue to be disseminated through ongoing QMPS education and extension activities, including presentations at the Miner Dairy Days, the National Mastitis Council Meeting, producer meetings, and continuing education meetings for veterinarians and publication in the dairy press.

This project benefits dairy farmers, the dairy industry and dairy cows. Herds that are involved in the project received herd-specific results and management advice. A large audience of dairy farmers, veterinarians and students is reached through direct contact with QMPS staff, through publications in professional and scientific journals and through teaching and continuing education courses. The W. H. Miner Agricultural Research Institute in Chazy, NY, is a partner in the project and will play an active role in dissemination of the results to producers and students. The dairy industry as a whole and consumers of dairy products benefit from improved understanding of methods to control *Klebsiella* mastitis because they will contribute to improvement of production efficiency, milk quality, and shelf life of milk. Finally, dairy cows will benefit. *Klebsiella* mastitis is a painful and often fatal condition that has a strong negative impact on cow health and animal welfare. Every case that we can prevent may be a cow's life saved.

Methods: In June, July, August and September 2007, feed, water and environmental samples were collected from farms in Clinton, Franklin and St. Lawrence County. This included samples from bedding (unused bedding, used bedding, and spots that were heavily soiled with leaked milk) and from alleyways. At the Miner Institute, samples from soil, corn, alfalfa, rumen content and feces were collected. In the other two counties, lower legs and teat ends of cows were sampled. Per visit, legs of 50 animals and teats of 50 different animals were sampled. Legs were sampled in lactating cow pens, whereas teats were sampled in the milking parlor. Teat ends were swabbed before and after pre-milking udder preparation. The preparation routine included use of teat disinfectants based on peroxide or iodine. Animals that were sampled were also scored for cleanliness.

All samples were tested for presence of *Klebsiella* using culture media that we developed specifically for *Klebsiella* detection. The selective culture plates are not perfect, and other bacterial species may grow on them. Isolates that looked like *Klebsiella* were therefore tested with additional laboratory methods to determine whether they were really *Klebsiella*. For isolates from crops, soil, rumen content and feces, we used DNA sequencing and DNA fingerprinting to identify bacterial species and bacterial strains within species, respectively. This allowed us to determine which types of samples contain the type of *Klebsiella* that has the ability to cause mastitis in dairy cows.

Results:

Klebsiella in environmental samples

Across herds and samplings, two-thirds of samples from alleyways, feces, and bedding tested positive for *Klebsiella*. Bedding drenched in milk due was *Klebsiella*-positive in 75% of cases. Most water samples, except those collected from faucets rather than drinking troughs, were *Klebsiella* positive, i.e. 83% of samples. Detection of *Klebsiella* was less common in TMR, which was mostly collected from feed alleys after cows had been eating. Only 30% of TMR samples tested positive. These results show that alleyways and soiled drinking water are important sources of *Klebsiella*.

Klebsiella on cows' legs and teats

Klebsiella was very common on legs: on average, 59% of animals tested positive. In Herd 1, animal hygiene scores, environmental hygiene and detection of *Klebsiella* on legs were similar for August and September (56% vs. 60% of legs). In Herd 2, animal and environmental hygiene were much better in September than August and drastic reduction in the proportion of legs testing positive for *Klebsiella* was observed (98% vs. 22% for August and September, respectively). Results for teats showed a similar pattern: in Herd 1, 54% of teats tested positive for *Klebsiella* before udder prep, and 22% tested positive after udder prep, with little difference between months. In Herd 2, all animals had *Klebsiella* on their teats before udder prep, and 74% of animals still tested positive after udder prep in August. In September, only 34% of animals had *Klebsiella* on teats before prep, and there was almost no *Klebsiella* left (6%) after prep. Before udder prep, cows with clean udders were as likely to have *Klebsiella* on their teats as cows with dirty udders. After udder prep, however, most *Klebsiella* was removed from clean udders, whereas dirty udders still had *Klebsiella* on them in many cases. Bacterial isolates from swabs and from clinical mastitis cases were compared. The proportion of *K. pneumoniae* and *K. oxytoca* in clinical mastitis cases was farm-specific, and mirrored the proportion of *K. pneumoniae* and *K. oxytoca* on teat. This means that *Klebsiella* on teats is a very likely source of *Klebsiella* mastitis, that teat hygiene is very important in mastitis prevention, and that pre-dip is not sufficient to eliminate *Klebsiella* from dirty udder..

Klebsiella in soil, crops and the rumen

Soil was collected in July, August and September. *Klebsiella* and *Klebsiella*-like organisms were detected 67% of corn plots and 57% of alfalfa plots that had received manure. Two of 3 alfalfa field plots that had not received manure for 50 years also tested positive. Based on DNA-sequencing, soil harbored four species of *Klebsiella* and *Klebsiella*-like organisms: *K. oxytoca*, *K. pneumoniae*, *K. variicola*, and *R. planticola.* Only the first two species are associated with mastitis. *Klebsiella* was isolated once from corn roots and once from alfalfa roots, but not from stems or leaves. In contrast, cultures from freshly cut corn, which was sampled just after harvest in September, showed heavy growth of *Klebsiella*. Of 10 corn varieties tested, 8 were positive for *Klebsiella* (80%). Most fecal samples (80%) and almost all rumen samples (95%) from cows at the Miner Institute contained *Klebsiella*. Almost all isolates from the rumen and feces were identified as *K. pneumoniae* based on DNA-sequencing results (93%), whereas almost all isolates from crops and soil were identified as one of the other species (87%). This implies that soil and crops are not important sources of mastitis-causing *Klebsiella.* Within many samples, multiple bacterial species could be found, and within a bacterial species, multiple strains could often be found within the sample.

Conclusions/Outcomes/Impacts: For years, wood-based bedding was seen as the most important cause of *Klebsiella* mastitis. Our earlier work on *Klebsiella* had shown that the bacteria are also very common in the feces of cows. This finding has been called a "paradigm shift" and raised two important questions: 1) does *Klebsiella* spread from the feces to the environment, so that the cows' udders are at risk of *Klebsiella* mastitis; and 2) does *Klebsiella* in the gut come from feed crops? The NNY project has enabled us to answer these questions with a resounding "Yes" for question 1, and an almost as resounding "No" for question 2.

Farm soil and crops contain organisms that are closely related to *Klebsiella*, but rarely the type of *Klebsiella* that causes mastitis. *Klebsiella*-free crops or soils will not solve *Klebsiella* mastitis problems. The main source of *Klebsiella* in the cows' rumen and gut is the constant intake with feed and, more importantly, drinking water that are contaminated with manure. Manure also contaminates bedding. Most used bedding contains *Klebsiella*, even if the bedding was originally *Klebsiella*-free. The real solution to *Klebsiella* mastitis lies in hygiene, particularly hygiene of alleys and holding pens. Most alleys and holding pens contain manure and *Klebsiella*. As cows walk around, manure gets onto their legs. It may also splash onto their udders. When cows lie down, *Klebsiella* may be transferred "from feet to teat". *Klebsiella* on cows' teats is only partially removed by pre-milking udder preparation, even when teat disinfectants are used. This means that cows are at risk of new *Klebsiella* infections in the barn as well as in the milking parlor.

Klebsiella mastitis is difficult or impossible to control with vaccination, antibiotic treatment or use of sand bedding alone. Cows contaminate their environment with *Klebsiella*, putting themselves at risk of mastitis. By keeping the cows and their environment clean, the risk of *Klebsiella* mastitis can be reduced. Hygiene of pens and alleyway is a critical control point in prevention of *Klebsiella* mastitis.

Outreach:

1. *Klebsiella* Mastitis. Presentation at Miner Dairy Days by G. Bennet, November 2007.
2. *Klebsiella* Mastitis Prevention and Control - QMPS tri-fold for dairy producers, distributed in Northern New York through QMPS, CCE offices and veterinarians.
3. See list of reports and articles (will be made available on-line once published)
4. Press release by Kara Dunn, NNYADP
5. QMPS veterinarians and technicians disseminate results through their on-farm consulting activities, and their education and extension activities for dairy producers, dairy veterinarians, and students of animal and veterinary science.

Next steps if results suggest continued work is needed in the areas of research, demonstration and/or education.

Prevention is the most important component of mastitis control programs. The 2007 funding from the Northern New York Agricultural Development Program has enabled us to identify critical control points in prevention of *Klebsiella* mastitis (most importantly: pen, alley and animal hygiene). Despite producers' best efforts to prevent mastitis, some cases will occur. In those cases, producers will try to save the cow through treatment. For some mastitis pathogens, it is known that specific characteristics of the cow and the bacteria affect chances of cure. This knowledge enables producers to select candidates for treatment as opposed to culling, and to choose an appropriate treatment duration.

Knowledge of such risk factors is not available for *Klebsiella* or for its cousin, *E. coli*. The next step would therefore be to evaluate characteristiscs of cows and *Klebsiella* and *E. coli* strains that affect the chance of cure. Ideally, this is done in the context of a treatment trial. QMPS will conduct a coliform mastitis treatment trial in 2008, which provides a unique opportunity to evaluate factors affecting cure on New York dairies.

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Reports and/or articles in which the results of this project have already been published.

1. *Klebsiella* mastitis - beyond bedding. Northeast Dairy Business, January 2008.
2. *Klebsiella* - Not By Bedding Alone. R. Zadoks, M. Munoz, H. Griffiths, G. Bennett and Y. Schukken. NMC 47th Annual Meeting Proceedings, January 2008.
3. *Klebsiella* In Feces Of Dairy Cattle - Where Does It Come From? R. Zadoks, H. Griffiths, M. Munoz, G. Bennett, E. Thomas, and Y. Schukken. NMC 47th Annual Meeting Proceedings, January 2008.
4. *Klebsiella* - From Feet to Teat. Submitted to Hoard's Dairyman.
5. Cleanliness Scores as Indicator of *Klebsiella* Exposure in Dairy Cows. M. A. Munoz, G. J. Bennett, C. Ahlström, H. M. Griffiths, Y. H. Schukken and R. N. Zadoks. Manuscript in preparation for Journal of Dairy Science.
6. Comparison of *Klebsiella* and *Raoultella* isolates from dairy farm soil, crops and animals. H. M. Griffiths, E. D. Thomas, M. A. Munoz, C. Ahlström, G. J. Bennett, and R. N. Zadoks. Short communication in preparation for Applied and Environmental Microbiology.

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Northern NY Agricultural Development Program
2006-2007 Project Report

Project Title: Nutrient Accounting for NNY Dairy Farms: Basis for Environmentally Sound Nutrient Management

Project Leader(s): (Include titles, affiliations and contact information.)

- Dr. Quirine M. Ketterings, Associate Professor, Nutrient Management Spear Program (NMSP), Department of Crop and Soil Sciences, Cornell University
- Dr. Larry Chase, Professor, Department of Animal Science, Cornell University

Collaborator(s): (List names and affiliations for Cornell, CCE and/or private sector individuals who participated in the project.)

- Caroline Rasmussen (project coordinator), Nutrient Management Spear Program, Dept. of Crop and Soil Sciences, Cornell University
- Cornell University:
  - Karl J. Czymmek, PRODAIRY, Cornell University
- Cornell Cooperative Extension:
  - Joe Lawrence (Lewis County)
  - Amy Ivy (Clinton County)
  - Carl Tillinghast (Franklin County)
  - Pete Barney (St Lawrence County)
  - Anita Deming (Essex County)
- Miner Institute:
  - Ev Thomas, Vice President, Agricultural Programs
- Agricultural Industry:
  - Peg Cook, Cook's Consulting

Cooperating Producers: (Include a list of producers who participated in the project. List producers by county.)

Background:

Our overall goal is to improve farm profitability while protecting the environment. Having a clear understanding of the imbalances between farm nitrogen (N), phosphorus (P) and potassium (K) imports and exports and the causes of these imbalances is necessary for the development of best management practices that address nutrient accumulation and aid in achieving long-term sustainability of the dairy and livestock industry in the Northern New York region. This project is in its third year. It provides an assessment of the current status of N, P and K balances for the 11 Northern New York farms that participated in 2004/2005, the 22 farms that participated in 2006, and the 24 farms that participated in 2007. This assessment will facilitate evaluation of management changes (opportunities) that could lead to improved whole farm nutrient balances and hence reduced risk of losses to the environment over time. To date, this dataset includes 31 individual dairy farms.

Methods: (What you did--very brief description with emphasis on information that would be important to farmers. Do not provide detailed descriptions of laboratory methodology etc. that would have meaning only to other scientists.)

We assessed farm N, P and K balances for NNY farms using an Excel software program "Mass Nutrient Balance" v. 4.2 (http://nmsp.css.cornell.edu/projects/massbalance.asp). The Mass Nutrient Balance is an accounting for nutrients (N, P and K) inputs (feed, fertilizer, N fixation, bedding, animals) and exports (milk, animals, crops, manure) and inventories (farm produced and purchased feed). The analysis was refined in 2007 in response to experiences in the first two project years and input from participants and extension educators. The updated version of the Mass Balance calculator was refined and expanded to include:

- Atmospheric nitrogen deposition.
- A more user-friendly and complete farm mass nutrient balance report.
- A comparison of current mass nutrient balance results to previous years.

Caroline Rasmussen worked with CCE field staff to collect the farm assessments. Twenty-four farms were completed (seven in St Lawrence, seven in Clinton, four in Essex, three in Franklin, two in Lewis, and one in Jefferson County). Of the thirty-one individual farms participating to-date, seven have contributed three years of data (data collection years 2004, 2005 and 2006), twelve submitted data for two years (data collection year 2005 and 2006), and twelve participated for the first time in 2007 (data for 2006 calendar year). All farms received a farm-specific report as well as an assessment of how their farm compared to others included in the project. Those farms that participated for 2 or more years received a progress report, comparing their year to year results.

Results: (Include data in tables, charts and/or graphic format as appendices. Format. Please use subheadings to distinguish different sections if appropriate.)

General farm characteristics: The twenty-four farms, submitting 2006 data, varied in size from 36 to 1,469 milking cows with from 140 to 2,650 tillable acres, representing animal densities of 0.14 to 1.02 animal units[1] per acre. Milk production ranged from 1,172 to 16,708 lbs of milk per acre and from 7,698 to 28,661 lbs of milk per cow per year. Twelve of the twenty-four farms sold crops off the farm. The percentage of purchased feeds (percentage of all livestock feed on a dry matter basis) ranged from 5% to 35%. General farm characteristics are shown in Table 1.

Nitrogen balances*:* The annual nitrogen balances are shown in Table 2. The difference between the N imported as feed, purchased fertilizer, animals and bedding and the N exported as milk, animals, crops and manure ranged from -35 pounds per acre (more exported than imported) to +188 pounds N per tillable acre (more imported than exported), with an average N remaining of +69 lbs N per tillable acre (Figure 1).

The N contribution from fixation by legumes was estimated from legume crop acreage, yield and crude protein content. Atmospheric deposition of N was estimated at 8 pounds per total farm acre per year. Atmospheric N deposition and N fixation added an average of 42 lbs N per tillable acre to the total N imported.

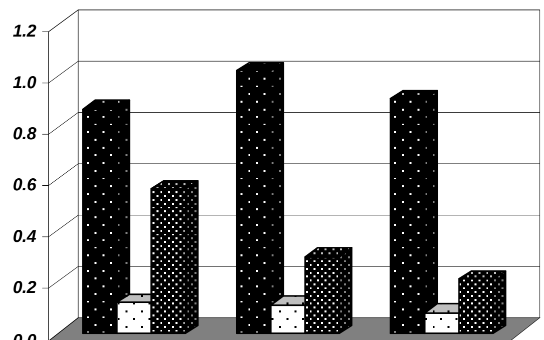
Purchased feed and fertilizer accounted for the bulk of N imported onto these farms. Together these major contributors accounted for 75% of all N imports (feed, fertilizer, purchased animals, bedding, atmospheric deposition and N fixation) and 99% of "manageable" imports (feed, fertilizer, animals and bedding) (Table 3 and Fig. 2). On all of the farms except two, the largest N export was in the form of milk sales and on average, milk accounted for 74% of all N exports on these farms. The major N export vehicle for two farms was crop sales. One of the farms exported manure at the rate of 52 lbs of N per tillable acre. Nitrogen fixation accounted for 0 to 39% of the total N imports on the farms.

Phosphorus balances: The study farms imported an average of 1.6 tons more P than they exported annually (Table 4). The P remaining varied from -3 (more exported than imported) to +20 lbs of P per tillable acre (Fig. 3). As with N, milk was the major P export item on all of the farms expect two, who both exported more P with crops than with milk. Purchased feed and fertilizer accounted for most of the P imports (on average 13 and 5 lbs of P imported per tillable acre, respectively). The P coming on the farm as either purchased animals or bedding averaged less than one half pound of P per tillable acre.

Potassium balances: Three case study farms exported more K than they imported; each of these farms exported 36 to 84% of their K as crop sales or manure exports. The remaining farms annually imported 0.42 to 49.23 tons more K than they exported (Table 5). The remaining K ranged from -20 (more K exported than imported) to +81 lbs of K[2] per acre (Figure 4). The distribution of K imports differed from the distribution of N and P imports. For seven of the farms, purchased fertilizer was the major K import category. On six participating farms, most of the K was exported as crops sales.

[1] One animal unit equals 1000 lbs.
[2] Multiply by 1.2 to obtain units of K_2O.

Multiple year comparisons: Seven Northern New York dairy farms participated in the mass nutrient balance over three years, providing data for calendar years 2004, 2005 and 2006. On average, these seven farms had an increase in mature cows and total animal units in each of these years (Table 6). During these 3 years, the average tillable crop and pasture acres remained constant, resulting in an average animal density increase from 0.73 in 2004 to 0.80 in 2005 and 0.86 animal units per acre in 2006. The average farm mass balance (imports-exports divided by total tillable acres) increased in each year from 2004 to 2006 for N, stayed constant for P and decreased for K. The N, P, and K remaining per cwt milk produced fluctuated over the years for N and decreased for P and K, showing improvement in P and K use efficiency. Yet, changes from 2004 to 2006 for N, P and K remaining per tillable acre vary dramatically from farm to farm (Fig. 5). Five of the seven farms had an increase in N remaining per tillable acre. Of the 7 farms, 3 had an increase and 4 had a decrease in P remaining per acre. Two farms had an increase and 5 showed a decrease in K remaining per acre.



	2003	2004	2005
lbs N/cwt	0.87	1.02	0.91
lbs P/cwt	0.12	0.11	0.08
lbs K/cwt	0.56	0.30	0.21

Mass nutrient balance benchmarks: The quantity of excess nutrients on the case study farms varied considerably. Fig. 1, 3 and 4 display lbs of N, P and K remaining per tillable acre, with farms ranked along the x-axis by farm size as measured by total animal units. The per acre P excess seemed to decrease as farm size increased (Fig. 3); the two largest farms in the dataset, with herd sizes of more than 700 mature cows per farm, have some of the lowest excess P levels (negative 2 and 0 lbs P remaining /tillable acre). On one farm, 70% of the total P exported left the farm as crops; on the other farm 42% of the total P exported was exported in manure. We hope to do more detailed farm assessments (within farm nutrient flows) to see what additional factors allow these farms to be more P efficient than the other farms in the project.

Three farm characteristics that help explain mass nutrient balance performance are (1) exporting nutrients as crops and or manure, (2) feeding a higher proportion of farm produced feeds (and a lower proportion of purchased feeds), and (3) nutrient use efficiency.

Crop Sales: One farm exported more N, P and K than they imported in 2006. This farm is primarily a crop farm who exported 74, 70 and 84% of their N, P and K, respectively, as crop sales in 2006. High animal and crop productivity and a low animal density (0.27 animal units per acre) resulted in negative mass nutrient balances. In the short term, low nutrient balances can be sustained but an annual negative mass balance will result in nutrient “mining” of the farm and this will eventually (longer-term) result in a loss in productivity.

In the 2004 and 2005 Northern New York Mass Balance assessment, farms that sold crops had lower mass nutrient balances than farms that did not sell crops. In the 24 farms participating in 2006, this trend continued (Table 7). Farms with crop sales tended to be smaller with less tillable acres, cow numbers and animal units than dairy-only enterprises. Farms with crop sales had lower animal densities and spread manure on a smaller proportion of their tillable acres. Farms with off-farm crop sales had a smaller percentage of purchased feeds and less N, P and K imported as feed per tillable acre. In 2004, the average of the 5 farms that sold crops imported about twice as much fertilizer N and P than the 6 farms that did not sell crops. In 2005, the farms that sold crops imported N and P fertilizer per crop acre at about the same rate as farms that did not sell crops and K fertilizer as a slightly lower rate than the farms that did not sell crops. In 2006, the N imported as purchased fertilizer was the same for both groups and the P and K fertilizer purchases were greater for farms that sold crops. In 2006, the milk production per animal was essentially the same for both groups.

Although the N, P and K remaining per acre generally increased with production intensity (milk production per tillable acre), farms that export crops and manure had lower nutrient excess per acre over the 3 year period. Additionally, the difference between the groups widens with increased production density (Fig. 6).

Proportion of animal feed that is farm produced versus purchased: NNY farms surveyed in 2005 and 2006, purchased 22.5% of the feedstuffs dry matter fed to both mature cows and young stock. For the most part, participating farms purchased feedstuff concentrates and produced forages on their farms. Of this purchased feed, 10% was purchased forage and 90% was purchased concentrates. Sixteen of the 22 farms participating in 2005 and 20 of the 24 farms participating in 2006 did not purchase any forages. Feed grains, farm produced on nine (41%) of the farms in 2005 and on 7 farms (30%) farms in 2006, accounted for between 2 and 77% of the individual farms total feed dry matter. Approximately one third of the N and P and one sixth of the K, in the livestock rations were from purchased sources (Table 8). However, the proportion of feed nutrients purchased (versus farm-produced) ranged from 5% to 60% for N, 8% to 66% and 1% to 39% for K.

The proportion of total feed dry matter imported as purchased feed is positively related to the mass nutrient balance (Fig. 7) but only explain 25, 12, and 23% of the variability in N, P, and K remaining per acre, respectively.

Nutrient Use Efficiency: An important measure of environmental impact is a firm’s productive efficiency. The efficiency with which the participating dairy farms use N, P and K to produce milk is presented in Fig. 8, 9 and 10. In each of these figures, the nutrients remaining (imports – exports) are divided by the total quantity of milk sold (lbs nutrient per hundred weight of milk sold). The farms are ranked by annual per cow milk production. Within and across all production levels, these NNY dairy farms vary greatly in the total quantity of nutrients remaining per unit of milk production. Understanding the differences between these farms can help to find ways to improve dairy farm economics and reduce losses to the environment at the same time.

Conclusions/Outcomes/Impacts: (Recommendations, guidelines, application[s] to NNY agriculture etc, including **negative results**. Production guidelines/suggested management practices etc. that flow from the research. If farmers are involved in the research or demonstration, provide information on their impressions on the importance of the work its usefulness at the farm level and benefits they are seeing.)

Although there is farm to farm variability, the proportion of nutrients remaining on the farm as a percent of imports was generally lower for P than for N. In 2006, 11 of the 24 participating farms had less than 5 lbs of P remaining per tillable acre. This may be a reflection on the extensive education and policy efforts to reduce P fertilizer use on high and very high P soils, reduce P ration levels to NRC requirements, and increase exports of crops and/or manure over the past several years. Farms that exported crops and/or manure had lower mass nutrient balances. Similarly, farms that produced more of their animal feed ingredients on the farm had lower balances. However, even farms with similar attributes in these areas had widely divergent mass nutrient balance results. An analysis of efficiency of farm nutrient use for milk production shows farms that operate at the same production level can vary in the lbs N used per cwt milk from negative 1.25 to 2.4 lbs N remaining per hundred pounds of milk sold, indicating possible opportunities for farms with the largest imbalances. A more detailed comparison between groups of farms with divergent nutrient use efficiencies may provide an insight into the characteristics which make some farms more efficient than others. Such assessment should be accompanied by analysis of farm business summary data to explore the impact of nutrient management strategies on both farm profitability and nutrient source reduction. Prices paid by producers for imported nutrients may play an important role in farm nutrient balances. Realized and forecasted price increases in fertilizers and purchased feeds will give producers additional incentives to minimize nutrient imports and recycle farm nutrients as effectively as possible.

Outreach: (Indicate what you have done to inform farmers of this project, its progress, findings and how farmers can apply the results to their farming operations. Attach copies of articles, slides or how these can be obtained including www site links etc. Include information on whether or not farmers are using the information, how they are using it and the benefits they see if possible.)

The project, by its nature, involves direct interactions between producers, consultants, extension, and on-campus research and extension teams in two departments (Animal Science and Crop and Soil Sciences). Producer involvement in the data acquisition and individualized farm analysis engaged producers to actively consider the causes of nutrient flows onto and off of their farms. Project results were communicated to each of the participating producers via farm specific reports. Summaries of all farms (without farm identification) were included in the report so producers could compare their nutrient balances to other farms in their region.

Next steps if results suggest continued work is needed in the areas of research, demonstration and/or education.

In 2007, we worked with two large dairy farms in central NY to evaluate farm data and develop whole farm and production system (crops, herd, etc.) performance indicators that could help identify the greatest opportunities for reducing nutrient mass balances. We identified the need for an on-farm fertilizer and manure use record keeping system and improved mass balance software program. Both are current under development with NYSDAM sponsorship and participation by Certified Nutrient Management planners (included NNY representation). We have contacted several Northern New York farms to participate in a more detailed farm efficiency analysis in 2008, if funding can be obtained (proposal submitted to NESARE). We hope to continue to collect mass balance farm data in 2008 as well to expand our NNY dataset. As producers participate in the project for multiple years, they can begin to use the Mass Nutrient Balance results as a bench-mark for farm environmental performance and progress.

Acknowledgments: (Project sponsors/funders; including Cornell sources, like the CUAES, as well as external sponsors.

We gratefully acknowledge the cooperation of the participating producers. This project was funded by a grant from the Northern New York Agriculture Development Program (NNYADP) and Hatch funds. Software development was supported with a grant from the Upper Susquehanna Coalition.

Reports and/or articles in which the results of this project have already been published. (Include department publications, handouts at CCE inservice, popular farm press etc.)

Person(s) to contact for more information (including farmers who have participated: (Include US postal addresses, phone numbers email addresses and/or web sites if applicable.)

- Dr. Quirine M. Ketterings, Associate Professor, Nutrient Management Spear Program, Dept. of Crop and Soil Sciences, 817 Bradfield Hall, Cornell University.
- Dr. Larry Chase, Professor, Dept. of Animal Science, 272 Morrison Hall, Cornell University.

Table 1: General farm characteristics for twenty-four case study dairy farms located in Northern New York State (2006 data).

Selected farm characteristics	Mean	Median	Minimum	Maximum
Number of mature cows	254	118	36	1,469
Annual milk production per acre (lbs)	7,913	7,234	1,172	16,708
Annual milk production per cow (lbs)	20,050	19,942	7,698	28,661
Animal units (1000 lbs live weight)	462	234	43	2,472
Animal density (animal units/acre)	0.68	0.71	0.14	1.02
Tillable crop and pasture (acres)	658	399	140	2,650
Manured cropland (acres)	468	291	89	2,000
Legume crop (%)[1]	29%	26%	0%	91%
Purchased feeds (% total feed dry matter)	23%	23%	5%	35%

[1] Legume crop acres as a percentage of total tillable crop and pasture acres.

Table 2. Nitrogen balance factors, mean, median, minimum and maximum for twenty-four case study dairy farms located in Northern New York State (2006 data).

	Mean	Median	Minimum	Maximum
Nitrogen Mass Balance				
Tons N remaining *	21.46	10.15	(20.59)	123.30
N remaining/acre receiving manure (lbs) *	107	95	(77)	317
N remaining/acre (lbs) *	69	70	(35)	188
N remaining/au (lbs N per 1000 lbs live weight)	90	105	(129)	191
% N remaining (import-export/import) *	46%	56%	(131%)	75%
Distribution of imported N				
N from purchased feed (lbs N/tillable acre)	89	81	3	211
N from purchased fertilizer (lbs N/tillable acre)	36	37	1	91
N from N fixation (lbs N/tillable acre)	25	23	0	67
N from purchased animals (lbs N/tillable acre)	1	0	0	9
N from bedding (lbs N/tillable acre)	2	0	0	30
Distribution of exported N				
N from milk sales (lbs N/tillable acre)	41	37	6	87
N from animal sales (lbs N/tillable acre)	5	4	0	12
N from crop sales (lbs N/tillable acre)	10	0	0	76
N from manure export (lbs N/tillable acre)	2	0	0	52

* Does not include nitrogen fixation by legumes or atmospheric deposition.

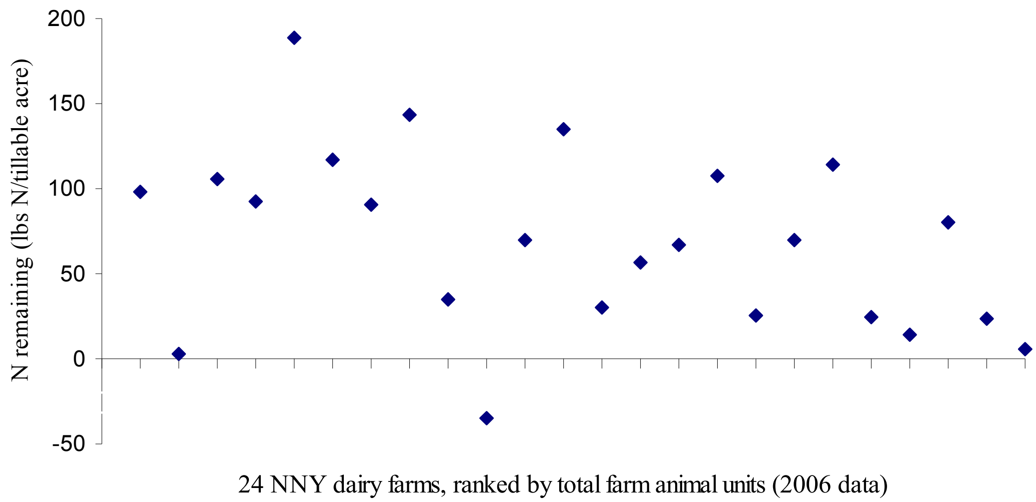
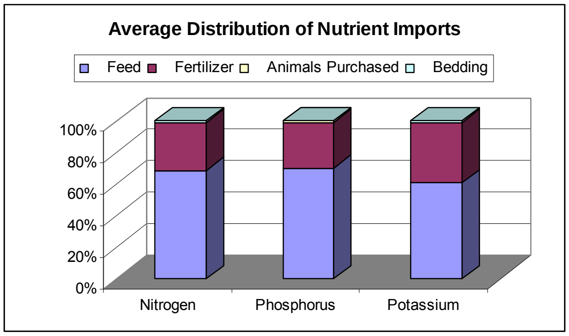


Figure 1: Nitrogen remaining (imports-exports) lbs per tillable acre on 24 Northern New York State dairy farms ranked by farm size (animal units); 1 animal unit=1,000 lbs.

Table 3: The average distribution of nitrogen, phosphorus and potassium imports and exports for 24 Northern New York State dairy farms (2006). Total N includes N from N fixation and atmospheric deposition as well as N from "managed" sources which include feed, fertilizer, purchased animals and bedding.

Annual imports	% total N	% managed N	% P imports	% K imports
Feed	50%	68%	70%	61%
Fertilizer	22%	30%	29%	38%
Animals purchased	0%	0%	1%	0%
Bedding	1%	1%	0%	1%
N fixation	15%			
Atmospheric deposition	12%			
Annual exports	% N exports		% P exports	% K exports
Milk	74%		73%	70%
Animals Sold	8%		11%	2%
Crops Sold	16%		14%	26%
Manure/Compost	1%		2%	2%



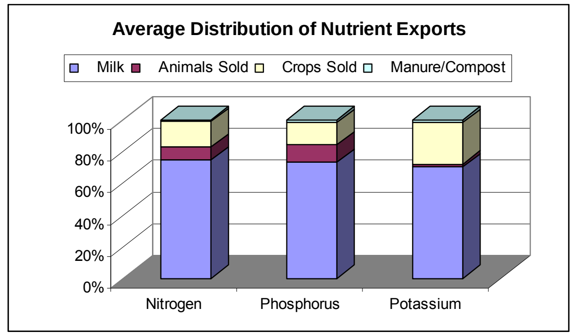


Figure 2: The average distribution of managed nitrogen, phosphorus and potassium imports and exports for 24 Northern New York dairy farms (2006 data). Imports items, feed, fertilizer, animals purchased, and bedding are displayed as a percentage of total annual imports. Export items, milk, animals sold, crops sold, manure and compost exports are displayed as a percentage of total annual exports.

Table 4: Phosphorus balance factors, mean, median, minimum and maximum for twenty-four case study dairy farms located in Northern New York State (2006 data).

	Mean	Median	Min	Max
Phosphorus Mass Balance				
Tons P remaining	1.63	1.06	(3.57)	8.36
lbs P remaining/acre receiving manure	11	11	(4)	36
lbs P_2O_5 remaining/acre receiving manure	26	23	(9)	84
lbs P remaining/acre	7	7	(3)	20
lbs P_2O_5 remaining/acre	16	16	(7)	45
lbs P remaining/au	10	12	(5)	28
% P remaining (import-export/import)	41%	47%	(16%)	66%
Distribution of imported P				
P from purchased feed (lbs P/tillable acre)	13	11	1	27
P from purchased fertilizer (lbs P/tillable acre)	5	4	0	12
P from purchased animals (lbs P/tillable acre)	0	0	0	2
P from bedding (lbs P/tillable acre)	0	0	0	1
Distribution of imported P				
P from milk sales (lbs P/tillable acre)	7	7	1	15
P from animal sales (lbs P/tillable acre)	1	1	0	3
P from crop sales (lbs P/tillable acre)	1	0	0	1
P from manure/compost (lbs P/tillable acre)	1	0	0	13

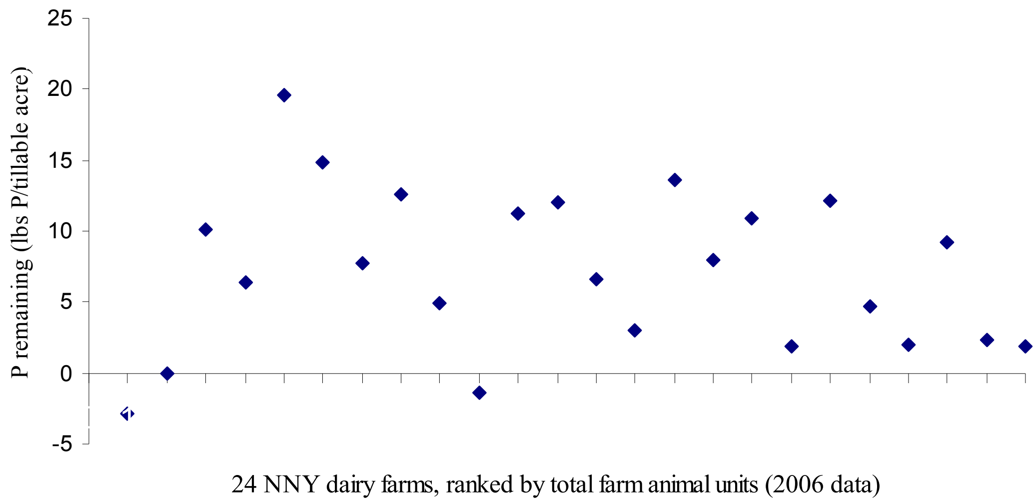


Figure 3: Phosphorus remaining (imports-exports) lbs per tillable acre on 24 Northern New York State dairy farms ranked by farm size (animal units); 1 animal unit=1,000 lbs.

Table 5. Potassium balance factors, mean, median, minimum and maximum for twenty-four case study dairy farms located in Northern New York State (2006 data).

Potassium Mass Balance	Mean	Median	Min	Max
Tons K remaining	6.22	2.20	(11.96)	49.23
lbs K remaining/acre receiving manure	30	26	(45)	109
lbs K_2O remaining/acre receiving manure	37	31	(54)	131
lbs K remaining/acre	20	17	(20)	81
lbs K_2O remaining/acre	25	20	(24)	97
lbs K remaining/au	28	25	(75)	82
% K remaining (import-export/import)	35%	52%	(236%)	86%
Distribution of imported K				
K from purchased feed (lbs K/tillable acre)	25	23	1	75
K from purchased fertilizer (lbs K/tillable acre)	17	13	0	89
K from purchased animals (lbs K/tillable acre)	0	0	0	1
K from bedding (lbs K/tillable acre)	0	0	0	6
Distribution of imported K				
K from milk sales (lbs K/tillable acre)	13	12	2	27
K from animal sales (lbs K/tillable acre)	0	0	0	1
K from crop sales (lbs K/tillable acre)	7	1	0	52
K from manure/compost (lbs K/tillable acre)	1	0	0	33

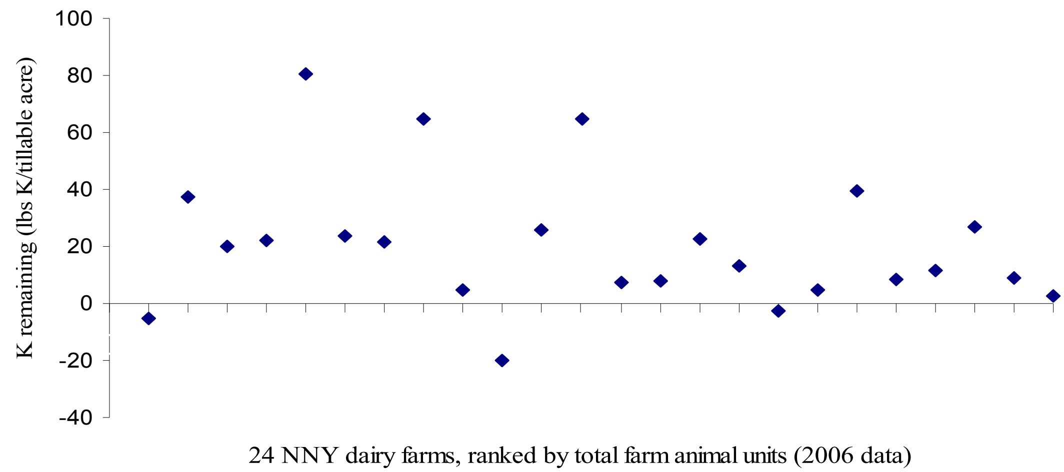


Figure 4: Potassium remaining (imports-exports) lbs per tillable acre on 24 Northern New York State dairy farms ranked by farm size (animal units); 1 animal unit=1,000 lbs.

Table 6. Selected farm characteristics and mass nutrient balance factors, average for same 7 Northern New York dairy farms with balance data in 2004, 2005 and 2006.

Business Size and Production	2004	2005	2006
Mature Cows	143	165	181
Animal units	261	301	323
Animal density (animal units/tillable acre)	0.73	0.80	0.86
Milk sold (lbs/tillable acre)	8,355	9,260	10,151
Milk sold (lbs/cow)	21,406	21,276	21,382
Tillable acres	359	357	358
Acres receiving manure	*na*	236	303
% purchased feed (% of total feed DM)	38%	20%	21%
% farm produced forage (% of total forage DM)	97%	75%	72%
Nitrogen Mass Balance			
Tons N remaining *	12.85	17.41	19.44
Lbs N remaining/tillable acre *	70	90	94
Lbs N remaining/acre receiving manure *	*na*	154	126
Lbs N remaining/au *	126	115	108
% N remaining (import-export/import) *	61	56	57
Lbs N remaining/cwt milk sold *	0.87	1.02	0.91
Milk N/total feed N (%)	*na*	17%	16%
Distribution of imported N	2004	2005	2006
N from purchased feed (lbs/tillable acre)	82	94	108
N from purchased fertilizer (lbs/tillable acre)	49	58	49
N from N fixation (lbs/tillable acre)	23	44	36
N from purchased animals (lbs/tillable acre)	0	2	1
N from miscellaneous imports (lbs/tillable acre)	1	1	0

Table 6 (continued). Selected farm characteristics and mass nutrient balance factors for the same 7 Northern New York dairy farms in 2004, 2005 and 2006.

	2004	2005	2006
Distribution of exported N			
N from milk sales (lbs/tillable acre)	44	52	53
N from animal sales (lbs/tillable acre)	5	5	6
N from crop sales (lbs/tillable acre)	12	9	6
N from miscellaneous exports (lbs/tillable acre)	0	0	0
Phosphorus Mass Balance			
Tons P remaining	1.56	1.89	1.97
Lbs P remaining/acre	9	10	9
Lbs P remaining/acre receiving manure	*na*	18	12
Lbs P remaining/au	13	13	10
% P remaining (import-export/import)	47	47	39
Milk P/total feed P (%)	*na*	19%	19%
Distribution of imported P			
P from purchased feed (lbs/tillable acre)	12	13	15
P from purchased fertilizer (lbs/tillable acre)	8	8	5
P from purchased animals (lbs/tillable acre)	0	1	0
P from miscellaneous imports (lbs/tillable acre)	0	0	0
Distribution of exported P			
P from milk sales (lbs/tillable acre)	8	8	9
P from animal sales (lbs/tillable acre)	1	1	1
P from crop sales (lbs/tillable acre)	2	2	1
P from miscellaneous exports (lbs/tillable acre)	0	0	0
Lbs P remaining/cwt milk sold	0.12	0.11	0.08
Potassium Mass Balance			
Tons K remaining	9.32	5.09	5.54
Lbs K remaining/acre	49	26	23
Lbs K remaining/acre receiving manure	*na*	51	29
Lbs K remaining/au	67	33	26
% K remaining (import-export/import)	62	51	43
Milk K/total feed K (%)	*na*	7%	8%
Distribution of imported K			
K from purchased feed (lbs/tillable acre)	26	23	29
K from purchased fertilizer (lbs/tillable acre)	43	23	15
K from purchased animals (lbs/tillable acre)	0	0	0
K from miscellaneous imports (lbs/tillable acre)	1	0	0
Distribution of exported K			
K from milk sales (lbs/tillable acre)	13	15	16
K from animal sales (lbs/tillable acre)	0	0	0
K from crop sales (lbs/tillable acre)	7	5	5
K from miscellaneous exports (lbs/tillable acre)	0	0	0
Lbs K remaining/cwt milk sold	0.56	0.30	0.21

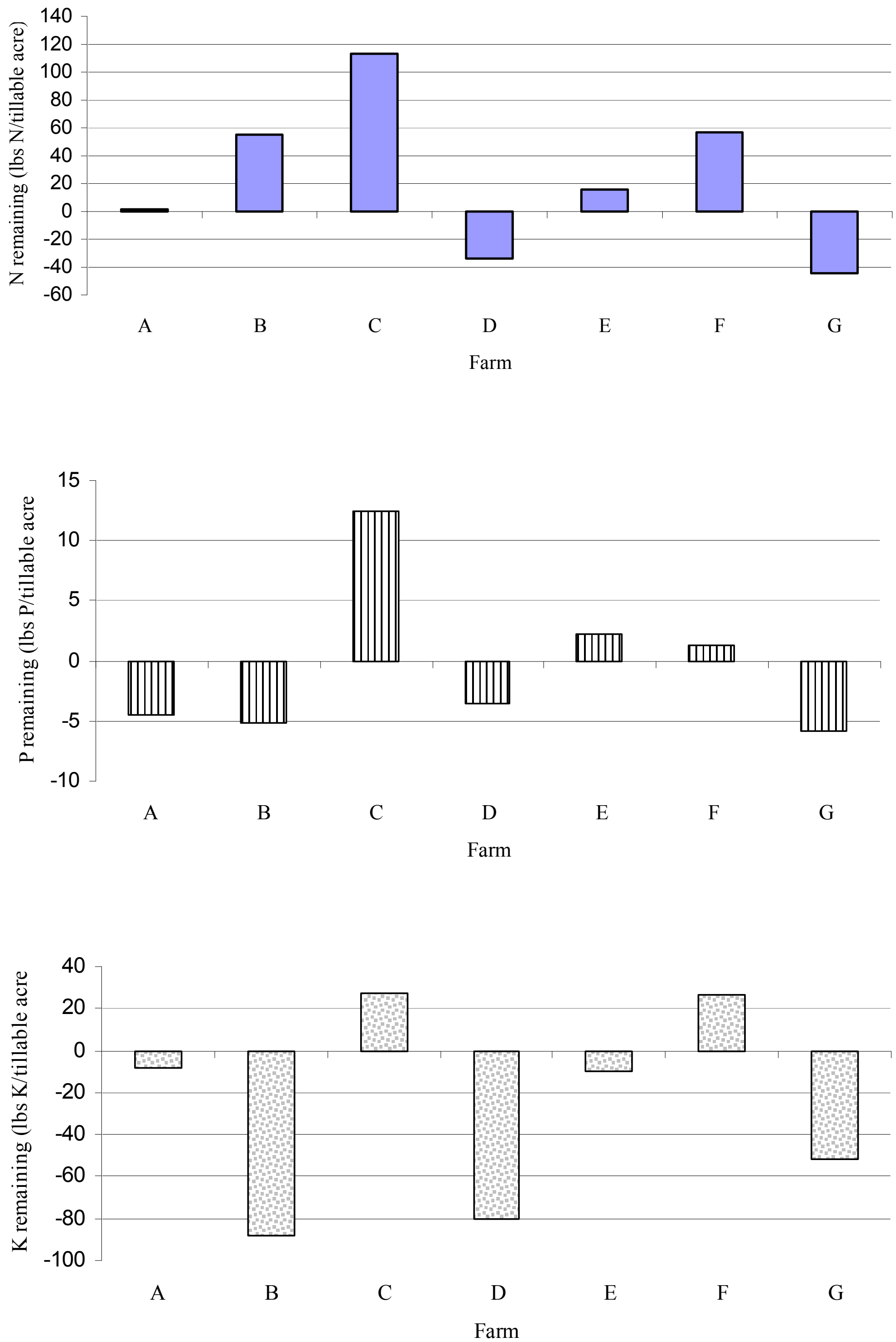


Figure 5. The changes from 2004 to 2006 for N, P and K remaining per tillable acre vary from farm to farm and between nutrients.

Table 7. Selected farm characteristics and average farm nitrogen, phosphorus and potassium balance factors, for 12 NNY dairy farms with crop sales and 12 NNY dairy farms without crop sales, 2006 data.

Business Size and Production	Farms with crop sales	Farms without crop sales
Mature cows	180	328
Animal units	343	581
Animal density (animal units/tillable acre)	0.59	0.78
Milk sold (lbs/tillable acre)	6,524	9,302
Milk sold (lbs/cow)	20,042	20,058
Tillable acres	633	683
Proportion of tillable acres receiving manure (%)	65	77
% purchased feed (% of total feed DM)	21	24
% farm produced forage (% of total forage DM)	1	2
Nitrogen Mass Balance		
Lbs N remaining/tillable acre *	49	90
Lbs N remaining/acre receiving manure *	103	111
N from purchased feed (lbs/tillable acre)	67	111
N from purchased fertilizer (lbs/tillable acre)	36	36
N from milk sales (lbs/tillable acre)	34	48
N from crop sales (lbs/tillable acre)	20	0
Phosphorus Mass Balance		
Lbs P remaining/acre	6	8
Lbs P remaining/acre receiving manure	13	10
P from purchased feed (lbs/tillable acre)	10	15
P from purchased fertilizer (lbs/tillable acre)	6	3
P from milk sales (lbs/tillable acre)	6	8
P from crop sales (lbs/tillable acre)	3	0
Potassium Mass Balance		
Lbs K remaining/acre	15	18
Lbs K remaining/acre receiving manure	27	34
K from purchased feed (lbs/tillable acre)	18	31
K from purchased fertilizer (lbs/tillable acre)	20	15
K from milk sales (lbs/tillable acre)	10	15
K from crop sales (lbs/tillable acre)	15	0

***** Values do not include N from N fixation or atmospheric deposition.

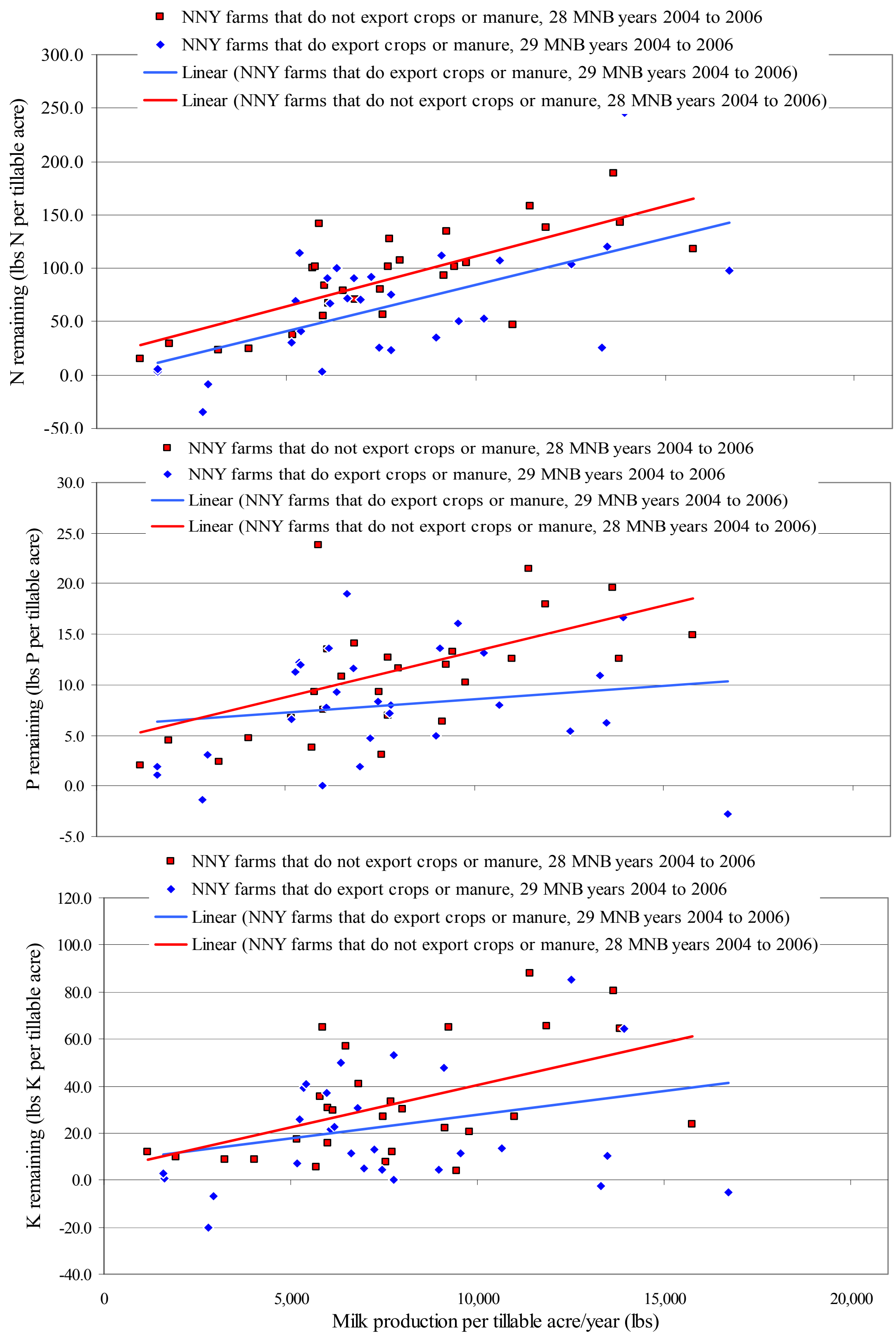


Figure 6. Dairy farms with off-farm crop sales generally had lower N, P and K remaining per tillable acre, a difference which increased with production intensity on Northern New York State dairy farms (57 Mass Nutrient Balances, 2004 to 2006).

Table 8. The proportion of purchased N, P and K fed on Northern New York Dairy Farms (46 mass nutrient balances, 2005 and 2006 data).

	N	P	K
Average (%)	34%	35%	16%
Median (%)	32%	31%	13%
Minimum (%)	5%	8%	1%
Maximum (%)	60%	66%	39%

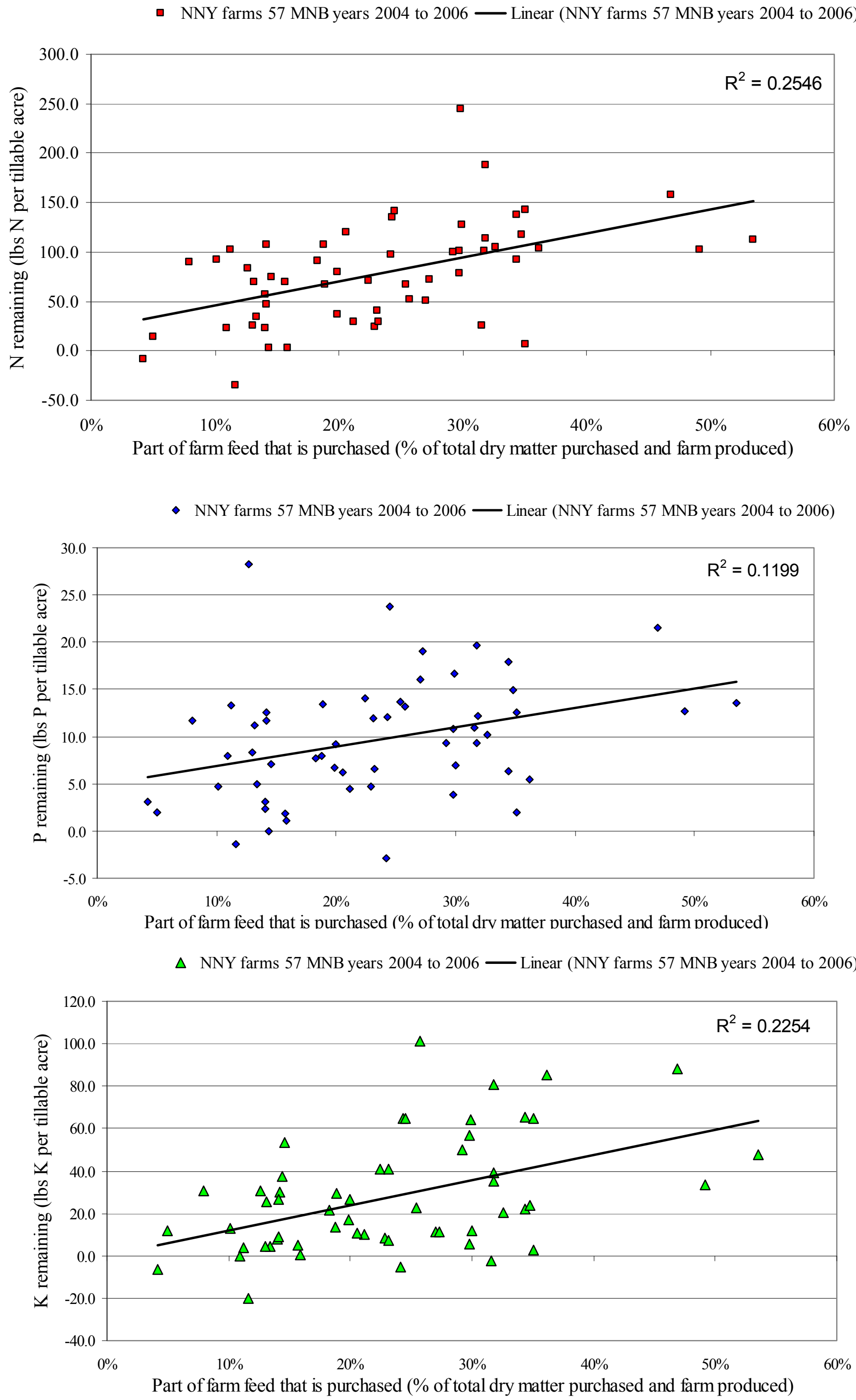


Figure 7. The N, P and K remaining per tillable acre is positively correlated to the proportion of feedstuffs that are purchased on 57 Northern New York dairy farm mass nutrient balances (2004 to 2006 data).

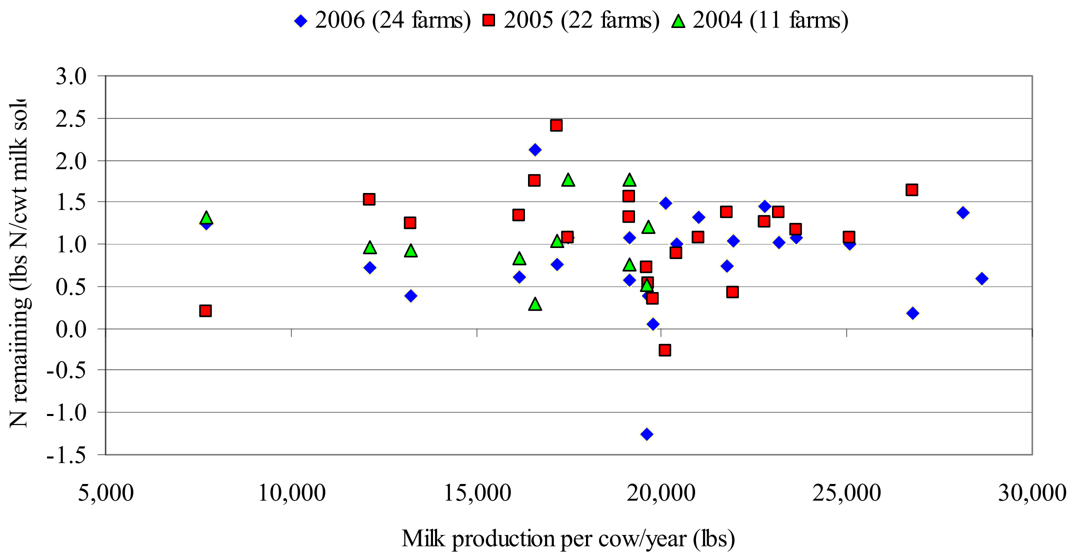


Figure 8. Nitrogen remaining per unit of milk (lbs N/cwt milk sold) for 57 Northern New York dairy farm mass nutrient balances (2004-2006 data).

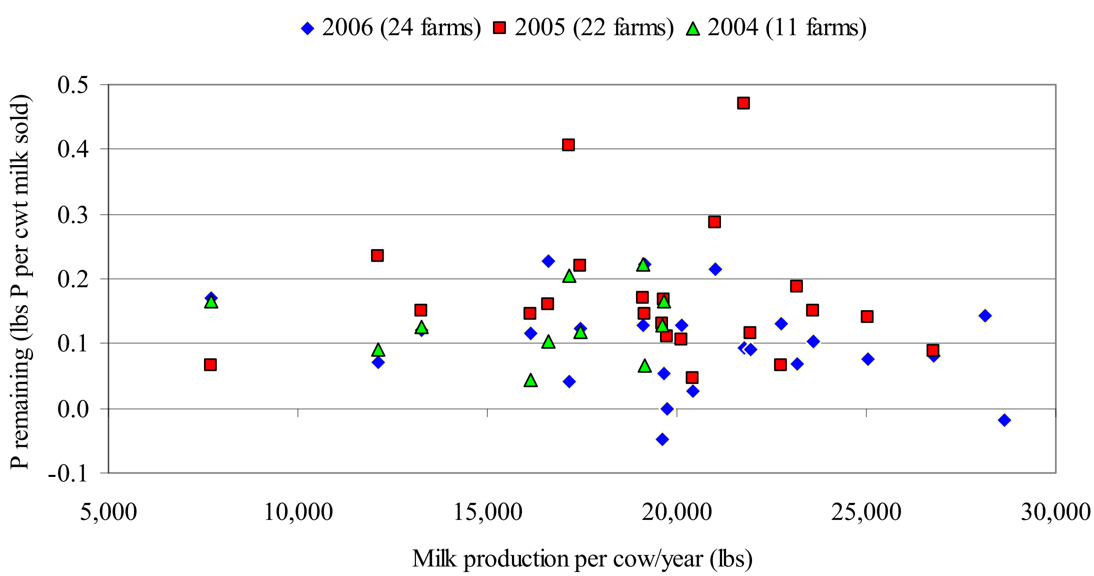


Figure 9. Phosphorus remaining (imports-exports) per unit of milk (lbs P/cwt milk sold) for 57 Northern New York dairy farm mass nutrient balances (2004-2006 data).

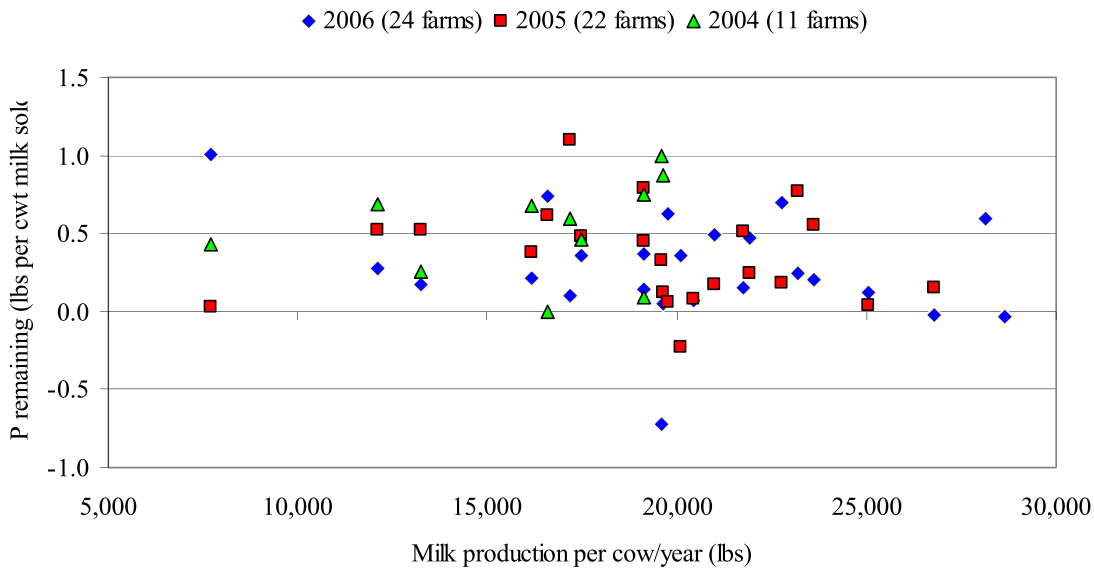


Figure 10. Potassium imports and exports per unit of milk (lbs K/cwt milk sold) for 57 Northern New York dairy farm mass nutrient balances (2004-2006 data).

NNY Agricultural Development Program
2006-2007 Project Report

Project Title: Precise Nitrogen Management for Corn Production

Project Leader(s):
Jeff Melkonian; Crop & Soil Sciences, Cornell University,
Harold van Es. Crop & Soil Sciences, Cornell University
Larry Geohring. Biol. & Environmental Engineering, Cornell University

Robert Schindelbeck. Crop & Soil Sciences, Cornell University
Michael Davis: Cornell research farms at Willsboro and Chazy.

CCE collaborators: **Peter Barney** (St. Lawrence Co.), **Michael Hunter** (Jefferson Co.), **Anita Deming** (Essex Co.) and **Carl Tillinghast** (Franklin Co.).

Background:

Deep placement of nitrogen (N) fertilizer for corn production. Successful new soil tillage management practices for corn production include the use of 'strips' or 'zones' that involve deep localized soil loosening with minimal surface disturbance. These methods maintain crop residue cover, conserve soil, and increase soil health and crop yields. With these, farmers may also apply N fertilizer through deep placement (10-12") when they perform the strip/zone tillage prior to planting. A three year replicated on-farm study in western NY has demonstrated that both the zone tillage and the deep N placement boost corn yields and improve soil health, and the combination of the practices resulted in average profit increases of $57 per acre. In this study, UAN was applied at planting (deep N placement) and contained a urease inhibitor to slow the conversion of urea to ammonium for up to two weeks (to reduce ammonia volatilization from broadcast N containing urea) It also contained a nitrification inhibitor to slow the conversion of ammonium to nitrate for up to 6 – 8 weeks, roughly corresponding to the beginning of the rapid growth and N uptake period for corn. The nitrification inhibitor was intended to protect the deep applied N from leaching, retaining more N in the root zone for the corn crop. Both the deep N placement and nitrification inhibitor also may reduce denitrification losses on fine-textured soils as suggested in a Minnesota study. There have not been any controlled trials that evaluated the N dynamics associated with deep vs. shallow N placement on different soil types, nor determined the potential for reduced N rates with increased soil health.

Precision N application. Nitrogen management for both silage and grain corn production continues to be a challenge for economic, agronomic and environmental reasons. Nitrogen fertilizer prices have recently risen 50% or more as the cost of fossil fuels have increased. Year-to-year variability in weather can affect the timing of application and amount of fertilizer to add that will meet the crop's N needs without over-fertilizing. Off-farm N losses to the environment from crop (particularly corn) production are receiving increased attention with possible legal implications. Improving crop N use efficiency is, therefore, important for maintaining or improving farm incomes from corn production, and can also reduce N losses to the environment. From past research, we have quantified the effects of various fertilizer N and manure management practices on N losses associated with corn production (see Appendix 1). This research, and other research at Cornell and elsewhere has shown a year-to-year variation in optimum N rates for corn of up to 80 lbs/acre that is due, in part, to variability in soil N as affected by early season weather. This range in optimum N rates represents an opportunity for more efficient use of N fertilizer. Based on this research, we have developed and calibrated a computer model-based approach (using the Precision Nitrogen Management Model, PNM) that accounts for the impact of early season weather on soil N to provide more precise recommendations for N management in corn. Dairy farmers are especially interested in such predictions, as fields are often manured based on estimated N availability, but may still require costly additional sidedressing in wet years. Given the high nitrogen fertilizer prices and the increased regulatory pressure to reduce agricultural N losses to surface waters and groundwater, there is a need for improved N management for corn production in northern New York. This project seeks to encourage NNY farmers and extension staff to adopt PNM-generated recommendations, allowing for more precise N management.

Methods:

Deep placement of N fertilizer for corn production. This study was conducted on sandy loam and clay loam plots at the Willsboro Farm. For each soil texture class, there were subplots representing long-term continuous corn and corn after grass under plow till and no till. Nitrogen (nitan) was applied on no-till plots through deep placement (10-12”) associated with deep tillage using a two row ripper with attached tubes behind the ripper shanks for deep N placement (Photo 1a,b) and (ii) conventional sidedress. On plowed plots, N (nitan) was applied as (i) broadcast/incorporated at planting using the same two row ripper but with N applied on the surface and immediately incorporated (Photo 2), and (ii) conventional sidedress. Deep N placement (no till) and broadcast/incorporated N at planting (plow till) contained a nitrification/urease inhibitor (Agrotain Plus®)[3] at the recommended rate. The same total N (125 lbs N/acre) was applied in all treatments. The crop was planted on 5/10/07 (Seedway E224RR, 85 d RM at 42,000 seeds/acre) and sidedress subplots received N on 6/19/07. We tracked N in the soil, crop and in subsurface drainage water from the subplots. Soil samples were collected for soil health measurements prior to planting and samples for soil N (0-6”, 6-12”) were collected periodically from planting to sidedress. Subplots at both the sandy loam and clay loam plots had sub-surface drainage with wells where the drainage water (from below the root zone) was collected after periods of high rainfall to determine N leached out of the root zone. The subplots on both the sandy loam and clay loam plots were harvested on 8/29/07 to get crop harvest information including silage yield (65% moisture and dry weight) and crop N uptake.

[3] Agrotain International LLC

Precision N application. We established different sidedress N treatments on plots at a long-term zone till and plow till tillage experiment at the Willsboro research farm. Soil samples were collected for soil health measurements prior to planting and samples for soil N (0-6", 6-12") were collected periodically from planting to sidedress. All plots were planted on 5/9/07 (Seedway E224RR, 85 d RM at 42,000 seeds/acre) and received 15 lbs N/acre starter. Different levels of sidedress N (nitan) (0, 45, 75, 105, 135 and 165 lbs N/acre) were applied on 6/19/07 as subplots in each of the tillage plots. The 105 lbs N/acre treatment corresponded most closely to the PNM-model adjusted sidedress recommendation for this date, location and soil type (Appendix 2, Climate Region 7 N). The subplots on both the zone till and plow till plots were harvested on 8/29/07 to get crop harvest information including silage yield (65% moisture and dry weight) and crop N uptake.

Results:

Deep placement of N fertilizer for corn production. The application of the deep tillage/deep N placement (Photo 3) and surface broadcast treatments (Photo 4) using the two row deep ripper was successful.

Sandy loam plots. There were no significant differences in final harvest population or in silage yield among the main treatments or related to previous cropping history (continuous corn, corn after grass). (The no till/sidedress subplots suffered significant animal damage and we were unable to obtain reliable data from this treatment. Additional measures will be taken in 2008 to prevent this from occurring again.) Average harvest populations ranged from approximately 35,000 to 37,000 plants/acre. Average silage yield (65% moisture) of the plow till/sidedress treatment (19 tons/acre) was a slightly lower than the other two treatments (no till/deep tillage and N placement (20.2 tons/acre) and plow till/surface broadcast N (21 tons/acre)) (Appendix 3, Fig. 1). May and June 2007 rainfall at the Willsboro research farm was below average (Appendix 3, Fig. 2). There was very little drainage into the tile lines under the subplots in 2007. We have not analyzed the collected drainage samples for N content yet, but given the very small flows, N losses through leaching out the root zone were minimal. Since leaching is the main pathway for N loss sandy loam soils, this indicates that, for a dry early season like 2007, N availability to the crop was similar regardless of the N management practice (deep N placement, broadcast/incorporation at planting, sidedress),. Reduced early season soil N losses combined with 125 lbs N/acre fertilizer applications resulted in relatively high soil N levels following harvest (50 and 70 lbs N/acre in the top 12").

Clay loam plots. There were no significant differences in final harvest population among the treatments. (As with the sandy loam plots, the no till/sidedress subplots suffered significant animal damage and we were unable to obtain reliable data from this treatment. Additional measures will be taken in 2008 to prevent this from occurring again.) Average harvest populations ranged from approximately 33,000 to 35,000 plants/acre. Silage yields (65% moisture) were slightly lower in the plow till/sidedress (18.2 tons/acre) and plow till/surface broadcast N (17.8 tons/acre) treatments compared to the no till/deep tillage and N (20.1 tons/acre) (Appendix 3, Fig. 3) indicating a possible advantage of deep tillage/deep N placement in the clay loam soils. (Results from the upcoming 2008 growing season should allow us to test this further.) As with the sandy loam subplots, there was very little drainage into the tile lines under the clay loam subplots indicating little N leaching losses out of the root zone. Previous research has shown that denitrification N losses are more significant than N leaching losses on heavier textured soils. However, we expect that denitrification losses were low because of the relatively dry conditions (N losses by denitrification are favored by high soil moisture and temperature). Again, as with the sandy loam subplots, reduced early season N losses combined with the 125 lb N/acre applications resulted in relatively high soil N levels (50 to 100 lbs N/acre in the top 12”) following harvest.

Precision N application. Soil N in the top 12” from late May to sidedress is shown for the zone till and plow till plots (Appendix 3, Fig. 4). Soil N (from mineralization of native organic matter) increased from approximately 50 lbs/acre in late May to approximately 160 lbs N/acre (zone till) and 125 lbs N/acre (plow till) in early June. The large accumulation in soil N under both tillage practices indicates the capacity of the soil to supply N when soil N losses are low due to lower than average rainfall. (The higher soil N accumulation in the zone till plots was correlated with higher soil organic matter (4.8%) in the top 6” of the soil under that tillage practice compared with plow till plots (3.9%).)

Both the zone till and plow till plots showed an N response to the different sidedress N rates. In both tillage plots, silage yields (65% moisture) increased to a maximum as sidedress N increased from 0 to 105 lbs N/acre (the PNM model recommended rate for this location) (Appendix 3, Fig. 5a (zone till subplots), b (plow till subplots)). Silage yield did not increase with sidedress N rates above 105 lbs N/acre on both the zone till and plow till plots. There was a significant yield response to the tillage practice also. Yields in the zone till subplots were 3.5 to 5 tons/acre (65% moisture) higher compared to the plow till plots at all sidedress N rates (Appendix 3, Fig. 5a, b).

Conclusions/Outcomes/Impacts:

Deep placement of N fertilizer for corn production. In 2007, there was no significant yield advantage on either the clay loam or sandy loam plots related to deep tillage and N placement in the no till subplots. (As previously mentioned, we did not have the data to compare the no till deep tillage and N placement with no till sidedress N.) Rainfall totals for May and June 2007 were low compared to the averages for these months so that soil N leaching losses were low (little drainage occurred in either the clay loam or sandy loam subplots) and it is likely that N losses due to denitrification were also low (although this was not measured directly). We believe this resulted in no advantage (reduced denitrification losses on heavier textured soils) or disadvantage (greater leaching losses on coarser textured soils) of the deep tillage/deep N placement compared to the other treatments. We will continue this testing in 2008 including an additional focus on the possible impact of the nitrification inhibitor on N losses.

One suggested management practice from this study is that a cover crop should be considered in years where there was a dry early season and significant residual soil N after harvest. We measured up to 100 lbs N/acre in some of the subplots after harvesting and past research has shown that soil N levels the following spring are generally low as a result of N losses over the fall/winter/early spring period when there is no crop cover and crop water uptake. Another suggested management guideline is to adjust N application rates for early season weather using tools like the PNM model (see below).

Precision N application. Based on our results at the Willsboro research farm in 2007 and other testing, we recommend that growers use the PNM model for more precise N management in corn production. The PNM model-recommended sidedress N rate of 105 lbs/acre was the optimum sidedress rate for both the zone till and plow till plots. There was also a clear yield advantage related to zone tillage. This should be considered as a management option where recommended (see the 2007 Cornell Guide for Integrated Field Crop Management).

Outreach:

Deep placement of N fertilizer for corn production. Results of the 2007 research will be presented at meetings in Canton (1/30/08), Plattsburgh (2/7/08) and Malone (2/8/08) in conjunction with presentations on the Soil Health NNYADP 2007 project (van Es et al.). Anita Deming (CCE Executive Director, Essex Co.) and John Idowu (Dept. of Crop and Soil Sciences, Cornell) are the contact people for these meetings.

Precision N application. The PNM model for field or farm level N application recommendations for corn will be offered in 2008 via the web. The url for accessing the interface will be made available later this winter. Training for CCE staff on the use of the interface will be held at a combined Soil Health/ PNM model workshop at Cornell University on Tuesday, March 18, 2008 ("Cornell Soils Workshop: Soil Health & Dynamic Nitrogen Modeling"). Bob Schindelbeck and Larissa Smith (Dept. of Crop and Soil Sciences, Cornell) are the contact people for the workshop.

We will also continue offering PNM model-generated sidedress N recommendations by climate region for 2008. These will be provided twice a week from late May to early July, 2008. As in the past, the recommendations will be sent out as part of an email extension bulletin to CCE staff, including those in NNY.

Next steps:

We have received NNYADP funding to continue both projects ("Deep placement of N fertilizer for corn production" and "Precision N application") at the Willsboro research farm in 2008. This will allow us to more thoroughly test deep N placement and the PNM model as N management tools for NNY, particularly since early season precipitation in 2007 was below average. Results from the 2008 field season will be presented at workshops in NNY in the winter of 2008-2009.

Acknowledgements:

We would like to acknowledge the NNY Agricultural Development Program for their generous support in 2007. We would also like to acknowledge Mr. John Altobelli

(grower) and Chuck Bornt (CCE, Team Leader, Capital District Regional Vegetable Program) for their assistance with the deep ripper/deep N applicator.

Reports:

Handouts on our 2007 NNYADP-funded research were provided at the 2007 CCE Agricultural and Food Systems Inservice, 11/15/07, at the Ramada Inn in Ithaca. The handouts were from an oral presentation by J. Melkonian as part of the Field Crops Soil Management Update.

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Soil N and yield plots.

Figure 1. Mean subplot silage yields in the sandy loam plot at the Willsboro research farm in 2007. NT_DeepN = no till deep tillage and N (125 lbs N/acre) placement at planting; PT_BroadcastN = plow till, N (125 lbs N/acre) broadcast and incorporated at planting; PT_SidedressN = plot till sidedress N (15 lbs N/acre) applied as starter and 110 lbs N/acre applied as sidedress on 6/19/07). (Error bars: ± s.e.)

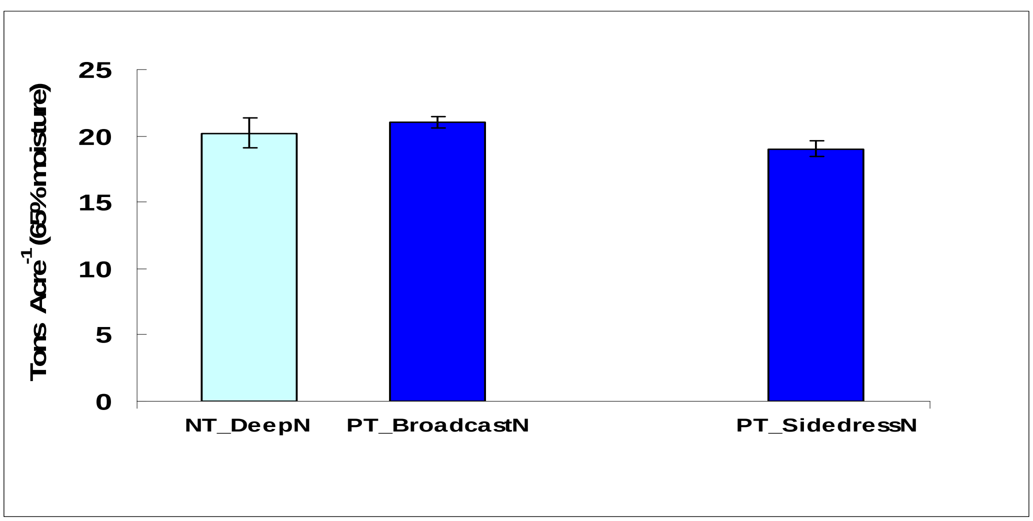


Figure 2. Long term vs. 2007 May and June rainfall totals (inches) for the Willsboro research farm.

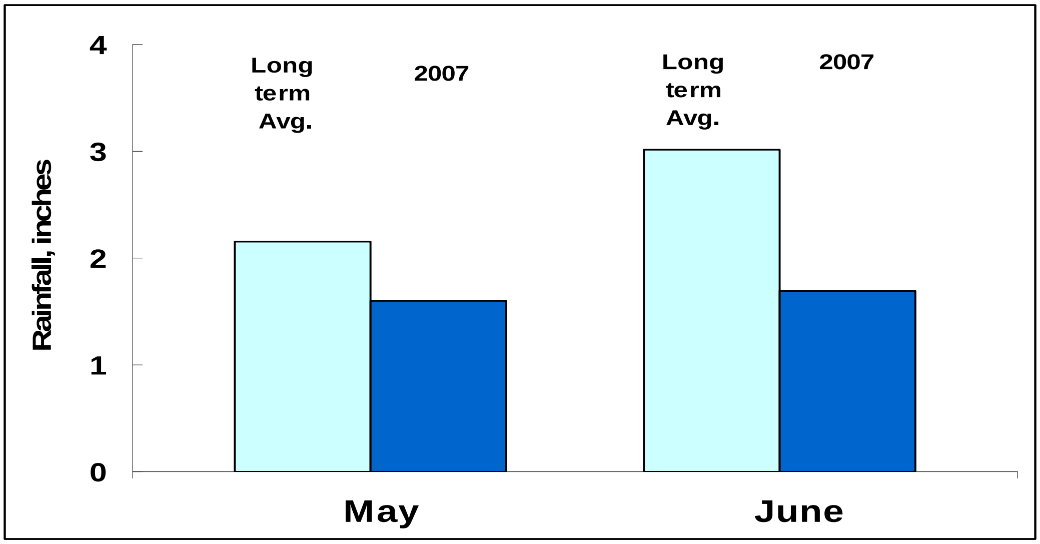


Figure 3. Mean subplot silage yields in the clay loam plot at the Willsboro research farm in 2007. NT_DeepN = no till deep tillage and N (125 lbs N/acre) placement at planting; PT_BroadcastN = plow till, N (125 lbs N/acre) broadcast and incorporated at planting; PT_SidedressN = plot till sidedress N (15 lbs N/acre) applied as starter and 110 lbs N/acre applied as sidedress on 6/19/07). (Error bars: ± s.e.)

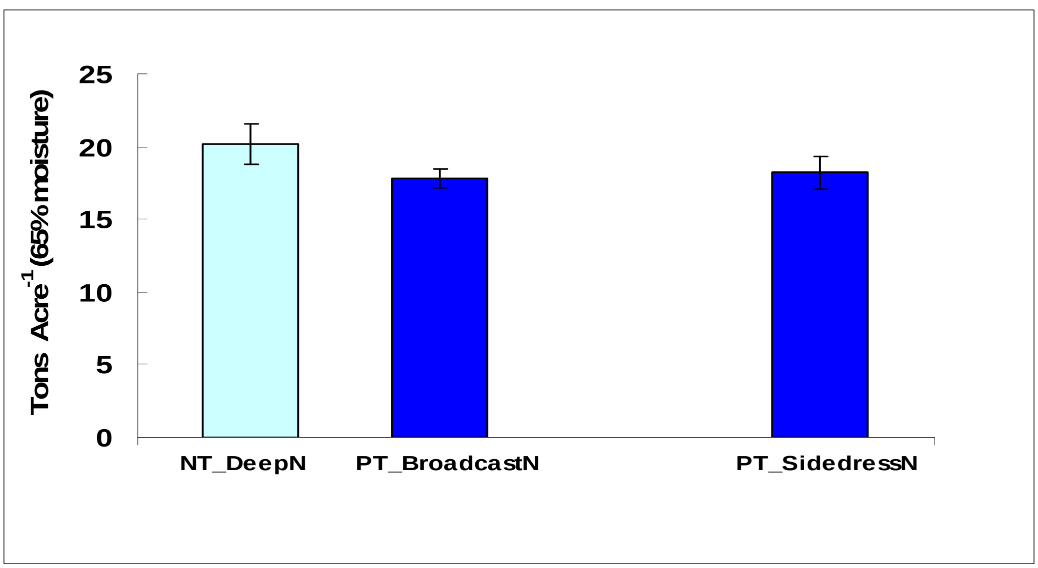


Figure 4. Soil N (nitrate-N and ammonium-N) in the top 12” of the root zone in the zone till and plow till plots at the Willsboro research farm in spring, 2007.

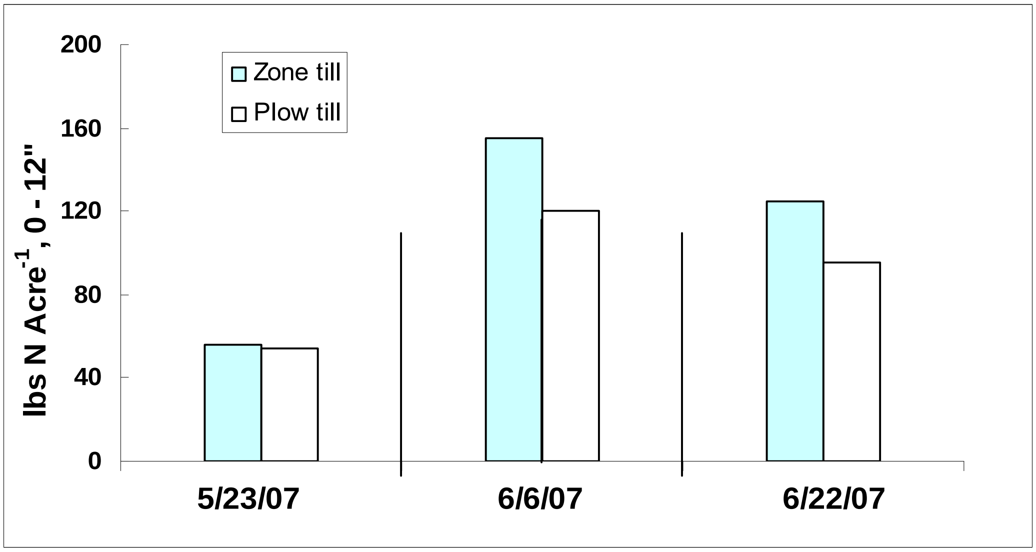
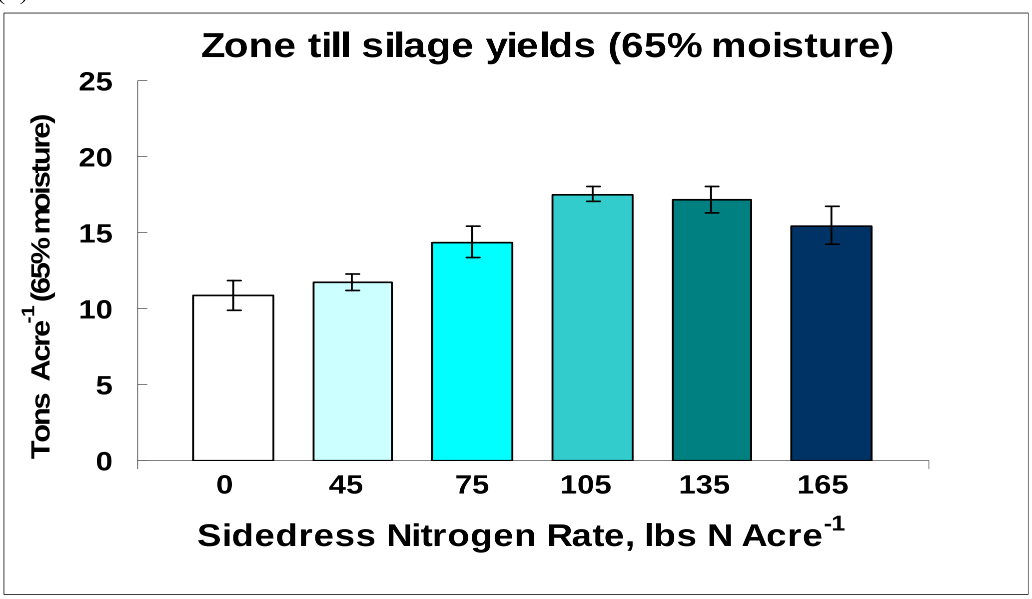
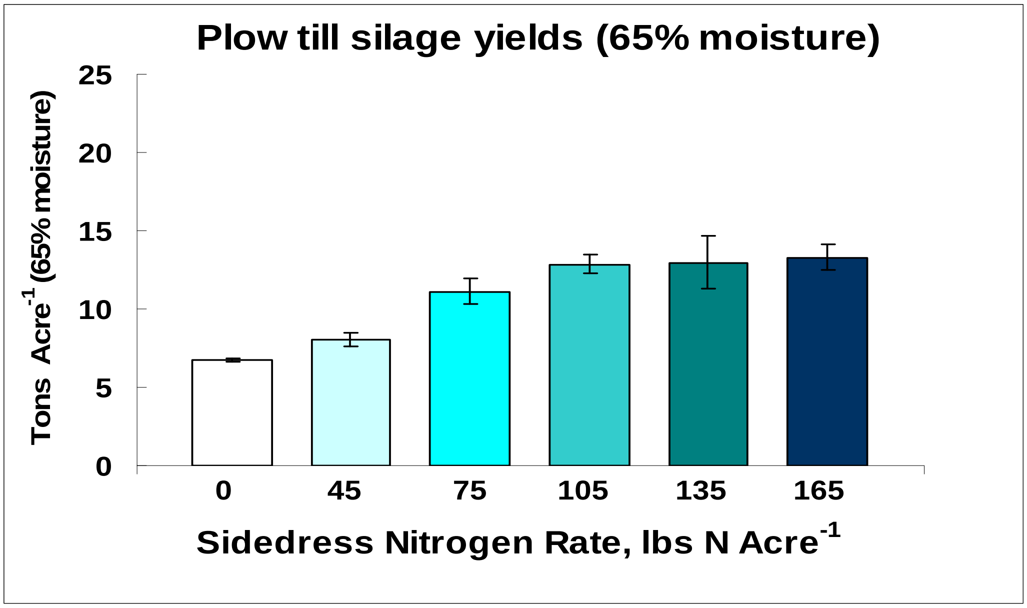


Figure 5 a,b. Mean sidedress N subplot silage yields in the zone till plots (a) and plow till plots (b) at the Willsboro research farm in 2007. (Error bars: ± s.e.)

(a)



(b)



Plow till silage yields (65% moisture)
Tons Acre-1 (65% moisture)
25
20
15
10
5
0
0
45
75
105
135
165
Sidedress Nitrogen Rate, lbs N Acre-1

NNY Agricultural Development Program
2006-2007 Project Report

Title of project: Nitrogen Needs for Corn Following Grass/Legume Sods

Project Leader:

- Quirine M. Ketterings, Associate Professor, Nutrient Management Spear Program (NMSP), Dept. of Crop and Soil Sciences, Cornell University

Project Coordinator:

- Joe Lawrence, Nutrient Management Spear Program, Dept. of Crop and Soil Sciences, Cornell University

Collaborators:

- Cornell University:: Karl J. Czymmek, PRODAIRY Greg Godwin, Nutrient Management Spear Program; Mike Davis, Willsboro Research Farm
- Cornell Cooperative Extension: Pete Barney (St. Lawrence County; Mike Hunter (Jefferson County

Cooperating Producers (2007):

- Mike Northrup (Jefferson County); Merle Yancey (Lewis County); David Fisher (St. Lawrence County)

Background:

Nitrogen prices and environmental concerns have caused many corn producers and advisors to rethink their current N management practices. From 2002 to 2004, laboratory and field trials were conducted in NY (including sites in St Lawrence, Jefferson and Clinton County) to evaluate the performance of a new soil N test, the Illinois Soil N Test (ISNT, also referred to as the aminosugar N test) in identifying whether or not additional N is needed. This work showed great promise for the test in New York State and has led to the development of critical ISNT values beyond which additional N from manure or fertilizer is not likely to result in a yield response. Additional field trials were needed specifically on N needs for corn in a corn-sod rotation.

Methods:

In 2007, we conducted four field trials; two were 2nd year corn sites, one was 3rd year corn and one 4th year corn site. Site characteristics for each trial are listed in Table 1. For the on-farm trials in St Lawrence, Lewis and Jefferson County, each trial had 4 treatments (starter N only, starter plus 50, 100 or 150 lbs N/acre) in 4 replicates per treatment. In Willsboro, a fifth treatment was added: no N (no starter, no sidedress N). Each plot was 4 or 6 rows wide (depending on the planter) and 50 feet long. Soil samples were be taken at PSNT time and at harvest (0-8 and 0-12 inch samples) and analyzed for the standard soil fertility package and soil nitrate. Chlorophyll tests were done when the corn was in the 5 leaf stage to assess potential N deficiency and at harvest. Plots were harvested for silage (2 rows of 40 feet each) and sub-samples were taken to determine moisture content, stalk nitrate, N removal and silage quality. Trials were located in St Lawrence, Lewis, Jefferson, and Essex Counties (Willsboro Research Farm).

Table 1: Site characteristics for the 4 nitrogen rate studies in Northern New York in 2007.

	Site location			
	St Lawrence	Lewis	Jefferson	Essex 3
	Soil series			
	Swanton fine sandy loam	Nellis loam		Stafford fine sandy loam
Planted	5/10/2007	5/15/2007		5/8/2007
Sidedressed	6/14/2007	6/18/2007	6/15/2007	6/15/2007
Harvested	9/14/2007	9/6/2007	9/7/2007	9/4/2007
	Cropping history/dry matter yield			
2006	Corn	Corn		Corn
	7.8 tons/acre	145 bu/acre		7.8 tons/acre
2005	Corn	Corn		Corn
	7.8 tons/acre	170 bu/acre		7.8 tons/acre
2004	Grass	Corn		Grass
	2.8 tons/acre	155 bu/acre		NA
2003	Grass			Grass
	2.8 tons/acre			NA
	Legume % in the sod			
	<10%	-		0
	Date sod killed			
	Oct ‘04	-		May ‘06
	Manure history (NM = no manure)			
2006	NM	NM	NM	NM
2005	NM	NM	NM	NM
2004	8144 gal/acre	NM	NM	NM
	16-Jun			
2003	16470 gal/acre[2]	NM	NM	NM
	June and Oct.			
	N fertilizer history (lbs N/acre)			
2006	.	130	.	.
2005	.	130		.
2004	.	130		.
2003	46			.
	Fertilizer addition at planting (2007)			
lbs N/acre	22	32		15 (0)[3]
lbs P_2O_5/acre	10 + 35	91		61 (0)[3]
lbs K_2O/acre	0 + 60	63		61 (0)[3] + 90

[1] Two cuttings.
[2] Two applications.

[3] A no starter treatment was included at the two Essex trials (Willsboro Research Farm).

Each of the sites was sampled for basic soil fertility levels when the corn was 6-12 inches tall and at harvest. These data are presented in Table 2. Additional K was applied at the Willsboro sites and the St. Lawrence County sites (based on 2006 soil test) to assure that P or K would not be a limiting factor for corn growth either.

Table 2: Soil management groups (SMG), soil series and general soil fertility data for the 4 nitrogen rate studies in Northern New York in 2007. L=low; M=medium, H=high, VH=very high, N=normal, E=excessive.

	Site Location			
	St Lawrence	Lewis	Jefferson	Essex 3
	Swanton fine sandy loam	Nellis loam		Stafford fine sandy loam
SMG	4	4		4
pH	6.7	7.4	7.6	6.6
OM (%)	3.3	3.7	5.0	1.9
LOI OM (%)	5.0	5.6	7.5	3.0
P (lbs/acre)	16.9	63.7	20.5	22.2
K (lbs/acre)	191.4	178.9	206.1	74.7
Mg (lbs/acre)	457	133	183	83
Ca (lbs/acre)	3020	6646	14691	2024

Results:

Yields and Optimum Economic N Rates:

The St. Lawrence and Jefferson County sites were non-responsive (Table 3 and Fig. 1).

Table 3: Silage yields for the 4 Northern New York trials.

N Rate	Silage yield (tons/acre 65% moisture)			
	St Lawrence	Lewis	Jefferson	Essex 3
No N				15.9 b
Starter N only	22.5 a	18.0 c	11.4 a	17.6 ab
Starter + 50 lbs N	23.8 a	20.5 b	14.1 a	19.6 a
Starter +100 lbs N	24.2 a	23.0 a	15.9 a	19.3 ab
Starter +150 lbs N	23.2 a	23.2 a	15.6 a	21.1 a
	Moisture content at harvest (% moisture)			
No N				53.2 a
Starter N only	63.3 a	60.8 a	49.6 a	56.5 a
Starter + 50 lbs N	62.1 a	61.4 a	54.1 a	54.1 a
Starter +100 lbs N	63.6 a	62.7 a	52.1 a	51.9 a
Starter +150 lbs N	64.0 a	62.8 a	48.5 a	53.1 a

†Average values with different letters (a,b,c) are statistically different ($\alpha = 0.05$)

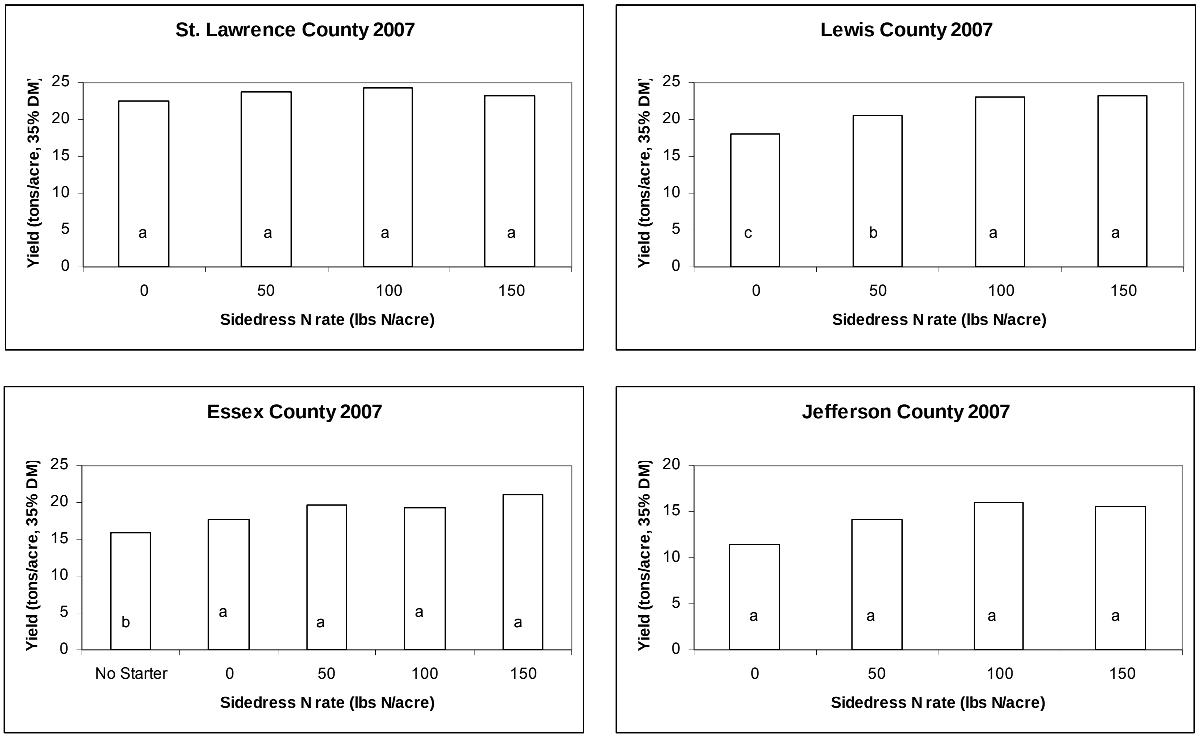


Figure 1: Yields as impacted by N application rate for 4 Northern New York field trials in 2007.

The Lewis County site responded showed a response to sidedress N while the Essex County site showed a response to starter N. Based on the calculation:

N rate (lbs/acre) = [(Yield Potential*1.2) – Soil N – Sod N] / (N efficiency/100) [1]

Essex County site 3 (2^{nd} year corn) would have required 74 lbs N/acre (65-85 lbs) for optimum yield for a yield potential of 18.7 tons/acre at 35% DM. The optimum economic N rate for this site in the 2007 growing season was about 136 lbs N/acre split applied as 30 lbs N/acre in the starter band and about 106 lbs N/acre applied at side-dress time (Table 4) with an actual yield of about 17.6 tons/acre. Assuming a yield potential of 19.4 tons/acre, equation [1] would have predicted an N rate of 103 (95-115) lbs N/acre. If there had been no sod-N carryover into the second year, the recommended N rates would have been 111 lbs (100-120) N/acre assuming an 18.7 tons/acre yield potential and 118 (110-130) lbs N/acre for the actually obtained yield. The Lewis County site (4^{th} year corn) would have required 133 (125-145) lbs N/acre for optimum yield with a yield potential of 23.8 tons/acre at 35% DM. The optimum economic N rate for this site in the 2007 growing season was 147 lbs N/acre split applied as 30 lbs N/acre in the starter band and about 117 lbs N/acre applied at side-dress time (Table 4) with an actual yield of about 23 tons/acre. These combined results suggest that second year N credits might need to be adjusted and additional work is needed.

Table 4: Optimum economic N rates (30 lbs/acre starter plus side-dress N) for Essex 3 and Lewis County as influenced by forage value and N fertilizer costs. See Tables 1 and 2 for site characteristics and Table 3 and Figure 1 for yields.

		Fertilizer Price ($ per lbs of N)			
		$0.30/lbs N	$0.40/lbs N	$0.50/lbs N	$0.60/lbs N
		Essex 3			
Forage Value ($ per ton)	$25/ton	161	141	121	101
	$30/ton	171	154	137	121
	$35/ton	178	164	149	135
	$40/ton	183	171	158	146
		Lewis			
Forage Value ($ per ton)	$25/ton	158	149	140	132
	$30/ton	162	155	148	140
	$35/ton	165	159	153	147
	$40/ton	167	162	157	151

Tools for N Management:

Pre-Sidedress Nitrate Test

The PSNT results predicted a need for addition N for all of the 2007 sites. However, only one site (Lewis) showed a response to sidedress N and the PSNT identified only this one site correctly (Table 5). The inaccuracy of the PSNT in 1st year corn is well documented, but the test is generally more reliable in 2^{nd+} year corn. Our 2005-2007 results show the challenges with taking an accurate PSNT in extreme growing conditions (wet in 2005 and 2006, dry in 2007).

Chlorophyll at PSNT Time

The new procedure for chlorophyll testing to predict the need for sidedress N fertilizer developed by Penn State (Beegle and Piekielek) recommends no additional N if the first reading at the 6 leave stage is 46.0 or greater. For sites with readings below 42.0, sidedress N is recommended and for sites between 42.0 and 45.9, a second reading is recommended 4-7 days later for corn at the 7-8 leaf stage. If for this second reading, values are 43.0 or greater, no additional N is needed. It was not feasible to do repeated measurements but based on the one time reading, the test was incorrect at 3 of 4 sites (Table 5). Data from 2005-2007 showed a very low accuracy for this test across all sites and we conclude a one-time chlorophyll measurement is not a valid option for NY.

Stalk Nitrate Test

Based on work in NY in 2005 and 2006 a site would have benefited from additional N if the Stalk N value is <250 ppm while if the value is >2000 ppm then the site had excess N. The four NNY sites showed a wide range of stalk N values (Table 5); however, at all sites there was a clear trend with increasing stalk N values as side-dress rates increased. This test is a very clear indicator in N management for corn in the 2nd year and beyond but should be used over multiple years as year specific conditions such as weather affect the value.

Table 5: Pre-sidedress nitrate test (PSNT), chlorophyll at sidedress and harvest time, end-of-season soil nitrate (12 inches), and stalk nitrate test data for the 4 NNY trials.

N Rate	PSNT (ppm)			
	St Lawrence	Lewis	Jefferson	Essex 3
	3rd year corn	4th year corn	2nd year corn	2nd year corn
	Non-responsive	Responsive	Non-responsive	Responsive
No N				9.9 a
Starter N only	10.5 a	13.8 a	10.0 a	9.5 a
Starter + 50 lbs N	9.5 a	12.1 a	15.5 a	9.5 a
Starter +100 lbs N	10.1 a	13.4 a	10.4 a	9.0 a
Starter +150 lbs N	11.4 a	12.3 a	11.1 a	8.4 a
	Chlorophyll at PSNT time			
No N				35 a
Starter N only	41 a	48 a	42 a	35 a
Starter + 50 lbs N	47 a	44 b	41 a	35 a
Starter +100 lbs N	39 a	47 ab	41 a	33 a
Starter +150 lbs N	37 a	48 ab	41 a	32 a
	Stalk nitrate test (ppm)			
No N				67 b
Starter N only	1252 b	104 b	80 c	75 b
Starter + 50 lbs N	2615 ab	54 b	85 c	118 b
Starter +100 lbs N	4245 ab	304 b	852 b	1960 a
Starter +150 lbs N	5907 a	2127 a	1607 a	2292 a
	End-of-season soil nitrate test (ppm)			
No N				0.0 a
Starter N only	2.7 a	0.0 a	0.0 a	0.0 a
Starter + 50 lbs N	0.0 a	0.0 a	0.0 a	0.0 a
Starter +100 lbs N	2.9 a	0.0 a	0.0 a	0.0 a
Starter +150 lbs N	4.5 a	0.0 a	2.7 a	1.8 a
	Chlorophyll at harvest			
No N				21 b
Starter N only	41 b	30 c	11 a	19 b
Starter + 50 lbs N	42 b	44 b	22 a	20 b
Starter +100 lbs N	44 ab	54 a	30 a	26 ab
Starter +150 lbs N	50 a	57 a	31 a	35 a

†Average values with different letters (a,b,c) are statistically different ($\alpha = 0.05$)

Chlorophyll at Harvest Time
The chlorophyll test results increased as the sidedress N rates increased (Table 5) but the End-of-season Stalk N test is a much more reliable indicator of the crops N status at the end of the year.

End of Season Soil Nitrate Test
End-of-season nitrate levels were very low (Table 5). This is an indication even in a dry year any fertilizer N not taken up by the plant will be lost to the environment.

Forage Quality

Crude and Soluble Protein
Slight drops in crude and soluble protein at these sites are consistent with the work done in 2005 and 2006 (Table 6). However, it is clear that is does not significantly affect the overall forage quality based on the values for milk per ton (Table 8) and economic analysis performed using a common Northeast USA TMR dairy ration showed the if there was no yield response it was much more costly and had had greater environmental impacts to sidedress N as a method to gain crude protein than to supplement the ration with soybean meal to make gain the crude protein lost by not sidedressing.

Table 6: Impact of N application on crude protein and soluble protein for the 4 Northern New York trials in 2007.

	St. Lawrence	Lewis	Jefferson	Essex 3
	3rd year corn	4th year corn	2nd year corn	2nd year corn
	Non-responsive	Responsive	Non-responsive	Responsive
	Crude Protein (% of DM)			
No Starter			.	5.2 c
0	7.0 b	5.4 c	.	5.1 c
50	7.3 b	6.2 b	.	6.2 b
100	7.4 b	7.4 a	.	6.7 ab
150	8.2 a	8.0 a	.	7.1 a
	Soluble Protein (% of DM)			
No Starter			.	1.3 b
0	1.8 a	1.6 b	.	1.3 b
50	1.9 a	1.8 b	.	1.5 ab
100	1.9 a	2.1 a	.	1.5 ab
150	2.0 a	2.2 a	.	1.8 a

† Forage data was not analyzed for Jefferson County site due to weed pressure and poor yields.

Other Forage Quality Parameters
Neutral detergent fiber (NDF), digestible NDF (dNDF), lignin and starch were also analyzed and no significant differences between N application rates were observed with any of these parameters (Table 7).

Milk per Ton and Milk per Acre

Milk per ton is a measure of lbs of milk per ton of silage measured by the U. of Wisconsin's milk2006 program. Despite the yield response at two sites there was no significant change in overall forage quality across the N application rates (Table 8). Milk per acre is a combination of forage quality and yield measured by the U. of Wisconsin's milk2006 program. Significant differences at Essex 1 indicate the decrease in yield at lower N application rates.

Table 7: Impact of N application on NDF, dNDF, lignin and starch for the 4 Northern New York trials in 2007.

	St. Lawrence	Lewis	Jefferson	Essex 3
	3rd year corn	4th year corn	2nd year corn	2nd year corn
	Non-responsive	Responsive	Non-responsive	Responsive
	NDF (% of DM)			
No Starter			.	53.2 a
0	43.8 a	47.5 a	.	51.8 a
50	42.6 a	47.2 a	.	51.8 a
100	45.2 a	45.8 a	.	52.0 a
150	44.1 a	45.1 a	.	48.5 a
	dNDF (% of DM)			
No Starter			.	63.8 a
0	64.9 a	68.5 a	.	61.7 a
50	64.8 a	67.0 a	.	62.7 a
100	63.9 a	67.7 a	.	63.9 a
150	63.4 a	67.1 a	.	64.0 a
	Lignin (% of DM)			
No Starter			.	3.8 a
0	3.3 a	3.3 a	.	3.7 a
50	3.3 a	3.4 a	.	3.9 a
100	3.5 a	3.4 a	.	4.0 a
150	3.5 a	3.4 a	.	3.6 a
	Starch (% of DM)			
No Starter			.	27.0 a
0	32.3 a	30.2 a	.	28.1 a
50	32.9 a	29.8 a	.	26.6 a
100	30.4 a	29.9 a	.	26.4 a
150	30.8 a	29.7 a	.	29.4 a

†Average values with different letters (a,b,c) are statistically different ($\alpha = 0.05$).

†† Forage data was not analyzed for Jefferson County site due to weed pressure and poor yields.

Table 8: Impact of N application on estimated milk per ton and milk per acre for the 4 Northern New York trials in 2007.

	Milk per ton (lbs/ton)			
	St. Lawrence	Lewis	Jefferson	Essex 3
	3rd year corn	4th year corn	2nd year corn	2nd year corn
	Non-responsive	Responsive	Non-responsive	Responsive
No Starter			.	3098 a
0	3308 a	3320 a	.	3069 a
50	3331 a	3310 a	.	3084 a
100	3247 a	3380 a	.	3098 a
150	3264 a	3381 a	.	3219 a
	Milk per acre (lbs/acre)			
No Starter			.	17273 c
0	26082 a	20938 b	.	18948 bc
50	27714 a	23794 b	.	21117 ab
100	27626 a	27224 a	.	20846 ab
150	26620 a	27449 a	.	23735 a

† Forage data was not analyzed for Jefferson County site due to weed pressure and poor yields.

Combined Results from 2005 and 2006

First Year Corn

Six 1st year corn trials were conducted in NNY in 2005 and 2006. These trials combined with ten others from around NYS showed no yield or forage quality response to additional N beyond a small starter application (Table 9). From the research station trials that included a 0 N treatment, we concluded that 1st year corn will benefit from a small starter N application (~30 lbs N/acre). If we combine all 1st year trials, we concluded that first year corn does not require any additional N beyond the starter. Furthermore, since 1st year corn fields do not require additional N there is no need to use any N management tools such as the PSNT, chlorophyll, or ISNT.

Table 9: Overall yield and quality of 1st year corn.

	On-farm sites		Research farm sites	
N sidedress rate	Corn silage yield (35% DM)	Milk per ton	Corn silage yield (35% DM)	Milk per ton
lbs N/acre	tons/acre	lbs/ton	tons/acre	lbs/ton
No Starter	.	.	19.6 b	3199 a
0	21.7 a	3193 a	21.1 ab	3195 a
50	22.2 a	3234 a	21.5 a	3257 a
100	22.4 a	3214 a	22.6 a	3194 a
150	22.4 a	3211 a	22.1 a	3168 a

†Average values with different letters (a,b,c) are statistically different ($\alpha = 0.05$)

Corn after corn or soybeans (2005-2007):

In NNY, seven 2nd year, one 3rd year and one 4th year corn trial were conducted of which five were responsive to additional N. If we combine this with 8 others from around NYS, we have a total of 9 non-response and 8 responsive sites. The range of responsive 2nd year site and the difference in the calculated recommended N rate vs. the optimum economic N rate (Table 10) makes it clear that we need to utilized tools such as the ISNT, End-of-season stalk nitrate and PSNT to better identify which sites are likely to be responsive when it comes to 2nd year corn or greater.

Table 10: Reported yield potential and N needs vs. actual yield and optimum economic N rate.

	Required N[1]	Optimum Economic N Rate[2]	Yield Potential[3] (35% DM)	Actual Yield[4] (35% DM)
	lbs N/acre	lbs N/acre	tons/acre	tons/acre
St. Lawrence 1 (2006)	102	0	21.3	21.2
St. Lawrence 1 (2007)	123	0	21.3	23.4
St. Lawrence 2 (2006)	102	0	21.3	21.7
Jefferson 1 (2006)	91	.	23.0	16.4
Jefferson 2 (2007)	?	0	?	14.3
Essex 1 (2006)	74	135	18.7	17.6
Essex 2 (2005)	74	140	18.7	25.0
Essex 3 (2007)	74	136	18.7	19.4
Lewis (2007)	133	147	23.8	23.0

[1] Required N based on N rate (lbs/acre) = [(Yield Potential*1.2) – Soil N – Sod N] / (N efficiency/100).
[2] Optimum Economic N Rate based on a forage value of $30 per ton and $0.54 N cost.
[3] Yield potential is based on soil type and drainage.
[4] Actual yield is averaged for non-responsive sites and the yield at the optimum economic N rate for the responsive sites.

ISNTxLOI

The ISNT x LOI OM critical value curve worked very well in predicting the N needs of 2nd + year corn, accurately predicting 7 of 9 NNY and 15 out of 18 2nd + year and corn after soybean sites state wide, with the one incorrect site having hail damage (Jefferson 2006) which

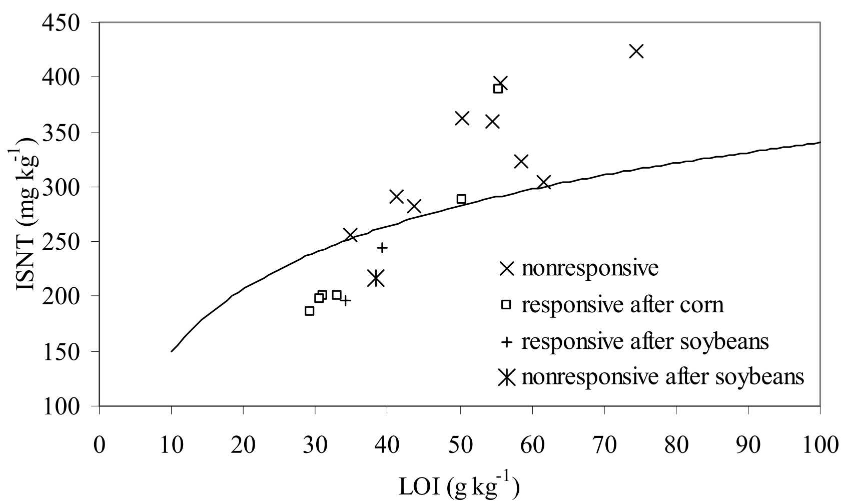


Figure 2: ISNT values of 18 corn sites in New York.

may have lead to its sidedress response, a corn after soybean site which was statically non-responsive but had large variability in the data and a responsive site (Lewis 2007) that was responsive but predicted to be non-responsive. This is very encouraging for the potential of adopting the ISNT x LOI OM for predicting N response in corn sites that are in their 2nd year or beyond. The ISNT was more accurate than the PSNT in predicting a response to sidedressing for 2nd + year corn which indicates the benefit of measuring a much more stable fraction of N with the ISNT that is not affected by precipitation around the time of sampling.

Conclusions/Outcomes/Impacts to Date:

- As shown through the work in 2005 and 2006 corn in the 1st year after sod does not benefit from additional N beyond a small starter application and no tools are need for predicting N needs.
- When corn follows corn in the rotation the response to N is variable and it is in these fields that we have the most opportunity to reduce N use by predicting whether or not a field will respond to N fertilizer.
- Though the PSNT is still used, this work showed that weather conditions, particularly wet weather in the spring, provide challenges with the test. In addition, PSNT sampling protocols (12 inch cores within a narrow soil sampling window) limits its adoption.
- The ISNT showed much greater accuracy and carries the benefit of only requiring an 8" soil sampling and having more flexibility regarding the time of year the sample is taken. To assure that the ISNT is only measuring the soil N supply and not measuring N supplied by other sources such as manure or sod, avoid taking samples for the ISNT within 5 weeks after sod plowdown or manure application.
- The End-of-season Stalk Nitrate test proved to be a very useful indicator of the N management on a field for a given season; however, using this tool to guide changes in N management requires 2+ years of data from the same field as year to year variability (such as weather conditions) affect the values.
- The End-of-season Stalk Nitrate test was released for use in NY in the fall of 2007. The ISNT will be released for use in NY in January 2008.

Outreach:

Results were presented in the form of extension articles (What's Cropping Up? and Northeast Dairy Business articles as well as fact sheets and newsletter articles) and through extension presentations (Corn Congress at the Miner Institute; Winter Meetings in Jefferson and St Lawrence Counties). In addition, talks about the project were given at the 2007 Field Crop Dealer Meetings (237 people). Fact sheets on the Late Season Stalk Nitrate Test, Nitrogen Guidelines for Corn, and ISNT were developed and posted on the NMSP website (http://nmsp.css.cornell.edu/publications/factsheets.asp). For further information: NNY extension projects: http://nmsp.css.cornell.edu/projects/nny.asp.

Next steps:

We proposed the following nitrogen project activities for 2008:

(1) ISNT and stalk nitrate assessment: Farms will be selected in five of six NNY counties. All corn fields on the farm will be sampled and analyzed for ISNT, standard soil fertility, and stalk nitrate at the Cornell Nutrient Analysis Laboratory. Farm records will be used to determine field histories. Assessments for ISNT and stalk nitrate distribution on the farm will be done for each of the farms (whole farm assessment).

(2) Field trial with protected N sources: We will compare ESN and Nutrisphere-N in their effectiveness to reduce N losses and enhance yields for corn production.

Acknowledgments:

We gratefully acknowledge the cooperation of the participating producers. This project was funded with a grant the Northern New York Agricultural Development Program with additional funding from the New York Farm Viability Institute and Federal Formula Funds.

Reports:

Articles in newsletters and popular farm press:

Publication	Article	Author	Issue
Farming	Forages	Ev Thomas	January 2007 (Vol. 10, No.1)
Country Folks	NYFVI-Funded Project Evaluates Economic and Environmental Benefits of Reducing Nitrogen Use on Corn Crop	Kara Dunn	October 16, 2006 (Vol. 32, No.50)
CCE of Jefferson County Ag and Natural Resources	NYFVI-Funded Project Evaluates Economic and Environmental Benefits of Reducing Nitrogen Use on Corn Crop	Kara Dunn	November 2006 (Vol. 8, No.11)
CCE Lewis County Ag Digest	NYFVI-Funded Project Evaluates Economic and Environmental Benefits of Reducing Nitrogen Use on Corn Crop	Kara Dunn	November 2006 (Vol. 12, No.11)
Northeast Dairy Business	Save on Nitrogen Cost	Joe Lawrence and others	February 2007 (Vol. 9, No. 2)
What's Cropping Up	Nitrogen Savings for 1st Year Corn	Joe Lawrence and others	Jan-Feb 2007 (Vol. 17, No. 1)
CCE of Jefferson County Ag and Natural Resources	Nitrogen Needs of 1st Year Corn	Agronomy Factsheet #21	Feb. 2007 (Vol. 9, No. 2)
Dairy and Field Crops News (CNY CCE team)	Nitrogen Savings for 1st Year Corn	Joe Lawrence and others	March 2007 (Vol. 14, No. 1)
Seneca County Ag Alert	Nitrogen on 1st Year Corn.	Mike Dennis	March 2007
CCE Lewis County Ag Digest	Looking to Cut Fertilizer Cost on Corn?	Joe Lawrence	April 2007 (Vol. 13, No. 4)
Ag News	Nitrogen Savings for 1st Year Corn	Joe Lawrence	

(Steuben)		and others	
Country Folks	Nitrogen Needs of 1st Year Corn	Agronomy Factsheet #21	May 2007 (Vol. 33, No. 27)
Country Folks	Looking to Cut Fertilizer Cost on Corn?	Joe Lawrence	May 2007 (Vol. 33, No. 27)
Country Folks	NNY Farmer Happy to Save Money on Not Overfertilizing Corn	NNY	May 2007 (Vol. 33, No. 29)
Empire State Farmer	NNY Farmer Happy to Save Money on Not Overfertilizing Corn	NNY	May 2007 (Vol. 30, No. 10)
Country Folks	On-farm Research Shows Farmers Can Use Less N to Save Money and Reduce Environmental Impact	Eleanor Jacobs and Kara Dunn	August 2007
Cornell Chronicle	On-farm Research Shows Farmers Can Use Less N to Save Money and Reduce Environmental Impact	Eleanor Jacobs and Kara Dunn	June 2007

Scientific Publications:

- Lawrence J.R., Q.M. Ketterings, and J.H. Cherney. 2008. Effect of nitrogen application on yield and quality of silage corn after forage legume-grass. Agron. J. 100:73-79.

Agronomy Fact Sheets:

- # 31: Late Season Stalk Nitrate Test (7/21/2007)
- # 21: Nitrogen Needs for First Year Corn (12/18/2006)
- # 35: Nitrogen Guidelines for Corn (12/03/2007)
- # 36: Illinois Soil Nitrogen Test (1/8/2007)

Person to contact for more information:

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Pictures:

St Lawrence County Site 1:

	
0 lbs N	50 lbs N
	
100 lbs N	150 lbs N

Lewis County Site:

	
0 lbs N	50 lbs N
	
100 lbs N	150 lbs N

Jefferson County Site

	
0 lbs N	50 lbs N
	
100 lbs N	150 lbs N

Essex County Site 3 (2nd year corn)

No starter or sidedress N

Starter only

50 lbs N

100 lbs N

150 lbs N

Northern NY Agricultural Development Program
2006-2007 Project Report

Project Title: Best Management Practices for the Use of Dairy Manure.

Project Leader:

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- Amy Ivy, Cornell Cooperative Extension, Clinton County
- Carl Tillinghast, Cornell Cooperative Extension, Franklin County
- Joe Lawrence and Sara Place, Cornell Cooperative Extension, Lewis County
- Pete Barney, Cornell Cooperative Extension, St. Lawrence County
- Ev Thomas, W.H. Miner Institute

Cooperating Producers:
Essex County:
- Loretta Suprenant and Robin Ulmer

Jefferson County:
- Art Baderman, Elmer Dart, Alan Hunter, Judy Pierce, and Jeff Zimmer

St. Lawrence County:
- Ira Benware, Dave Fisher, Tim Heiden, Kevin McCollum, and Gary Tiernan

Background:
Environmental regulations, high fertilizer prices, improved manure handling and storage technologies, and steadily increasing animal densities on farms force us to re-examine manure management. Maintaining a high quality, high yielding crop has always been a priority for farmers. We must now work to sustain those yields while minimizing the potential for nutrient loss while providing farmers with management options that allow manure nutrients to be most efficiently used.

The greatest concern in applying manure is typically the fate of phosphorus (P) and nitrogen (N). These elements are macronutrients that are needed in large quantities so producers want to ensure these nutrients are readily available for crop uptake. But, both N and P could be potential pollutants if lost from the farm fields and transported to surface and/or groundwater. It is critical to understand the potential environmental loss pathways of these nutrients as minimizing loss through one pathway may lead to increasing losses through others. For instance, surface application of manure without incorporation may reduce N leaching but increase P accumulation and/or P runoff. Incorporation of manure may reduce P runoff but if amounts are not adjusted, it may lead to increase N leaching.

An additional question often asked is “How quickly do we build soil test levels with application of fertilizer or manure?” or in other words “How much P is needed to increase soil test P levels with one unit?” Recent developments in the poultry industry advocate the use of chemical Al-based amendments to lower P availability and conserve N but it is unknown how (cost) effective these amendments are for dairy manure.

Our project had three major research components: (1) assessment of the amount of P fertilizer vs manure, with or without chemical treatment, needed to raise soil test P levels with one unit; (2) runoff versus leaching losses in tile drained systems; and (3) development of outreach materials on soil fertility and nutrient management.

Phosphorus Runoff and Tile Drainage Project

Methods:
This year was the second year of rainfall simulations conducted on manured plots. Our primary objective for this study is to quantify losses of P and N in tile lines and surface runoff while evaluating the effects of manure application on orchardgrass yield, quality and nutrient uptake. We established 12 large (60’ x 500’) orchardgrass plots designed to collect runoff and drainage water on the Willsboro Research Farm. Baseline measurements for these plots collected in previous years include general fertility of topsoil, depth profiles, orchardgrass yield and quality, analysis of leachate samples collected from the lysimeter plot manhole sites and rainfall runoff simulations. In 2006 we conducted rainfall simulations in plots 2, 7 and 8. Yield measurements continued on the 12 large plots in 2007. Natural flow rates were measured following rainfall events of over 0.5 inches as well as at other times. The leachate was analyzed for N and P. The dates of these events are summarized in Table 1. Plots with similar flow characteristics were chosen based on flow rate measurements taken in spring 2006 and the flow histories of the plots. To increase our chances of getting runoff, sections of the plots with the greatest slopes (ranging from 3-9%) were chosen. The chosen plots, numbered 4, 5 and 6, also had higher levels of natural flow. As in 2006, three plots were chosen to receive each of three treatments for rainfall simulation runoff and leaching measurements. A control treatment received only inorganic fertilizer. The other two treatments involved the application of manure at a rate of 5000 gallons per acre (providing 25 lbs/acre P) in addition to the inorganic fertilizer. For one treatment, an Aerway soil aerator was run over the plot prior to manure application. Manure was applied to undisturbed ground for the final treatment. Manure was applied only within the area of the runoff frames. Manure treatments were applied after each cut. Rainfall simulations were performed from 3 to 5 days following the application.

The protocol followed for the rain simulation was modified from the protocol developed by the National Phosphorus Project. The equipment used and rainfall rates followed the protocol. Due to our manure treatment we did not saturate the soil the day prior to the rainfall simulation and rained on each treatment only once. We also decided to standardize the amount of time rain was applied to each plot, instead of raining until 30 minutes after runoff commences. The simulation after the first cutting followed an extremely dry spring, so the rainfall duration was increased to 2.5 hours at a rate of 125 ml/s. However, even at this rate there was no runoff or drainage from any of the treatment plots. After the second cutting a rainfall period of 1.5 hours was used. This was adequate to generate drainage in two of the three plots but runoff did not occur in any of the plots. During the simulation, all flow from the tile drain in the plot was weighed and retained to determine flow rate and total volume recovered. Samples were taken at 5 minute intervals for analysis. A bulk sample collected over the entire event was also obtained. Filtered samples were submitted to the Cornell Nutrient Analysis Laboratory for nitrate nitrogen and elemental (P) analyses. Prior to rainfall simulations, 8" soil samples were taken within the plot. Sample holes were plugged to prevent preferential flow. At the second cutting a hand harvest was performed within the runoff frames. Hand samples were also taken outside the frames for comparison with the machine harvest yields.

Research Results:

Yields: First and second cut yields of the larger plots (no manure applied) are shown in Table 2. The average 2007 yield was 2.57 tons of dry matter per acre, much less than previous years, primarily due to dry weather. Yields and forage quality were very similar between plots, identifying uniformity of the plots. Yields from all treatments of the second cut hand harvests within the frames (Table 3) were higher than those obtained by machine harvest within the whole plots. This is likely due to the treatment areas receiving rain from the simulator. To verify this, an extra set of hand harvest was conducted from outside the plots. These yields were similar to the machine harvest yields.

Leaching data – natural flow: There were few rainfall events sufficiently large to generate flow in the tile drains. When there was flow, the concentrations of phosphorus in the leachate were very low, as shown in Table 4. The highest concentration of 0.042 mg/L occurred in the spring. Nitrate nitrogen concentrations were also low (Table 5) with a high of 0.144 mg/L following a 1.6 inch rainfall in July.

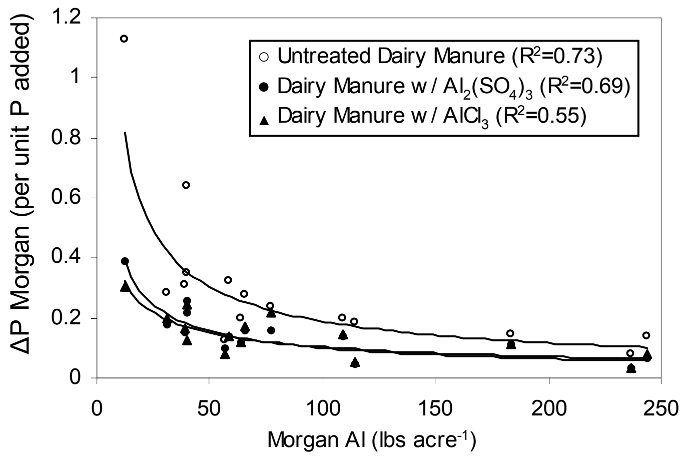
Runoff data: We applied significant amounts of simulated rainfall but were unable to generate runoff this year. This indicates that runoff is unlikely to be a problem in dry years independent of fertilizer/manure application method.

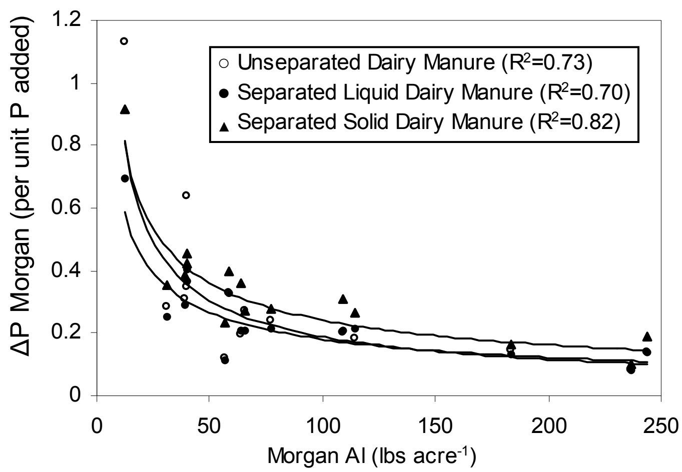
Leaching data: The amount of rainfall required to initiate flow from the tile lines was highly variable, as were the time to flow initiation and flow duration (Table 6). Tile flow was initiated between 47 and 109 minutes after water was applied to the plots. This is similar to conditions in the fall of 2006, where in some plots tile flow took as long as 103 minutes to begin. The duration of drainage was also variable, ranging from 50 to 109 minutes. The average volume of tile water collected was the same for inorganic and the Aerway treatment (2%). For the plots to which the manure was applied on the surface without Aerway disturbance, a larger portion of the amount of rainfall applied was recovered in the tile drain (4% in plot 5 and 17% in plot 4). If significant, such a difference would suggest Aerway disturbance might reduce preferential flow but additional work is needed as results were highly variable and we were unable to generate flow in one of the three replications in the experiment, reducing statistical rigor.

Average concentrations of P and nitrates were similar to concentrations at peak flow. Plot 4 had some baseline flow which had to be accounted for in flow rate and nutrient concentration calculations. Plot 5 was not impacted by baseline flow. Phosphorus loss through the tile line was low overall (Table 7).

Comparing the three treatments in plot 5, nitrate concentrations in the leachate were higher in the manured plots than in the inorganic fertilizer plot (Table 7). Average and peak N concentrations varied from 9 to 12 ppm in the surface applied manure without Aerway. Initial comparisons suggest N losses to be lower in Aerway treated plots (excluding plot 4 where source water contained more N than tile water) than in plots where manure is surface applied, suggesting Aerway treatment can reduce N loss in tile. However, the dataset is too variable to draw such conclusions and 2006 data do not show the same trend. Additional larger-scale field work is needed.

Soil P Accumulation Project





We previously (2006 project) found that Morgan extractable Al was the best predictor of a soil's P sorption capacity, and that soils with high Morgan extractable Al levels need more P to achieve the same Morgan soil test P increase as a soil with lower Al levels. In 2007, we conducted incubation studies using fifteen different NNY soils to further assess the effect of Al on P sorption capacity. The soil types used for the study were Malone from Clinton County; Amenia, Churchville, Deerfield, and Kingsbury from Essex County; Collamer, Kingsbury, Rhinebeck, and Vergennes from Jefferson County; and Adams, Croghan, Grenville, Kalurah, Pyrities, and Swanton from St. Lawrence County. We also compared the effects of addition of different manure fractions (unseparated, separated liquid, and separated solid) on soil test P increases, and the effects of two manure additives: aluminum sulfate (alum, $Al_2(SO_4)_3$) and aluminum chloride ($AlCl_3$). The alum was added at the rate of 21 gal/1000 gal for unseparated dairy manure and 19 gal/1000 gal for separated liquid dairy manure; the $AlCl_3$ was added at 14.5 gal/1000 gal for both unseparated and separated liquid dairy manure. The two graphs above illustrate our results. This work confirms that high Al soils need more P to achieve the same soil test P increase as low Al soils. It also shows that

(1) untreated manure is more effective at increasing soil test P levels than manure treated with alum or $AlCl_3$; and (2) there are no large differences in the effectiveness of unseparated, separated liquid, and separated solid dairy manure in raising soil test P levels with the same addition of total P. We will further evaluate the data set as our treatments included a comparison of manure P versus fertilizer P as well. In addition, we will investigate P and N dynamics upon chemical treatment in a greenhouse experiment with similar manure treatments and sorghum sudangrass as test crop.

Conclusions/Outcomes/Impacts:

One year of runoff and two years of leaching data show very low levels of P movement over the surface and through the profile of the plots, including those treated with manure. There is initial evidence that aeration of grass prior to manure application reduced P runoff in wet years (not in 2007) without increasing N and P loss in tile lines. Nitrate leaching to the tile line appears to be an area of greater concern than P leaching in our work in Willsboro. Results so far suggest aeration prior to manure application does not enhance N or P leaching to tile drains and might be a good alternative to surface application of manure. However larger-scale plots are needed to further investigate the impact of Aerway incorporation on grass production and N and P dynamics.

The P incubation study has shown to date that soils high in Morgan Al (greater than 50 lbs/acre) need more P to increase soil test P levels than low Al soils, Al-treatment of manure reduces soil test P increase (i.e. the Al binds and makes P unavailable for plant uptake), and there does not seem to be a difference between raw manure, separated solids and liquids in the amount of P needed to raise soil test P with one unit.

Outreach:

In 2007, we generated six additional agronomy fact sheets, published a peer-reviewed journal article, and completed the 2002-2006 soil test summary reports for the 6 NNY counties. For a complete listing, see “reports”. New project results will be discussed in upcoming winter meetings.

Next steps:

Based on the results of the P incubation study, we initiated a greenhouse pot experiment with sorghum sudangrass as test crop and untreated manure, manure treated with alum, manure treated with $AlCl_3$ as the three main treatments using a sandy low N and low P soil from St Lawrence County. This experiment included a series of pots to which P was added so an N response could be studies (conservation of N with the chemical treatments) and a series to which N was added to study the impact of chemical treatment on P availability. This project is ongoing (1st cutting was harvested, 2nd cutting is growing).

For the field season of 2008, we proposed to focus on quantification of N dynamics and P accumulation upon Aerway incorporation of manure versus surface application and/or injection. Work in other parts of New York has show Aerway incorporation can result in N conservation equal to chisel incorporation but additional field trials are needed to test this under NNY conditions.

Acknowledgments: This work was sponsored by a grant from the NNYADP. Additional funding was supplied by Federal Formula Funds.

Reports and/or articles.

Agronomy Fact Sheets:

18: Manure Spreader Calibrations (1/19/2007)
  - Shawn Bossard, Kristen Bossard, Joe Lawrence, Quirine Ketterings

24: Teff as Emergency Forage (3/22/2007)
  - Mike Hunter, Peter Barney, Tom Kilcer, Jerry Cherney, Joe Lawrence, and Quirine Ketterings

25: Mass Nutrient Balance Software (6/7/2007)
  - Sara Moss, Caroline Rasmussen, Q. Ketterings, Joe Lawrence, Peter Barney

26: Brown Midrib Sorghum Sudangrass Nitrogen Management (6/30/2007)
  - Quirine Ketterings, Tom Kilcer, Jerry Cherney, Peter Barney, Greg Godwin, Patty Ristow

27: How Quickly Will Soil Test P Levels Increase? (7/10/2007)
  - Ryan Haden, Quirine Ketterings, Jason Kahabka, and Karl Czymmek

28: Phosphorus Removal by Field Crops (7/21/2007)
  - Quirine Ketterings, and Karl Czymmek

Journal Article:

- Haden, V.R., Q.M. Ketterings, and J.E. Kahabka (2007). Factors affecting the change in soil test P levels following manure and fertilizer application. SSSAJ 71: 1225-1232.

Soil test summaries:

- Essex County Soil Sample Survey (2002-2006) (released August 24, 2007).
  - Rao, R., A., Deming, Q.M. Ketterings, and H. Krol (2007). Essex County Soil Test Summary (2002-2006). CSS Ext. Bull. E07-6. 33 pages.
- Jefferson County Soil Sample Survey (2002-2006) (released August 23, 2007).
  - Rao, R., M. Hunter, Q.M. Ketterings, and H. Krol (2007). Jefferson County Soil Test Summary (2002-2006). CSS Ext. Bull. E07-5. 36 pages.
- Clinton County Soil Sample Survey (2002-2006) (released August 23, 2007).
  - Rao, R., A. Ivy, Q.M. Ketterings, and H. Krol (2007). Clinton County Soil Test Summary (2002-2006). CSS Extension Bull. E07-4. 33 pages.
- Franklin County Soil Sample Survey (2002-2006) (released July 30, 2007).
  - Rao, R., C. Tillinghast, Q.M. Ketterings, and H. Krol (2007). Franklin County Soil Test Summary (2002-2006). CSS Ext. Bull. E07-3. 32 pages.
- St. Lawrence County Soil Sample Survey (2002-2006) (released July 12, 2007).
  - Rao, R., P. Barney, Q.M. Ketterings, and H. Krol (2007). St. Lawrence County Soil Test Summary (2002-2006). CSS Ext. Bull. E07-2. 35 pages
- Lewis County Soil Sample Survey (2002-2006) (released July 10, 2007).

- Rao, R., J. Lawrence, S. Place, Q.M. Ketterings, and H. Krol (2007). Lewis County Soil Test Summary (2002-2006). CSS Ext. Bull. E07-1. 34 pages.

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Photos






Table 1. 2007 field operation spanned from late April until late October.

Date		Field Activity
4/26/2007		Sampled natural flow
4/30/2007		Top dress (75 lbs N/acre)
6/12/2007		1st hay cutting
5/8/2007		Sampled natural flow
5/17/2007		Sampled natural flow
6/15/2007		Install frames
6/16/2007		Apply manure at 5000 gal/acre
6/18/2007		Rain simulation/no runoff or drainage
6/19/2007		Rain simulation/no runoff or drainage
6/20/2007		Sampled natural flow
6/25/2007		Top dress (75 lbs N/acre)
7/12/2007		Sampled natural flow
7/24/2007		Hand harvest subplots
7/25/2007		2nd hay cutting
7/30/2007		Apply manure at 5000 gal/acre
8/1/2007		Rain simulation/no runoff
8/2/2007		Rain simulation/no runoff
8/3/2007		Rain simulation/no runoff
10/30/2007		Sampled natural flow

Table 2. 2007 Orchardgrass yield and quality for the 12 plots. Yield data are expressed in tons of dry matter.

	Yield			Quality			
Plot	(Tons of Dry Matter)			Crude Protein % Dry Matter		Neutral Detergent Fiber % Dry Matter	
	1st Cut	2nd Cut	Total	1st Cut	2nd Cut	1st Cut	2nd Cut
1	1.70	0.55	2.25	13.6	20.0	64.6	60.0
2	2.31	0.68	2.99	12.8	19.3	69.1	61.6
3	1.80	0.57	2.37	11.4	18.4	66.0	58.2
4	2.04	0.61	2.65	12.1	21.0	67.2	58.9
5	2.22	0.66	2.88	11.2	19.8	69.6	57.2
6	2.02	0.62	2.63	12.5	20.4	68.7	60.1
7	1.95	0.70	2.64	11.1	19.5	67.7	57.9
8	1.63	0.61	2.25	10.9	19.8	64.8	55.7
9	1.84	0.78	2.62	10.4	20.2	68.2	59.0
10	1.95	0.75	2.70	11.2	17.2	66.4	58.0
11	1.76	0.70	2.46	10.8	18.4	66.8	60.6
12	1.74	0.71	2.46	10.0	17.1	68.3	61.2
Mean	1.91	0.66	2.57	11.5	19.3	67.3	59.0

Table 3. 2007 orchardgrass yield and quality hand harvested within and adjacent to the rainfall simulator frames. Yield data are expressed in tons of dry matter.

Treatment	Plot	Yield	Quality	
			CP	NDF
		TDM	% DM	% DM
Inorganic	4	0.86	23.4	59.3
	5	0.76	20.8	56.9
	6	0.69	21.6	54.9
	Mean	0.77	21.9	57.0
Aerway	4	0.69	21.8	56.4
	5	0.64	23.4	53.2
	6	0.82	24.4	52.3
	Mean	0.72	23.2	54.0
Surface	4	0.73	22.8	60.7
	5	0.88	23.2	55.9
	6	0.84	24.2	52.4
	Mean	0.82	23.4	56.3
Outside	4	0.70	23.6	51.1
	5	0.71	19.6	55.9
	6	0.47	24.4	49.0
	Mean	0.62	22.5	52.0

Table 4. Phosphorus concentration and flow rates in natural flow of tile lines in 12 plots in 2007.

	P concentration (mg/L) NF = No Flow, <det = levels below detection.											
	Date Sampled											
Plot	4/26/07		5/8/07		5/17/07		6/20/07		7/12/07		10/30/07	
	P (mg/L)	Flow (L/min)	P (mg/L)	Flow (L/min)	P (mg/L)	Flow (L/min)	P (mg/L)	Flow (L/min)	P (mg/L)	Flow (L/min)	P (mg/L)	Flow (L/min)
1	0.042	0.71	NF	.	0.014	0.75	NF	.	0.024	1.56	0.007	0.19
2	0.039	0.34	NF	.	NF	.	NF	.	NF	.	NF	.
3	0.032	1.43	NF	.	<det	1.34	0.045	0.47	0.022	2.40	NF	.
4	0.026	2.47	NF	.	<det	3.36	NF	.	0.022	4.08	NF	.
5	0.013	0.63	NF	.	0.013	1.04	NF	.	0.008	2.10	NF	.
6	0.022	1.54	NF	.	<det	1.00	NF	.	0.004	1.98	NF	.
7	NF	.	NF	.	NF	.	NF	.	NF	.	NF	.
8	NF	.	NF	.	NF	.	NF	.	NF	.	NF	.
9	0.010	1.50	0.013	1.04	<det	1.05	NF	.	0.006	1.56	NF	.
10	0.013	5.10	0.009	8.01	0.024	3.48	NF	.	0.001	6.60	NF	.
11	NF	.	NF	.	NF	.	NF	.	NF	.	NF	.
12	NF	.	NF	.	NF	.	NF	.	0.019	0.19	NF	.

Table 5. Nitrate N concentration and flow rates in natural flow of tile lines in 12 plots in 2007.

	Nitrate N concentration (mg/L) NF = No Flow, <det = levels below detection											
	Date Sampled											
Plot	4/26/07		5/8/07		5/17/07		6/20/07		7/12/07		10/30/07	
	N (mg/L)	Flow (L/min)	N (mg/L)	Flow (L/min)	N (mg/L)	Flow (L/min)	N (mg/L)	Flow (L/min)	N (mg/L)	Flow (L/min)	N (mg/L)	Flow (L/min)
1	0.030	0.71	NF	.	<det	0.75	NF	.	<det	1.56	0.007	<det
2	0.032	0.34	NF	.	NF	.	NF	.	NF	.	NF	.
3	<det	1.43	NF	.	<det	1.34	0.011	0.47	0.052	2.40	NF	.
4	0.013	2.47	NF	.	0.034	3.36	NF	.	0.028	4.08	NF	.
5	<det	0.63	NF	.	<det	1.04	NF	.	<det	2.10	NF	.
6	<det	1.54	NF	.	<det	1.00	NF	.	0.144	1.98	NF	.
7	NF	.	NF	.	NF	.	NF	.	NF	.	NF	.
8	NF	.	NF	.	NF	.	NF	.	NF	.	NF	.
9	0.019	1.50	0.011	1.04	<det	1.05	NF	.	0.037	1.56	NF	.
10	<det	5.10	0.035	8.01	0.04	3.48	NF	.	0.049	6.60	NF	.
11	NF	.	NF	.	NF	.	NF	.	NF	.	NF	.
12	NF	.	NF	.	NF	.	NF	.	<det	0.19	NF	.

Table 6. Quantity and percentage of rainfall collected as drainage. There was no tile flow in plot 6. Total volume applied was 675 liter in 90 minutes.

		Time until Flow	Length of Drainage Event	Drainage Collected	
Treatment	Plot	Minutes	Minutes	L	%
Inorganic	4	109	140	11.74	1.7
	5	80	50	14.27	2.1
	Mean	94.5	95	13.01	1.9
Aerway	4	80	120	15.48	2.3
	5	83	38	10.21	1.5
	Mean	81.5	79	12.84	1.9
Surface	4	47	190	117.46	17.4
	5	68	50	28.34	4.2
	Mean	57.5	120	72.90	10.8

Table 7. Phosphorus and nitrate-N average and peak flow concentrations and loss through tile lines following the 90 minute rainfall event. Concentrations are adjusted for source water (Plots 4 and 5) and baseline flow (Plot 4) which accounts for negative values of concentration. There was no tile flow in plot 6. Total volume applied was 675 liter in 90 minutes.

		P Average	P Peak Flow	P Loss	N Average	N Peak	N Loss
Treatment	Plot	mg/kg	mg/kg	mg per plot ($4m^2$)	mg/L	mg/L	mg per plot ($4m^2$)
Inorganic	4	-0.24	0.07	0.0	1.78	-0.38	20.9
	5	-0.09	0.11	0.0	1.15	0.74	16.4
	Mean	-0.17	0.09	0.0	1.47	0.18	18.7
Aerway	4	-0.23	-0.23	0.0	-0.32	-0.39	0.0
	5	0.09	0.09	0.9	8.00	8.90	98.8
	Mean	-0.07	-0.07	0.5	3.84	4.26	49.4
Surface	4	-0.17	0.12	0.0	9.17	12.17	1077.1
	5	0.24	-0.01	6.8	10.95	10.22	310.3
	Mean	0.04	0.06	3.4	10.06	11.20	693.7

NY Agricultural Development Program
2006-2007 Project Report

Project Title: **Expanding Soil Health Assessment in NNY: Dairy Farms and Biofuel Production**

Project Leader(s):

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Collaborator(s):

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Cooperating Producers:

Growers collaborators: **Sam Hendren**, **Eric Leerkes** and **Chris Spaulding** (Essex); **Dennis Egan**, **Ralph Child** and **Doug Malette** (Franklin); **David Fisher**, **Dan Chambers** and **William White** (St. Lawrence) **Don Nohle** (Jefferson), **Marc Laribee** and **Bernhard Gohlert** (Lewis).

Background:

The intensive production of agronomic crops has contributed to reduced soil quality, and resulted in lower crop productivity and farm profitability. Among the causes are soil compaction, surface crusting, low organic matter, increased pressure and damage from diseases, weeds, insects and other pests, as well as a lower density and diversity of beneficial soil organisms. These constraints have increased the interest of land managers in assessing the health status of their soils and in implementing sustainable soil management practices. The Cornell Soil Health team has recently established a standard protocol for soil health assessment based on extensive research that included long-term field experiments (at Willsboro and Chazy) and growers' fields in NNY. Recently, dairy producers have shown interest in assessing the effects of manure management practices on soil health. A targeted study on how soil health indicators are affected in dairy systems will help these growers to better manage their soils.

The use of crop biomass as an alternative energy source has been generating a national debate in both the agricultural and energy sectors. Farmers are gaining interest in harvesting corn stover for biofuel production through cellulosic conversion. This provides additional income, and would reduce concerns about diversion of food into energy production. However, there are significant concerns whether soil health will be jeopardized through long-term removal of corn stover and the agricultural community is eager to find answers to this question. A long-term (32 years) experiment at Chazy in NNY is a unique resource that would allow us to provide good quantitative data through our soil health assessment methods.

Methods:

We used the standard Cornell soil health protocol to assess dairy production fields in NNY and some other parts of NY to have a better statewide view on how soil health indicators are affected in dairy production systems. The Cornell Soil Health Test (CSHT) protocol consists of 15 soil indicator measurements that are integrated to assess soil constraints of farm fields. The indicators used in the CSHT include wet aggregate stability, available water capacity, surface hardness, sub-surface hardness, organic matter, active carbon, potentially mineralizable nitrogen (PMN), root health, pH, extractable phosphorus, extractable potassium and some minor elements.

Evaluation of the long-term effect of crop biomass removal on soil health was performed on a 32 year old Cornell experimental plot in Chazy, NY. The experiment consisted of four treatments replicated in four blocks:

- plow-till with stover returned (PT-R),
- plow-till with stover harvested (PT-H),
- no-till with stover returned (NT-R) and
- no-till with stover harvested (NT-H).

PT plots were moldboard plowed in the fall of each year, disked in the spring and then planted. NT plots were planted at the same time. In stover-harvested (H) plots, all above-ground plant matter was removed in the fall of each year. In stover-returned (R) plots only grain was harvested. Corn residues were incorporated into PT plots, and left on the surface of NT plots.

Soil samples were collected from the surface horizon for the measurement of physical, chemical and biological soil properties to be used as indicators of soil health. Laboratory measurements were performed for 24 soil physical, biological and chemical properties, and additionally water infiltration was assessed in the field making a total of 25 measurements.

Results:

Our first research objective was to investigate how soil health indicators are affected in dairy production systems from growers' fields across NY State. From figure 1, relatively higher percentages of the fields sampled had soil physical indicators constraints compared to biological and chemical indicators. About 40% of the fields had low available water capacity, and between 45-50% had problems with surface and sub-surface compaction (Fig. 1). Close to 20% of the fields had low organic matter and about 40% had low active carbon in the soil (Fig. 1). Very few fields (<10%) had constraint of PMN which is an indicator of nitrogen release potential of the soil (Fig. 1). As expected, relatively fewer fields were constrained by the chemical indicators (Fig. 1). From this result, it is evident that the major soil health indicators to address in dairy systems are the surface and subsurface compaction. These problems may be due to the heavy equipment and machinery such as manure spreaders going over the field. The result suggests the need for growers to exercise caution in how they go over the land with field equipment to avoid compaction of the soil. In those fields that are already compacted, there may be need for some remediation to avoid the deleterious effects of compaction on crop growth. Our second research objective was to evaluate the long-term effects of harvesting corn stover on soil health indicators. Our results from the 32 years Chazy study are outlined below:

Overall Treatment Effects

Residue treatment significantly affected eight out of the 25 measured soil properties while the tillage treatment affected 15 out of the 26 measured soil properties (Table 1). Nine out of the 25 measured properties did not respond significantly to either stover harvest or tillage (Table 1). It was noted during field sampling, that the soil surface of the plow till plots, especially those with stover harvested, were crusted, sealed, cracked, compacted and lacking aggregation, while this was not the case for no till plots (Plate 1)

Residue management effects

A comparison of the overall stover-harvested relative to stover-returned treatments means showed that the former consistently had lower soil health scores: They had less organic matter by 8%, lower decomposition rates by 57% and lower easily extractable and total glomalin contents (proteins involved in biological functions and soil aggregation) by 25% and by 16%, respectively. Stover harvest also decreased the available water capacity by 8% and increased the bulk density by 5%, while K and Mg concentrations decreased by 44%, and 20%, respectively.

Comparison of residue and tillage effects

Of the soil properties that were affected by tillage and residue treatment, the majority changed more dramatically due to tillage than due to stover harvest. In comparison to a 5% difference in bulk density due to stover harvest, tilled soils (PT) were 10% denser relative to NT. Relative to NT, PT decreased available water capacity by 13%, OM by 25%, total glomalin by 26%, Mg contents by 15%, decomposition rate by 51%, and easily extractable glomalin by 19%. Other soil properties also showed significant differences between tillage treatments (Table 1): aggregate stability decreased by 62% under PT relative to NT, PMN by 40%, NO_3-N by 27%, and Zn by 33%. Overall pH was higher, i.e. more alkaline under PT (8.05) compared to NT (7.81). Higher Al by 27%, higher Mn by 18% and lower Parasitic Nematodes by 85% were also found under PT.

Conclusions/Outcomes/Impacts:

Soil Health Indicators in Dairy Systems:

Significant numbers of dairy farm fields have problems of surface and subsurface compaction. A similar observation was made for the fields in cash grain crops from previous years' results. Specific research and educational outreach to target the prevention of soil compaction and to remediate already compacted fields would help NNY growers sustain and improve the soil quality of their fields.

Corn Stover Harvest Study:
Comparing the means of soil health indicator separated by tillage and residue treatment, there was a consistent trend from "better" to "worse" as follows: NT-R > NT-H > PT-R > PT-H. No-tillage significantly improves many soil processes (as measured through soil health indicators) irrespective of residue treatment, and stover return provides additional (although smaller) soil health benefits, especially with respect to several organic-matter-dependent soil processes. This results in improved soil structure and stability, water storage capacity, carbon storage, cellulose decomposition potential, and nutrient availability.

We conclude from this study that, on a silt loam soil in a temperate climate, long-term stover harvest had lower adverse impacts on soil health than long-term tillage. Stover harvest appears to be sustainable when practiced under no tillage management. In real commercial farm situations, management strategies such as crop rotation, cover cropping and additions of organic amendments can help improve soil health, making stover use as feedstock for energy industries a more viable and sustainable option. Also, partial stover removal, rather than complete harvest, may adequately address soil health and erosion concerns, while providing valuable additional income for biofuel.

Outreach:

Our outreach in the past year focused on producing educational materials to help growers and educators in the region understand the concepts and assessment of soil health better. We published a Soil Health Training Manual which we distributed to growers in the region. This manual is also accessible on the soil health website. The link for accessing the manual is:
http://soilhealth.cals.cornell.edu/Cornell%20Soil%20Health%20Manual.htm
We also reworked our website to provide more information on the progress of soil health initiative in NY and the Northeast. The Cornell Soil Health website link is:
http://soilhealth.cals.cornell.edu
We have planned 4 winter meetings to hold in January and February of 2008 to promote soil health knowledge among growers in all the NNY regions.

Next steps if results suggest continued work is needed in the areas of research, demonstration and/or education.

We plan to continue our soil health educational activities in NNY. We will continue to promote the new Cornell Soil Health Test as a soil management tool among NNY growers. This new test will help growers to identify and manage soil health constraints in their fields for increased and sustained productivity. We will continue to advance management strategies to overcome soil health constrains that we have observed in many NNY fields. We also plan to produce more educational materials such as fact sheets and case studies to help growers and educators learn more about the benefits of soil health management.

Reports and/or articles associated with this project.

1. Gugino, B.K, Idowu, O.J., Schindelbeck, R.R, van Es, H.M., Wolfe, D.W., Moebius, B.N., Thies, J.E. and G.S. Abawi (2007) Cornell Soil Health Assessment Training Manual, 1st ed. Cornell University, Geneva, NY.
2. Bianca Moebius, Harold van Es, John Idowu, Robert Schindelbeck, Daniel Clune, David Wolfe, George Abawi, Janice Thies and Beth Gugino (2007) Harvesting Corn Stover for Bioenery: Does it have Long-term Effects on Soil Health? What's Cropping Up? 17, (3) 5-8.
3. John Idowu, Bianca Moebius, Harold van Es, Robert Schindelbeck, George Abawi; David Wolfe; Janice Thies; Beth Gugino; Dan Clune. (2007) The New Cornell Soil Health Test: Protocols and Interpretations. What's Cropping Up? 17, (1) 6-7.

Person(s) to contact for more information (including farmers who have participated:

John Idowu (Project Coordinator) Department of Soil and Crop Sciences 1015 Bradfield Hall Cornell University, Ithaca, NY 14853	Ralph Child (Farmer) 156 Child Rd. Malone NY, 12953
Doug Malette (Farmer) 7926 State Rt. 11 Chateaugay NY, 12920	FredTuttle (Farmer) 2847 State Rt. 11 N. Bangor NY, 12966
John Beane (Farmer) 2980 State Rt. 11 Malone NY,12953	Steve Dermick (Farmer) 1501 State Hyw. 37 Hammond NY,13746
Bernie Moulton 3259 Co. Rt. 14 Madrid NY,13660	Joe Fults 30180 Fults Rd. Evans Mills NY, 13637
Lee Garvey 495 Sunset Dr. Willsboro NY, 12996	

Photos

Plate 1. A picture of soil surface of 2 plots comparing 32 years of moldboard plow tillage with stover harvested with no-till soil with stover returned as surface residue.

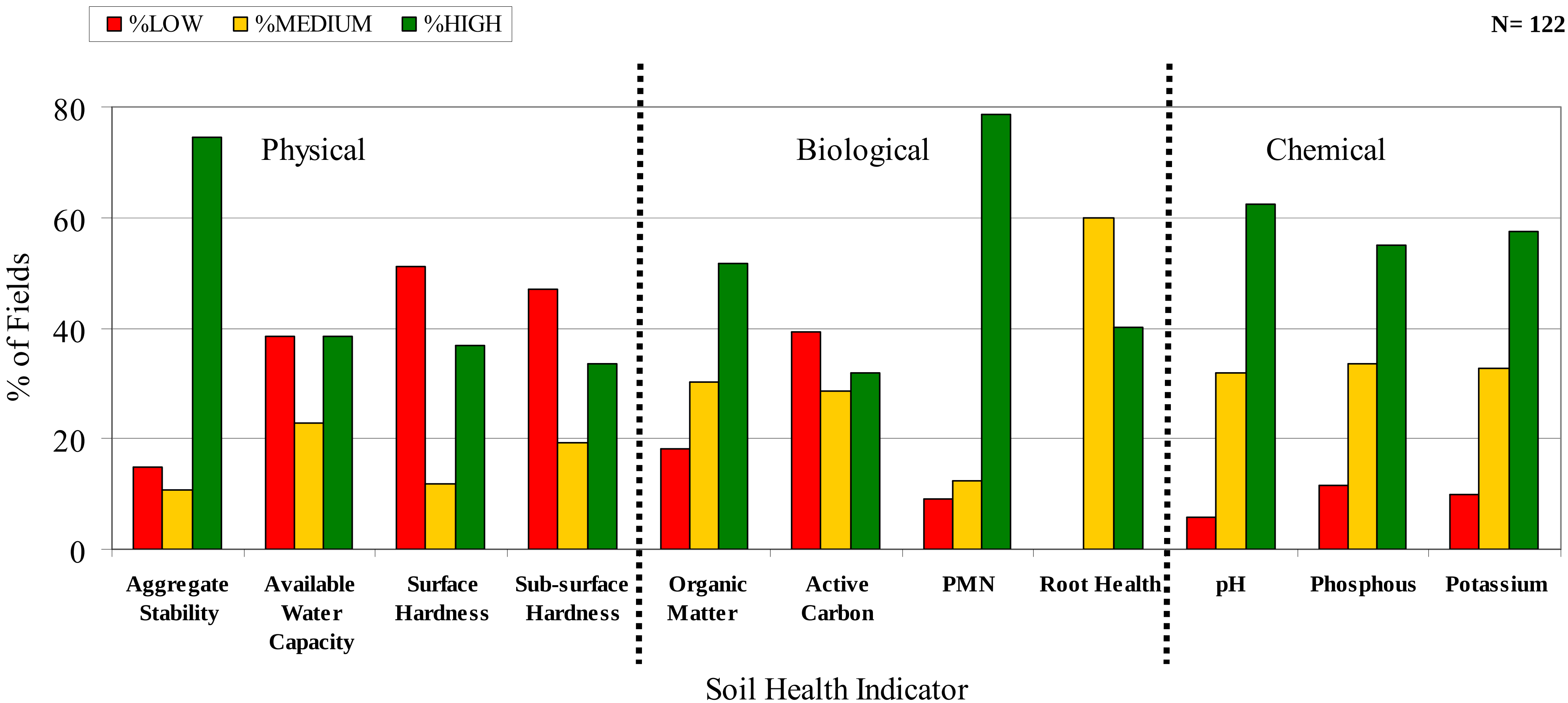

Figure 1. Performance of soil health indicators in dairy production systems.

Table 1: Soil Measurements and their level of significance under tillage and residue effects.

Physical Measurements	Tillage Effect	Residue Effect
Aggregate stability (WSA)	***	ns
Bulk Density (p_b)	***	*
Micro-penetration Resistance (within soil cores)	ns	ns
Saturated Hydraulic Conductivity	ns	ns
Macro-porosity (large pores)	ns	ns
Meso-porosity (medium pores)	ns	ns
Available Water Capacity (AWC)	***	**
Field Water Infiltration	ns	ns
Chemical Measurements		
Nitrate Nitrogen (NO_3-N)	*	ns
Phosphorus	ns	ns
Potassium	ns	****
Magnesium	**	***
Calcium	ns	ns
Iron	ns	ns
Aluminum	**	ns
Manganese	**	ns
Zinc (Zn)	**	ns
pH	****	ns
Biological Measurements		
Organic Matter (OM)	****	**
Parasitic Nematodes	****	ns
Beneficial Nematodes	ns	ns
Decomposition Rate	**	**
Potential Mineralizable Nitrogen (PMN)	*	ns
Easily Extractable Glomalin	*	**
Total Glomalin (TG)	***	**
Total number of significant indicators	**15**	**8**

Significant at : * p = 0.10, ** p = 0.05, *** p = 0.01, **** p = 0.001, ns = not significant (the more the asterisk, the higher the strength of significance)

NNY Agricultural Development Program
2006-2007 Project Report

Project Title: Biological Control of Alfalfa Snout Beetle with Entomopathogenic Nematodes.

Project Leader(s):

Elson Shields, Department of Entomology, Cornell University

Tony Testa, Department of Entomology, Cornell University,

Collaborator(s):

Mike Hunter, Jefferson Co. Cornell Cooperative Extension
Pete Barney, St Lawrence Co. Cornell Cooperative Extension
Carl Tillinghast, Franklin Co. Cornell Cooperative Extension

Cooperating Producers:

Jefferson Co.: Doug Shelmidine, John Peck

Lewis Co.: Mark Karelus, Bernie Gohlert

St Lawrence Co.: Mark Akins, "Skip" Putney

Franklin Co.: Eugene Poirire, Carolyn McNamara/Dick Eakins

Background:

Alfalfa snout beetle, within the infested counties, continues to be the single most contributing factor to alfalfa death and stand loss in NNY. Snout beetle related stand loss is often mistakenly identified as winter kill because the majority of plant death occurs after the growing season during the fall and early winter. This insect was introduced into NNY at the port of Oswego between 1848 and 1896, when the first individual was collected and identified. Snout beetle became a major pest problem after alfalfa was introduced into NNY in the 1920s. Attempts were made to control this insect from the 1940s to 1972 with the widespread distribution of poison baits. During this time, snout beetle continued to spread. Widespread baiting ended in 1972, due to environmental concerns and the snout beetle population exploded in the early 1980s. Research focused on the use of biological control to suppress snout beetle was initiated in 1990 and has been supported in part by NNYADP since its initiation.

In 2002 and 2003, the snout beetle population on the Peck Farm (Great Bend, Jefferson Co.) crashed from about 1 million beetles per acre to an extremely low level. Subsequent research has shown that the entomopathogenic (insect attacking) nematodes released on the farm in a series of small plots during 1993-98, have been moved throughout the farm by farming practices and caused the population crash of snout beetle. A small rebound of beetles was observed in a field bordering a neighbor's heavily infested farm in 2007. John Peck's farm has progressed from having the alfalfa stands completely killed out during the first production year from snout beetle feeding to actually plowing alfalfa plants down at the end of an alfalfa stand's life (5 years). With the establishment of 6 different small test plots on the Peck farm, it required nearly 10 years for the nematodes to spread throughout the farm and control snout beetle.

The question is: "How can we move the biological control success on the Peck Farm to the rest of the infested farms in the NNY?"

Since the entomopathogenic nematodes used as the biological control for snout beetle are adapted to NNY, a farm or field only needs to be inoculated once for the establishment of the nematodes in the field. If only a single field per farm is inoculated, the farmer will move the nematodes around the farm with the movement of soil during normal farming operations, but it will take years for the nematodes to become established in all of the affected fields on the farm and control the population of snout beetle on the farm. However, if a farmer friendly method could be developed to rear the nematodes on the farm and a method of application be developed compatible with on-farm equipment to inoculate individual fields, then each farmer could more rapidly spread the biocontrol nematodes throughout their fields for faster control of snout beetle.

In 2007, we shifted our research focus to address the problems associated with large-scale application of nematodes for wide scale control of snout beetle. Field plots were established in 13 different fields located on 7 farms across 4 - NNY snout beetle infested counties.

Methods and Results:

Field inoculation techniques: Two field sites were located in southern Jefferson Co. on the Doug Shelmidine farm to evaluate field inoculation methods into established alfalfa fields compatible with current farming practices.

At each site, four different soil inoculation techniques were tested. The plots consisted of four rows of flags. The flags within the row, were separated by 10 ft and the rows were separated by 20 ft to allow the farmer to cut the alfalfa between the treatment rows. At each flag within a row, the same type of nematode inoculation was placed. The inoculation methods tested were 1) nematode infected insect cadaver placed on the soil surface, 2) nematode infected insect cadavers placed four inches under the soil surface (a natural condition), 3) nematodes suspended in water and applied to the soil surface (a method used in experimental plots for more than 10 years) and 4) nematode infected soil placed at each flag. Soil samples were collected at the flags at 6 inch intervals within a treatment to document nematode establishment and spread from the point of inoculation. Soil samples were collected 22 days, 69 days and 109 days after the June 6, 2007 inoculation date. After soil samples were collected from the field, the samples were bioassayed for the presence of nematodes in the laboratory at Cornell.

As we all remember, the 2007 growing season was noted as one of the driest on record with a significant lack of rain and very dry soil conditions. In spite of the difficult environmental conditions, nematodes became established at both sites. The level of establishment was much lower than expected but considering the dry soil conditions, we are pleased that nematode establishment even occurred. The best establishment rate for both of the nematode species tested was the buried cadaver, a natural condition of nematode attack of soil insects. The second best establishment was the suspension of nematodes in water and applying the water to the soil surface. The placement of the cadaver on the soil surface and the placement of nematode infested soil on the surface were both disappointing with their establishment results. Nematode movement from the inoculation site was 42 inches over the 109 days of the growing season. Movement may actually have been greater but the difficulty of collecting soil samples in extremely dry soil may have underestimated the actual nematode movement. An example of the nematode establishment and movement data is displayed in Figure 1.

High Nematode Concentration Plots:

In past research plots, a high concentration of nematodes were applied to guarantee nematode establishment in the field. This technique was scaled up from the small 10 ft x 20 ft research plot to an 8 ft x 70 ft strip oriented across the grain of the field. The orientation of the inoculated area was important because the movement of soil during the plowing and other soil preparation work will move the nematodes into the rest of the field. Two different species of nematodes were applied to each plot at a rate of 12.5 million nematodes of each species per plot (total of 25 million nematodes). The 25 million total nematodes were suspended in 3 gals of water and sprayed on the soil surface of the plot. An additional 6 gals of water were sprayed on the plot to assist the nematodes in entering the soil. The spray boom was equipped with fertilizer stream nozzles spaced on 12 inch centers. A total of 45,000 nematodes were applied to each square ft of plot area (22,500 of each species). A different combination of nematode species was applied in each of the 3 different counties.

Field plots were located in Lewis Co (Mark Karelus and Bernie Gohert farms), St Lawrence Co (Mark Akins and 'Skip' Putney farms) and Franklin Co (Eugene Poirier and Carolyn McNamera/Dick Eakins farms). On the Lewis Co. farms, the nematode combination of *Steinernema carpocapsae* 'NY001' and *Heterorhabditis bacteriophora* 'Oswego' was used. In St Lawrence Co., the nematode combination of *S. feltiae* 'Valko' and *H. bacteriophora* 'Oswego" was used and in Franklin Co, the nematode combination of *S. carpocapsae* NY001' and *S. feltiae* 'Valko' was used. All three of the nematode combinations showed positive results in field plots on the Peck Farm.

Nematode establishment was documented at all field sites in spite of the extremely dry soil conditions throughout the summer. Establishment rates of 10-35% was lower than expected, but the dry soil conditions and very dry summer influenced our ability to collect good representative soil samples for bioassay. The actually establishment rate may be much higher. The plots will be re-sampled in the spring of 2008 to verify the actual establishment rate. The rate of spread from these sites will be documented during the2008 growing season. Data from three of the farm sites is displayed in Figure 2.

Low Nematode Concentration Plots:

In this set of plots, the concept of applying the biocontrol nematodes at a very low concentration over a much larger area was examined. Using this method, a field would become completely colonized much quicker, if the low density of nematodes became established in the soil. These low concentration plots were applied by mounting an 8 ft spray boom on the back of a pickup truck with 2-55 gal tanks mounted in the truck. Fertilizer stream nozzles were mounted on the boom on 6-inch centers and the application rate of the boom was 5 gals per min. With a truck speed of 6 mph, and concentrating the water into 2 inch bands every 6 inches, the water application rate was 0.5 ounces per linear ft. The force of the water exiting the fertilizer stream nozzle at 40 psi blasted the water stream through any alfalfa canopy present and deposited the nematodes on the soil surface in a good stream of water. Nematodes were applied at three different densities. On the Doug Shelmidine farm (southern Jefferson Co.), nematodes were applied at 900,000 nematodes per gal of water or 1100 nematodes per square ft. Nematodes were applied on the Bernie Gohlert farm (Lewis Co.) at 3 million nematodes per gallon or 4000 nematodes per square ft. An intermediate nematode concentration of 1.8 million nematodes per gal or 2200 nematodes per square ft were applied on the Mark Akins and 'Skip' Putney farms (St Lawrence Co.) and Carolyn McNamera/Dick Eakins farm (Franklin Co.)

Areas of the truck applications were sampled once after application to verify nematode establishment. Nematodes became establish at all sites in spite of the very dry soil conditions and conditions "hostile" to nematode establishment. At the Shelmidine site and the Putney site, only one of the two species applied were detected. Since Hb.'Oswego' cruises deeper in the soil and the dry soil conditions prevented a deeper soil core, Oswego may have become established at both of these sites. Our years of experience with this nematode on the Peck farm would suggest that establishment did occur even though we were unable to detect it. All 2007 application plots will be re-sampled in May-June 2008 to re-affirm nematode establishment. We believe this type of low nematode concentration has excellent potential for use by individual farmers to inoculate their own fields. A sample of the establishment data from these application trials is displayed in Figures 3 and 4.

Conclusions/Outcomes/Impacts:

The 2007 research identified that the best method of inoculating infested fields is to suspend the nematodes in water and spray the nematodes onto the soil surface in a high volume of water using fertilizer stream nozzles. The application trials will give us a good starting point to estimate the most efficient method to inoculate fields with the bio-control nematodes. Spreading out a 100 million nematodes using a lower concentration of nematodes in the water carrier will enhance the spread of nematodes throughout the field and reduce the time required to control snout beetle in each field. This information will allow the farmers to apply their own nematodes through their own spray with minor modifications.

Outreach:

No extension presentation were requested about snout beetle research and progress in 2007. Presentations are scheduled for March 12, 2008 in Canton and March 13, 2008 in Carthage. No presentations have been scheduled to date for Franklin Co. The topic of these presentations will be a research update about alfalfa snout beetle.

In addition, there was a news release titled: Cornell Researchers and Farmer Report More Progress Against Pest peculiar to Northern NY. Released 5/21/07

Next steps:

The focus for 2008 has to be directed in perfecting a farmer-friendly nematode rearing method so nematodes can be reared on the farm and dumped into the spray tank with minimal labor.

Acknowledgments:

This research has been supported by NNYADP and Cornell University Agricultural Experiment Station.

Reports:

An article about the history of alfalfa snout beetle in NNY and the success of the biological control effort with nematodes was submitted to the “American Entomologist” in early January. Reprints of the article will be made available for general distribution when the article is published. The contents of the article has already been made available to Kara Dunn for possible use.

Person(s) to contact for more information (including farmers who have participated:

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Mark Akins 296 Five Mile Line Rd Lisbon, NY 13658 315.393.0813	"Skip" Putney 382 Five Mile Line Rd Lisbon, NY 13658 315.393.5652	Eugene Poirire Taylor Rd North Bangor, NY 12966 518.483.6696
Carolyn McNamara Dick Eakins Malone Garden Apts. 75 Pleasant St Malone, NY 12953 518.483.0307	John Peck 24082 Co. Rd. 47 Carthage, NY 13619 315.493.3191	

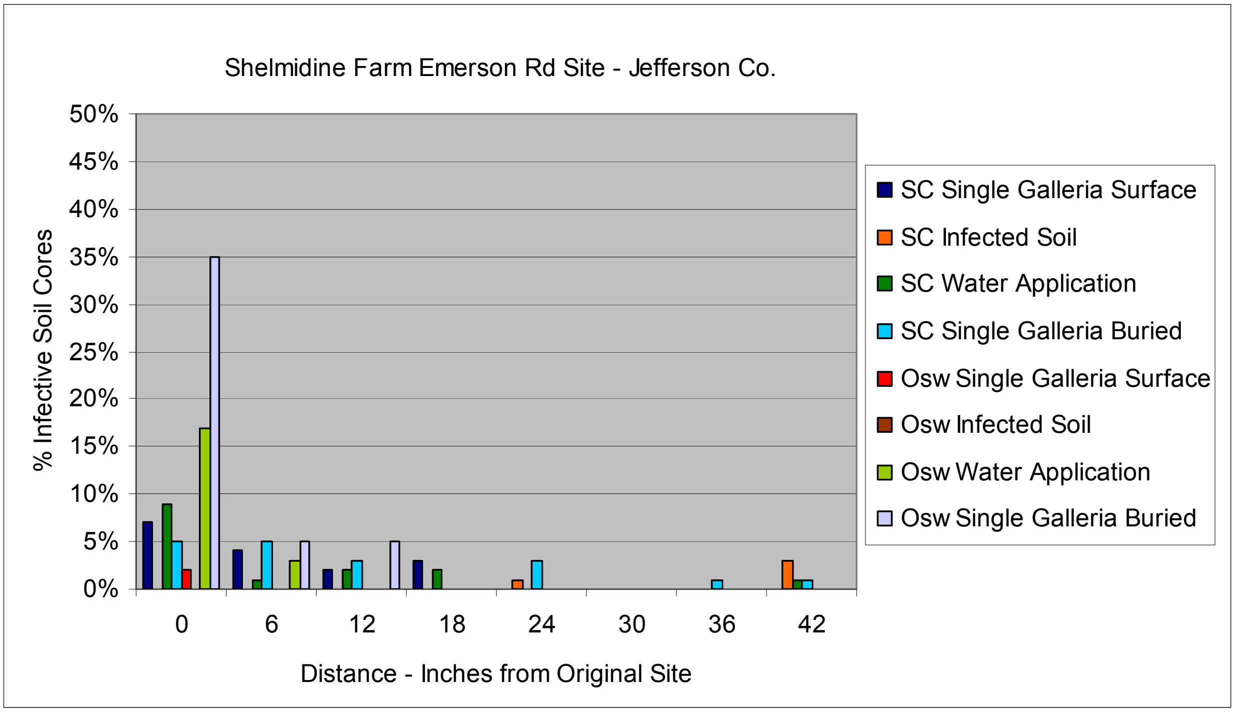
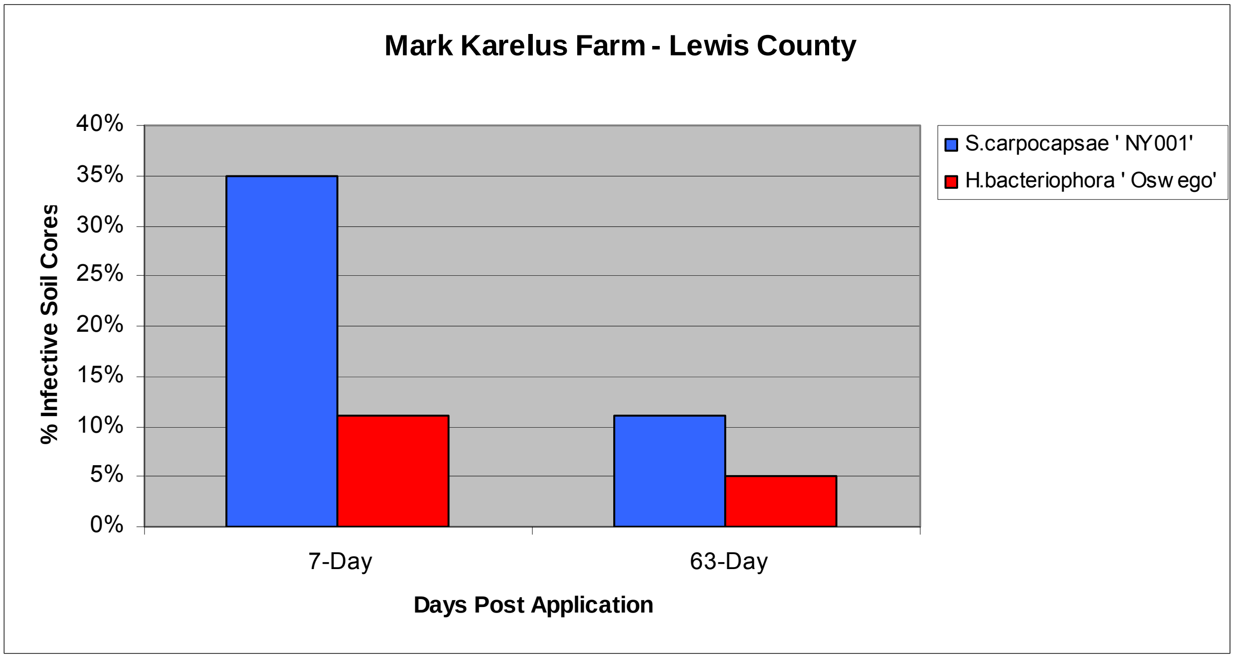


Figure 1. Establishment of *S. carpocapsae* 'NY 001' (SC) and *H. bacteriophora* 'Oswego' (Osw) using four different inoculation methods in the field.



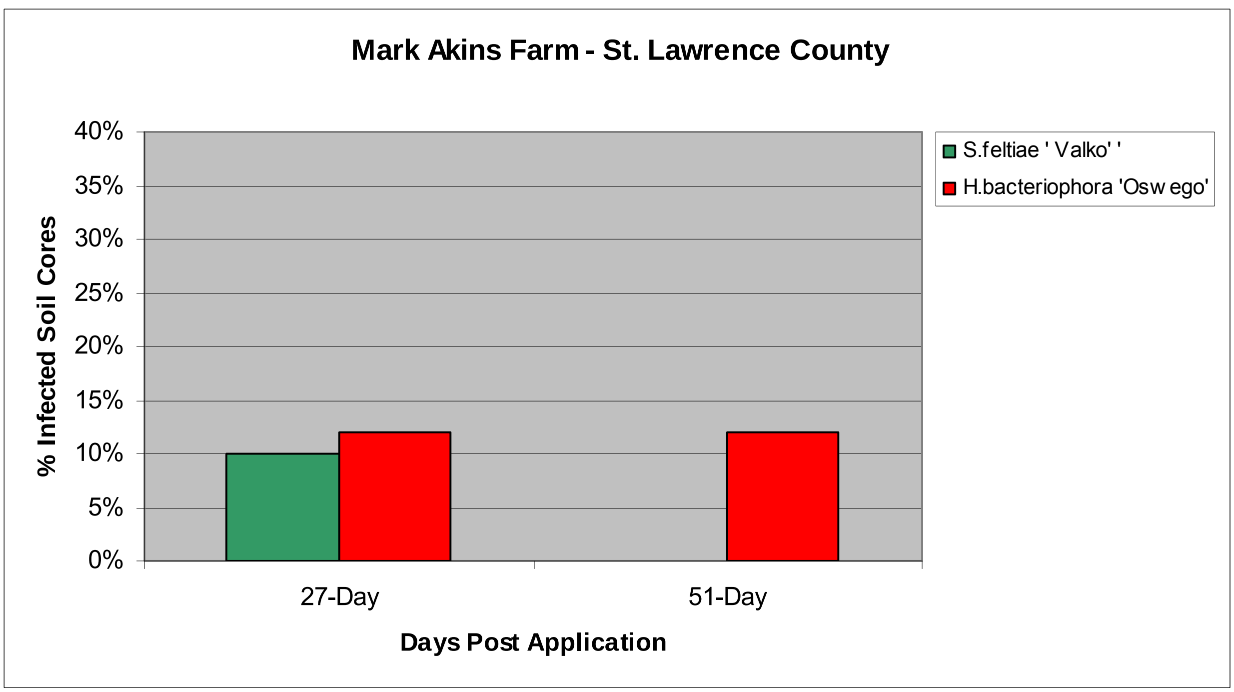


Figure 2. Establishment of three species of bio-control nematodes using an eight foot hand boom with a high concentration of nematodes in water used as carrier.

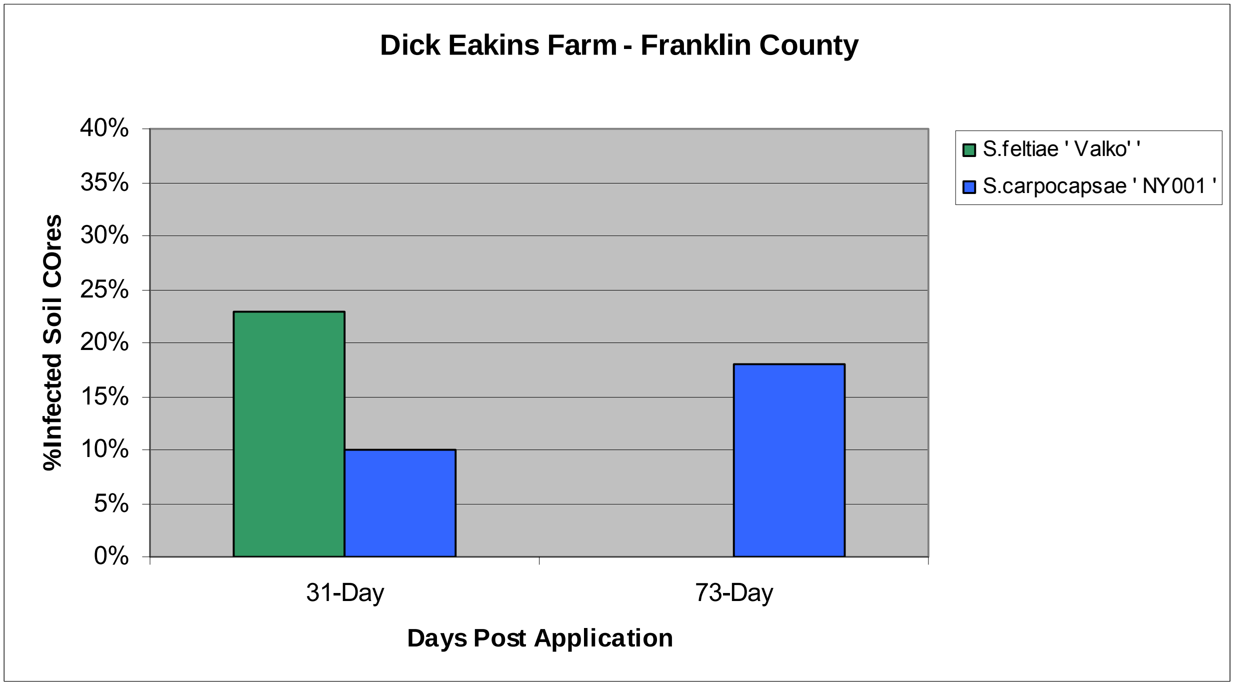
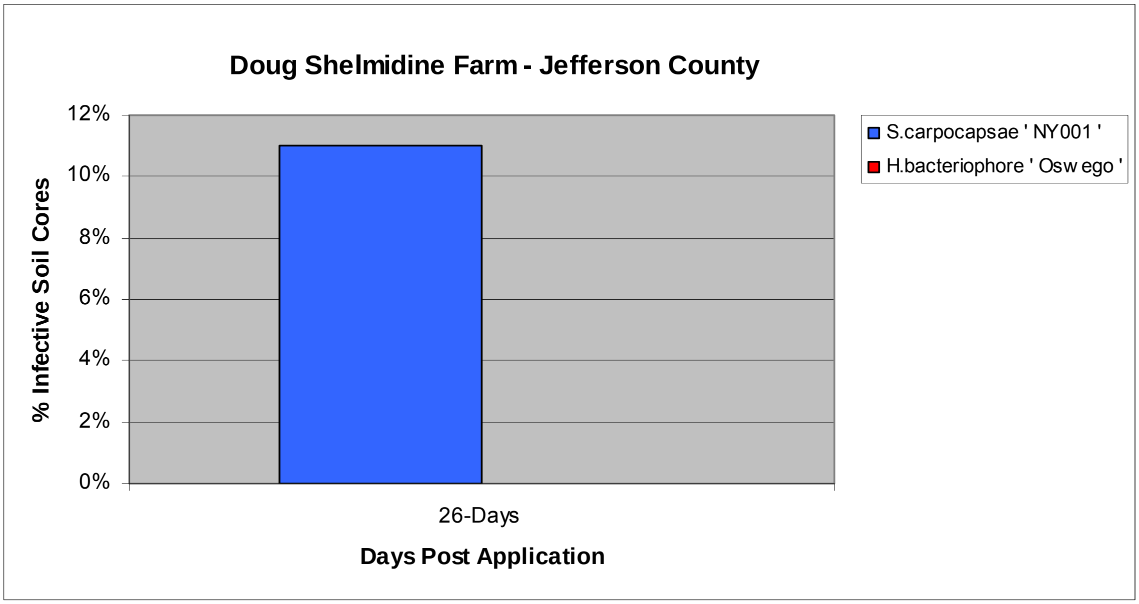


Figure 2 cont. Establishment of three species of bio-control nematodes using an eight foot hand boom with a high concentration of nematodes in water used as carrier.



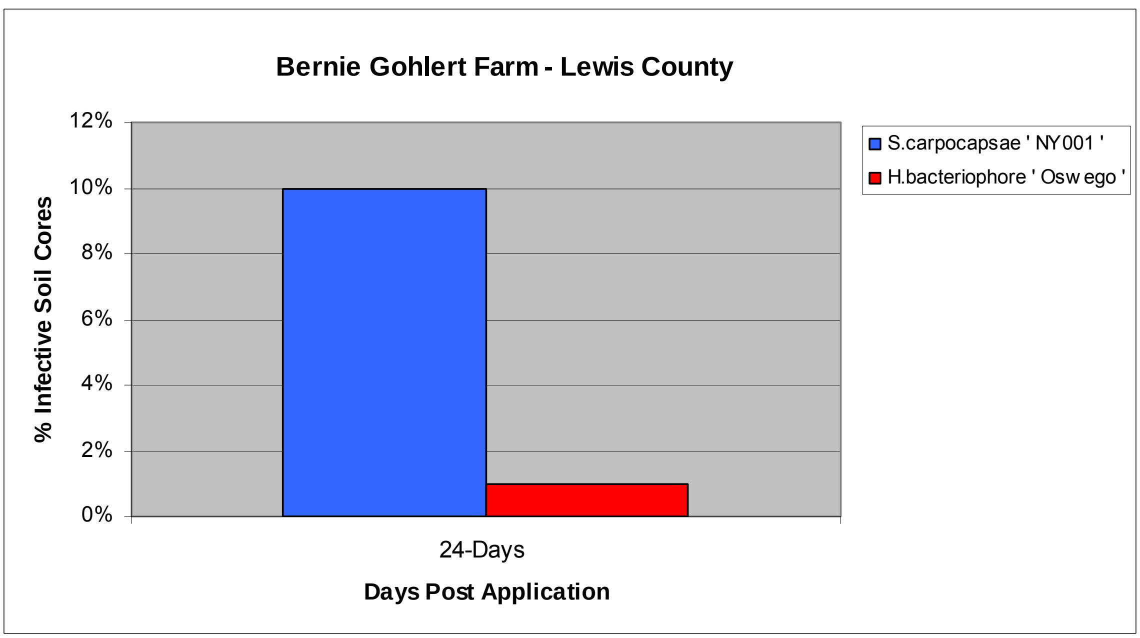
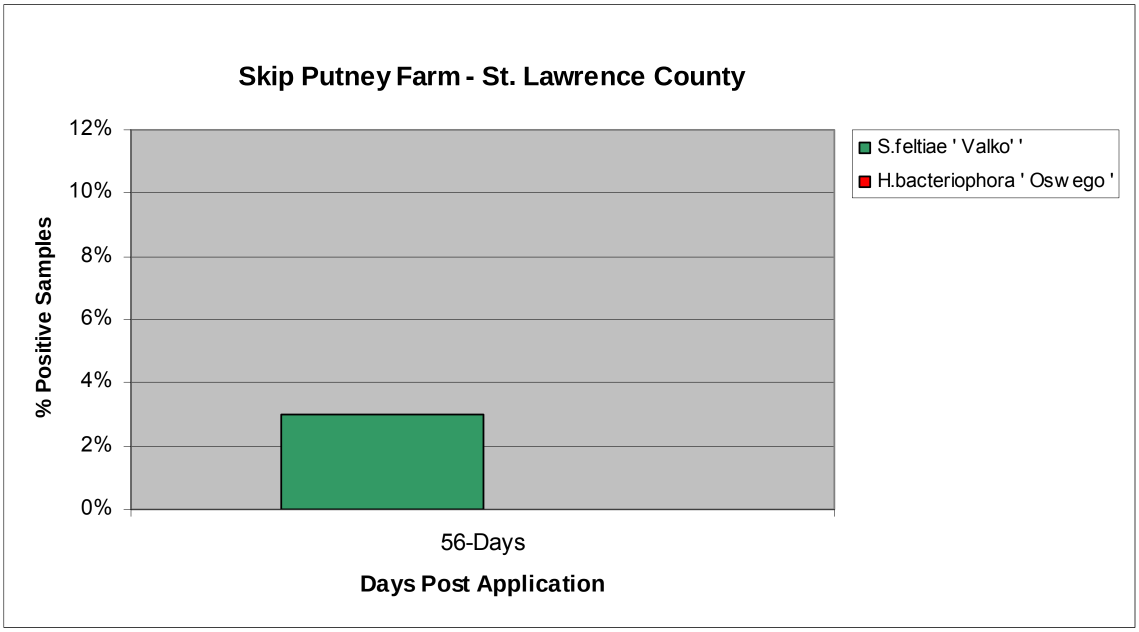


Figure 3. Establishment of bio-control nematodes using a low concentration of nematodes in a high volume of water applied through an eight ft boom mounted on a truck.



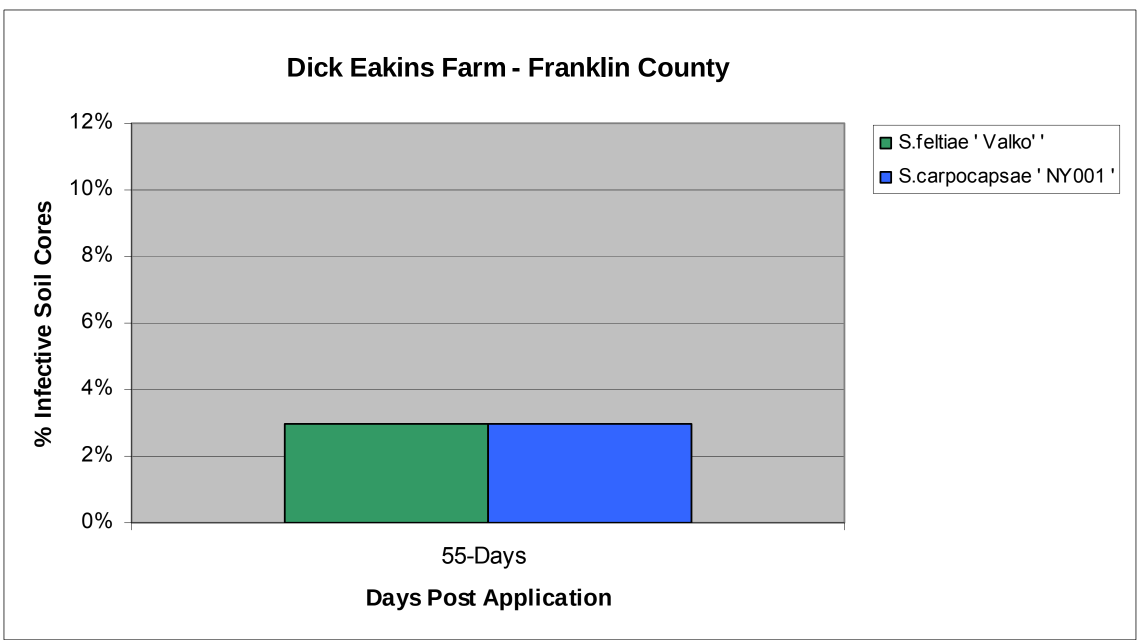
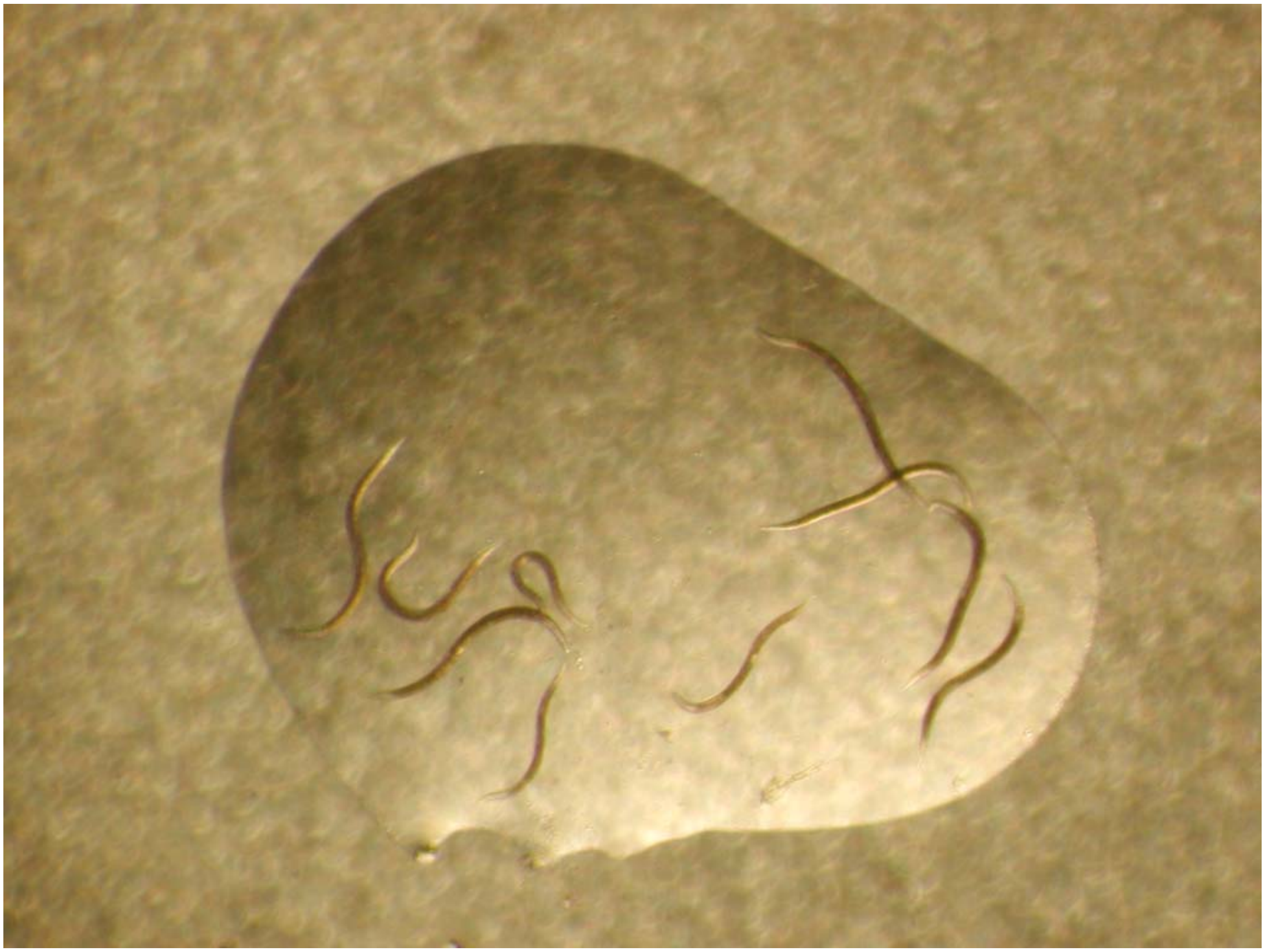


Figure 3. Establishment of bio-control nematodes using a low concentration of nematodes in a high volume of water applied through an eight ft boom mounted on a truck.



Picture of the infective stage of the alfalfa snout beetle bio-control nematode.

Field application of bio-control nematodes in a high concentration of nematodes per volume of water.

NNY Agricultural Development Program
2006-2007 Project Report

Project Title: Breeding Alfalfa Snout Beetle Resistant Alfalfa Varieties

Project Leader(s):

D.R. Viands, Department of Plant Breeding and Genetics

E.J. Shields, Department of Entomology

J. Crawford, Department of Plant Breeding and Genetics

A. Testa, Department of Entomology

E. Thomas, Department of Plant Breeding and Genetics

J. Hansen, , Department of Plant Breeding and Genetics

Collaborator(s):

Chuck Burnett, Seed producer, Nampa, ID.
Mike Hunter, CCE Jefferson County

Cooperating Producers:

John Peck and Howard Keefer in Carthage, NY.

Background:

Alfalfa snout beetle (ASB), *Otiorhychus ligustica*, is the most destructive insect pest of alfalfa in Northern New York (NNY) and is continuing to spread. Alfalfa snout beetle is currently infesting nine NNY counties and has invaded Canada across the St. Lawrence River. Otherwise, there is no other known infestation of this insect in North America.

Alfalfa snout beetle was introduced from Europe into the Port of Oswego during the middle to late 1800's in a ship ballast. It was first discovered as a problem around 1930 after alfalfa was introduced into Oswego County. This pest causes severe yield and stand losses on alfalfa by larval feeding on alfalfa roots. New infestations are often mistaken for winter injury since the majority of plants die after the last harvest and before spring growth. To date, there are no effective methods of controlling this destructive insect pest. With other introduced insect pests, two strategies have been effectively used to reduce the insect populations to manageable levels. These strategies are 1) breed alfalfa with resistance to the insect and 2) identify and establish in NNY biological control organisms from the native home of ASB.

None of the alfalfa varieties grown in northern USA during the 1990s appeared to be resistant when grown on a field heavily infested with ASB. In 1998 at Watertown, NY, the perennial *Medicago* core collection and other germplasms were evaluated for resistance/tolerance to ASB. The 173 plant populations ranged from 3.7 to 4.8 (1 = no root damage, 5 = dead plant). This variability suggested that resistance genes may exist at a low level in a few populations. Therefore, we initiated recurrent selection to increase the level of resistance in several alfalfa populations. In addition, alfalfa varieties grown in Hungary in association with native ASB populations were obtained through contacts within Hungary. Therefore, we have been interested in selecting within these Hungarian varieties since ASB populations exist in Hungary and other parts of Europe, but are less destructive there than in NNY.

Breeding for ASB resistance/tolerance by screening plants in infested fields is time-consuming (2 years/screening), and not reliable because the insect pressure in fields is not uniform. In a field screening, susceptible plants may be selected because they escaped injury. In order to screen thousands of alfalfa plants for resistance to ASB, a reliable greenhouse screening method was needed. A greenhouse screening method was developed by E. J. Shields and A. Testa with funding from the NNY Agricultural Development Project. With this greenhouse screening method, the ASB population pressure can be controlled by the number of eggs applied uniformly to each container and by the length of time the larvae are allowed to feed on the alfalfa roots. Thus, plants with a low level of resistance can be selected over several cycles of selection, and the frequency of resistance genes can be increased in several alfalfa populations.

The ultimate goal is to develop alfalfa varieties that are resistant to ASB, and thus more persistent and productive in areas infested with ASB. Therefore, production of high quality forage for the dairy and other livestock industries would be achievable more economically in the North Country.

Methods:

During this past year, we completed the fourth or fifth cycle of selection for resistance in 16 alfalfa populations. Plants with the least injury were selected and seed produced for the next cycle of selection. Plant populations consisted of the most elite in the Cornell Forage Breeding Program, varieties from ASB-infested areas of Hungary, and plant introductions that we earlier identified with least injury on John Peck's farm in the North Country. Since 2003, a total of more than 100,000 plants have been evaluated for resistance to ASB. About 33,000 plants were evaluated in 2007.

Based on the data from the experiment conducted in 2006 (see Figures 1 and 2 for summary data), we contracted a collaborator in Caldwell, ID, to produce a few pounds of seed of the three alfalfa populations in which the most progress from selection had been realized. This seed will be used for a field experiment described below.

Results:

During 2007, experiments were not conducted for generating data. As described in the previous section, recurrent selection was continued, and seed was produced for further experiments.

Conclusions/Outcomes/Impacts:

As stated in last year's report, the significant progress from selection provides the first real hope that we can develop alfalfa varieties with resistance to ASB. We anticipate that development of resistant varieties in combination with other control measures will provide protection of the alfalfa crop from ASB injury. Therefore, alfalfa production on land that is infested with ASB will be enhanced, thus making production more economical.

We do not yet know if the resistance levels achieved thus far are sufficient to protect the alfalfa crop in fields with ASB. A future experiment will provide this information, but we are continuing selection to enhance the resistance levels.

Outreach:

Updated progress on this research was reported to extension educators and seed company representatives during a field day presentation last summer. It also was reported to seed sales people and growers during a presentation in January. During a December meeting with seed companies closely associated with our program, the seedsmen expressed very strong interest in a new alfalfa variety with resistance to alfalfa snout beetle.

Next steps if results suggest continued work is needed.

Funding has been granted to continue the ASB breeding research into 2008.

Selection: Although progress from selection already has been realized, we will try to increase the resistance levels by continuing selection in the 16 plant populations under controlled conditions in Ithaca. A total of about 30,000 plants will be screened.

Heritability: We are continuing a heritability experiment to determine the most effective breeding method for continuing to increase the level of plant resistance. Parent plants have been randomly taken from two alfalfa populations selected for resistance to ASB, and open-pollinated seed will be produced on these plants during winter 2008. In summer 2008, the progenies (from seed of each parent plants) will be evaluated in a replicated experiment in the greenhouse for level of resistance or susceptibility to ASB. Heritability estimates for individual plant selection will be compared to that of progeny selection by using data from the parent plants and their progenies.

Field Experiment: Seed from the 2007 Idaho seed production cages will be planted in an ASB-infested field in NNY (likely Jefferson Co.) to compare Cycle 3 with the base populations for plant stand and forage yield during the next two or three years. Mike Hunter, extension specialist in Jefferson Co., is helping us to identify a field appropriate for this experiment. This experiment will provide information to determine if resistance in the greenhouse translates to resistance in the field, and the level of resistance needed to adequately protect the alfalfa crop.

Acknowledgments:

Project Funders:
Northern New York Agricultural Development Program
Cornell University Agricultural Experiment Station (Hatch Multistate Project NE-1010)

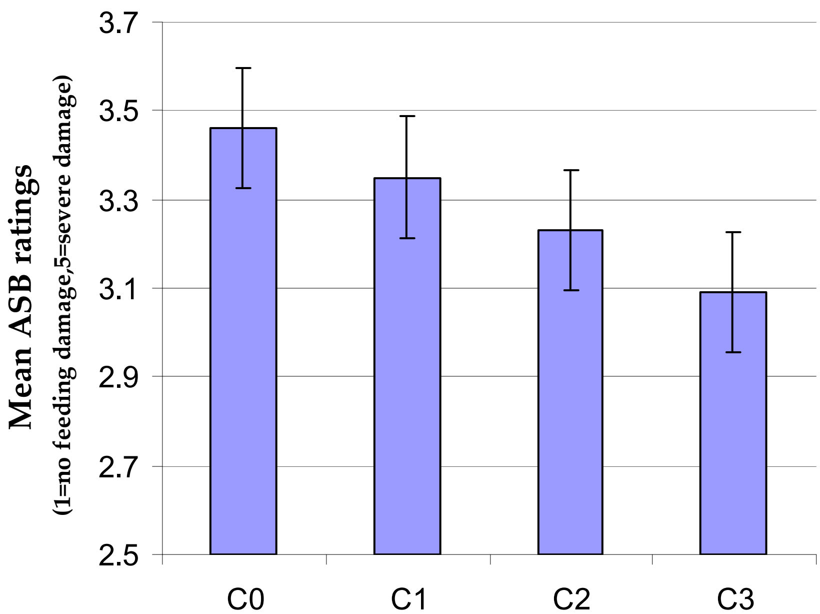
Reports and/or articles:

No reports have been published. Our collaborating seed companies are willing to pay for patenting of the resistant plant material, thus preventing us from publishing until we have sufficient evidence to warrant the patent.

Person(s) to contact for more information:

Donald R. Viands; Cornell University; Department of Plant Breeding and Genetics; 523 Bradfield Hall; Ithaca, NY 14853-1902. 607-255-3081; drv3@cornell.edu;
http://plbrgen.cals.cornell.edu/people/profiles/viandsdonald.cfm

Base Population Cycle 1 Cycle 2 Cycle 3



Figures 1 and 2. Progress from selection for resistance to alfalfa snout beetle. From left to right, the base populations averaged a score of root damage (1=no root damage, 5=root totally chewed off or dead plant) of 3.46, Cycle 1 = 3.35, Cycle 2 = 3.23, and Cycle 3 = 3.09. Photo and histogram by Jamie (Neally) Crawford, Cornell Forage Breeding Project.

NNY Agricultural Development Program
2006-2007 Project Report

Project Title: **Evaluation of Warm Season Grasses for Biofuel Production in Northern NY.**

Project Leader(s):
D.R. Viands, Department of Plant Breeding and Genetics
J. Hansen, Department of Plant Breeding and Genetics
H. Mayton, Department of Plant Breeding and Genetics
Collaborator(s):
Gary Bergstrom, Russ Hahn, Quirine Ketterings, Elson Shields, Mike Davis (W.H. Miner Agricultural Research Institute), Pete Barney (St. Lawrence Co. Extension), Anita Deming (Essex Co. Extension), Paul Salon (USDA Big Flats Plant Materials Center, Corning, NY), Mike Hunter (Jefferson Co. Extension), Steve Jones (Bellevue Central School District).

Cooperating Producers: Belleville Central School District, Jefferson County, NY

Background: The close proximity of agricultural land in the Northeast to major population and transportation centers makes this region ideal for development of bioenergy crops and industrial bi-products from energy conversion processes. Corn grain is the primary bioenergy crop used for ethanol production in the US, but perennial grasses have the potential to be more economical and environmentally sustainable than corn for ethanol production. The cellulosic conversion process that produces ethanol from biomass utilizes a greater percentage of the plant than the corn-ethanol conversion process. Corn is an annual crop and requires substantial inputs each planting year, whereas the grasses identified as candidates for dedicated bioenergy crops are perennials and can be harvested for several years with very little input. Perennial grasses can be used for conversion to liquid fuels or for direct combustion. Life cycle analyses of perennial grasses have demonstrated that these crops will reduce greenhouse gas emissions when used as an alternative to fossil fuels. In addition, perennial grasses reduce soil erosion and improve soil health and structure through production of an extensive root system.

Switchgrass (*Panicum virgatum* L.) has been selected as a model biofuel feedstock crop by the United States Department of Energy (DOE) due to its native geographic distribution and potential for high biomass production. The majority of research conducted on switchgrass for the DOE was done in the Midwest where management practices and environmental conditions differ from those in Northeast. Therefore, data obtained in the Midwest trials may not reflect how different perennial grass species or varieties within species will perform in New York. The objectives of this project are to evaluate several switchgrass varieties along with other warm season grass species for biomass yield and bioenergy crop value.

Methods: A replicated perennial grass trial (144 total plots) was established in a field (Collamer silt loam soil type) adjacent to the Belleville Central School in Jefferson County, NY (Figures 1 and 2). A few weeks prior to planting the field, an annual ryegrass cover crop was sprayed with the herbicide Roundup® (Monsanto, St. Louis, IL). The field was prepared for planting by mold-board plowing, disking, rototilling, and smoothing with a Brillion seeder (Brillion Iron Works Inc., Brillion, WI, Figure 3). Plots (3.5 ' X 15 '), each with six rows spaced six inches apart, were established in a randomized complete block design with six replications. Seed of the different trial entries (Table 1) was planted with a Carter (Carter Manufacturing Co., Brookston, ID) small plot seeder. Twenty trial entries were planted in monoculture (a single variety of a grass species) and four entries consisted of a mixture of two different grass species. After planting, the field trial was cultipacked to enhance seed to soil contact.

Seeding rate for switchgrass and eastern gamagrass was 10 lb pure live seed (PLS)/A; big bluestem 12 lb PLS/A; and coastal panicgrass 8 lb PLS/A (Table 2). Pure live seed is the percentage of seed that is alive, and percent quick germination is the percent of seeds that will germinate shortly after planting, the remainder of the seed is dormant or dead. The actual seeding rate per variety was corrected for percent pure live seed and percent quick germination reported on the seed tag label by the companies from which seed was obtained (Table 2). The approximate number of pure live seeds per monoculture plot ranged from 274 for eastern gamagrass to 19,493 for 'Pathfinder' switchgrass. This range is due to variation in seed size and percent quick germination among the seed lots. After correcting the seeding rate for the percent quick germination rate, the actual seeding rate ranged from 9 to 63 lbs/A (Table 2). Thus for research purposes, the number of seeds per plot was standardized across all seed lots. For this short term research project, it was necessary to have the same number of germinable seeds planted per plot to collect adequate data on stand counts. Producers would not normally correct for percent quick germination because some of the dormant seed should germinate. Since seed of warm-season grasses is expensive, it is important for producers to try to purchase seed lots with high percent pure live seed and high percent quick germ to keep input seed costs as low as possible. This is an area that needs further research in order to determine and make recommendations for the most appropriate seeding rate for planting.

During the seeding year, data were collected on percent stand established and canopy height. Plant disease incidence and severity, weed pressure, and seedling vigor were also recorded. Because it takes three years to establish a mature stand of the warm season grasses selected for the trial, yield and cell wall composition of the trial entries and quality characteristics important for conversion to biofuels will begin to be evaluated in 2008. Weeds were cut once during the growing season in July with a string trimmer. After planting, fertilizer or pesticides were not applied in order to minimize total input costs.

Results: Researchers have reported that a grass stand of approximately 40% in the establishment year was a good indication of a successful planting. By this criterion, all of the grass species/varieties had acceptable establishment except for 'Niagara' big bluestem and 'Pete' eastern gamagrass. The average percent stand of all grass entries planted in Jefferson County in 2007 was 62 %. The switchgrass varieties 'Blackwell', 'Carthage', 'Shelter', 'Forestburg', and 'Cave-in-rock' had the highest 1st year stands (Table 3). These data are consistent with stand establishment data from other warm season grass trials planted at various locations in New York State in 2007. Big bluestem cultivars 'Goldmine' and Niagara and other warm season grass species did not establish as well as the majority of switchgrass cultivars. The seed for the switchgrass cultivar Pathfinder was heavily contaminated with foxtail weed seeds and thus we were unable to collect data on stand establishment (Table 3).

In terms of overall growth measured by canopy height, the switchgrass cultivars Blackwell, Carthage and Cave-in-rock performed well. Significant weed pressure was observed in the plots (Figure 4); however, the warm season grass plants apparently were still able to receive adequate sunlight and moisture and were not smothered by the weeds. The most common broadleaf weeds observed in the plots were pigweed, lamb's quarter, and ragweed. Other weeds present were foxtail, and nutsedge. Leaf spot disease symptoms were observed on most varieties but did not exceed more than 10 % in any individual grass plot.

Conclusions/Outcomes/Impacts: Purchasing and planting good quality seed is critical to successful establishment of warm-season grasses. Also, producers should correct seeding rates for percent pure live seed, as each seed lot will vary in the amount of inert material in the seed bag. Establishment of the warm season perennial grasses without the use of post-emergent herbicide applications resulted in plots with heavy weed pressure (Figure 4), yet good stands of the grasses were obtained in most cases when good quality seed was planted. All of the plots in each replicate had at least 40% weed infestation. Competition with annual and perennial weeds is a common problem that has been reported in the literature in establishment years for warm season perennial grass field trials. Data collected in 2008 will provide more information on stand, weed pressure, cultivar biomass yields and bioenergy quality characteristics.

Outreach: Information regarding the trial was reported at field days held in Tompkins County, at the USDA/NRCS Plant Materials Center in Big Flats, and in Dutchess County. Information and data from this research trial was reported to extension educators at the Agriculture-Food-In-Service meeting in Ithaca, NY, held during the second week of November 2007. Several field day meetings will be held during the 2008 field season.

Next steps if results suggest continued work is needed in the areas of research, demonstration and/or education. Yield data of the various perennial grasses harvested from the plot trials and characteristics associated with energy conversion will be evaluated in 2008. An additional small plot trial identical to the experiment in Jefferson county will be established at the W.H. Miner Agricultural Research Institute in 2008.

Acknowledgments: This project was funded by the Northern New York Agricultural Development Program and the Cornell University Agriculture Experiment Station. Salaries for summer technicians working on the Jefferson county trial were also funded in-part by a grant from the New York Farm Viability Institute.

Reports and/or articles in which the results of this project have already been published. These data will be included in fact sheets, information packages, reports and articles associated with perennial grass biofuel projects currently underway at Cornell University. They also will be available on a web site that is being created.

Person(s) to contact for more information (including farmers who have participated: Hilary Mayton hsm1@cornell.edu; Julie Hansen jlh17@cornell.edu; and Donald Viands drv3@cornell.edu; Cornell University; Department of Plant Breeding and Genetics; 523 Bradfield Hall; Ithaca, NY 14853-1902. 607-255-5043; http://plbrgen.cals.cornell.edu/people/profiles/viandsdonald.cfm

Appendices:

Table 1. Common name and scientific name of grasses planted.

Common name	Species
big bluestem	*Andropogon gerardii*
coastal panic grass	*Panicum amarulum*
eastern gamagrass	*Tripsacum dactyloides*
indiangrass	*Sorghastrum nutans*
switchgrass	*Panicum vergatum*

Table 2. Variety, common name and species along with % pure live seed (PLS), % quick germination, and seeding rate of perennial grass entries in Jefferson County cultivar evaluation trial.

Entry	**Variety**	**Common name**	**% PLS***	**% Seed tag quick germination**	**Seeding Rate lb PLS/A**	**Actual** Seeding Rate lb/A**
1	Bonanza	big bluestem	72	80	12	15
2	Goldmine	big bluestem	56	68	12	18
3	Niagara	big bluestem	22	74	12	16
4	Atlantic	Coastal panic grass	87	88	8	9
5	Pete	eastern gamagrass	84	30	10	33
6	Blackwell	switchgrass	86	31	10	32
7	Carthage	switchgrass	94	51	10	20
8	Cave-in-rock	switchgrass	95	71	10	14
9	Cave-in-rock***	switchgrass	95	37	10	27
10	Forestburg	switchgrass	77	21	10	48
11	Kanlow	switchgrass	93	86	10	12
12	Pathfinder	switchgrass	74	16	10	63
13	Shawnee	switchgrass	93	93	10	11
14	Shelter	switchgrass	86	22	10	45
15	Sunburst	switchgrass	98	98	10	10
16	Trailblazer	switchgrass	93	83	10	12
17	Nebraska 54	indiangrass	92	67	10	15
18	Nebraska 28	switchgrass	92	92	10	11
19	Rumsey	indiangrass	86	78	10	13
20	Pawnee	big bluestem	63	68	12	18
21	Cave-in-Rock	switchgrass	95	37	5	14
	Bonanza	big bluestem	72	80	6	8
22	Sunburst	switchgrass	98	98	5	5
	Niagara	big bluestem	22	74	6	8
23	Cave-in-rock	switchgrass	95	37	5	14
	Pete	eastern gamagrass	84	30	5	17
24	Niagara	big bluestem	22	74	6	8
	Pete	eastern gamagrass	84	30	5	17

* % Pure live seed (PLS)
** Actual seeding rate is corrected for quick germination rate.
*** Cave-in-rock seed for this entry was stratified before planting

Table 3. Data of percent stand established and canopy height of perennial warm season grasses from the 2007 field season from the small plot trial established in Jefferson County, NY.

Entry	Variety	Common name	% Stand 9/5/07	Height (inches) 9/5/07
9	Cave-in-rock*	switchgrass	83	30
14	Shelter	switchgrass	83	25
7	Carthage	switchgrass	81	30
6	Blackwell	switchgrass	80	35
1	Bonanza	big bluestem	77	26
13	Shawnee	switchgrass	75	28
10	Forestburg	switchgrass	70	23
16	Trailblazer	switchgrass	70	35
18	Nebraska 28	switchgrass	70	21
11	Kanlow	switchgrass	68	25
15	Sunburst	switchgrass	62	24
20	Pawnee	big bluestem	62	26
8	Cave-in-rock	switchgrass	60	30
2	Goldmine	big bluestem	57	16
19	Rumsey	indiangrass	57	19
17	Nebraska 54	indiangrass	48	22
4	Atlantic	coastal panic grass	43	29
3	Niagara	big bluestem	32	20
5	Pete	eastern gamagrass	19	19
12	Pathfinder	switchgrass	.	.
21	Cave-in-Rock	switchgrass	62	28
	Bonanza	big bluestem	62	22
22	Sunburst	switchgrass	43	34
	Niagara	big bluestem	43	26
23	Cave-in-Rock	switchgrass	70	36
	Pete	eastern gamagrass	70	19
24	Niagara	big bluestem	65	10
	Pete	eastern gamagrass	65	10

* Cave-in-rock seed for this entry was stratified before planting

Figure 1. Replicated perennial grass trial located at the Belleville Central School (in background), in Jefferson County, NY.

Figure 2. Student from Belleville Central School helps prepare field for planting biofuel perennial grass cultivar evaluation trial established in May 2007.

Figure 3. Dr. Julie Hansen, holding warm season grass seed packages to be planted in the biofuel trial, with students from Belleville Central School (SUNY-ESF Willows in the background).

Figure 4. Perennial grass small plot trial located in Jefferson county, NY.

NNY Agricultural Development Program
2006-2007 Project Report

Project Title: **Corn Silage Hybrid Trials in Northern NY**

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Farmer Participants: John Greenwood, St. Lawrence Co and Ron Robbins, Jefferson Co.

Background: Corn silage is a major crop in New York because dairy producers prefer this high-energy forage in the feed ration. Dairy producers in the six-county region (Lewis, Jefferson, St. Lawrence, Franklin, Clinton, and Essex) of Northern NY have planted about 100,000 acres of corn silage annually since 1999, which represents almost 85% of the annual corn acreage in Northern NY. Consequently, dairy producers in Northern NY plant about 20% of the New York corn silage crop (~500,000 acres). Clearly, corn silage is an important crop in Northern NY and Northern NY is an important region of the state for corn silage production. Corn silage research in Northern NY would greatly benefit both Northern NY and New York State.

We have evaluated numerous corn hybrids under different management practices including planting date, plant density, row spacing, N rate and timing, harvest date, and harvest cutting height. In most instances, the hybrid planted had a greater influence on silage quality than have management practices. Consequently, we believe that hybrid selection is the most important management practice affecting corn silage quality in most growing seasons.

Until 1990, most agronomists and animal nutritionists believed that high-yielding grain hybrids were the best corn silage hybrids. In the 1990s, however, it became increasingly clear that high-yielding silage hybrids with excellent quality do not require high grain content. In fact, many agronomists and animal nutritionists now believe that stover fiber digestibility is the most important hybrid characteristic affecting silage quality. Consequently, seed companies have recently released brown midrib and leafy hybrids, which have high stover fiber digestibility. Corn silage hybrid trials, however, have shown that some of the new silage hybrids have reduced emergence in cool wet springs, poor kernel set in warm dry summers, and poor standability at harvest. Corn silage hybrid trials can provide excellent information on the agronomic performance and silage quality of corn silage hybrids grown in specific regions, such as Northern NY, in normal growing conditions, years of cool and wet springs, or years of warm and dry summers.

Methods: We planted all hybrids with a 2-row plot planter at three sites in Northern NY at about 36,000 plants/acre to achieve harvest populations of 32,000-34,000 plants/acre. The Sackets Harbor site was planted on 2 May, the Madrid site on 8 May, and the Chazy site on 12

May. All hybrids were grouped within a 5-day Relative Maturity (RM, i.e. 91-95 day, 96-100, etc.) group, and planted in a randomized complete block design with four replications. Each individual plot consisted of two 22-ft. rows spaced 30 inches apart. Each individual plot received about 250 lbs/acre of 10-20-20 at planting. The Chazy site received about 140 lbs N/acre of sidedressed N at the 4 to 5-leaf (V4 to V5) stage. The Sackets Harbor and Madrid sites were well-manured dairy sites so they received no sidedressed N. We used preemergence herbicides and hand-weeding to control weeds.

Both rows, trimmed back to an 18-foot length, of each hybrid were harvested for silage yield with a retrofitted 3-row New Holland Chopper with a platform and a weigh- basket, mounted on load cells. The goal was to harvest all hybrids in the 60-70% moisture range and only a very few of the hybrids were outside that range at Madrid and Chazy. All hybrids were harvested at Madrid on 11 September and at Chazy on 14 September. Unfortunately, we were unable to harvest the Sackets Harbor site in a timely manner because extremely dry August conditions resulted in silage moisture in the range of 65- 70% by 1 September. By the time that we were ready to harvest the site on 10 September, the moistures were in the 55-60% range, and most hybrids had incurred significant bird damage. Consequently, we decided not to harvest the site because of the extreme bird damage and the less than optimum moistures.

An approximate 10,000 g well-mixed sample was originally collected from each plot. The 10,000 g sample was then ground further in the field with a chipper-shredder. An approximate 1,000 g sub- sample was then weighed with a gram-scale in the field and stored on ice packs in a cooler or refrigerated in a generator-powered freezer (samples were not frozen). At the end of each day, the samples were brought back to a Cornell Research Farm for drying. The samples were dried at 140^0F in a forced air drier to constant moisture and then weighed to determine moisture content of each sample.

Samples were processed and analyzed by Cumberland Valley Analytical Services, Inc. Samples were analyzed by wet chemistry for neutral detergent fiber (NDF), according to procedures by Van Soest et al. (1991). Samples were incubated for 30 hours at 39^{o}F in a buffered rumen fluid, according to procedures by Van Soest and Robertson (1980) using a flask system and Van Soest buffer. Following fermentation, residues were analyzed for NDF by wet chemistry to determine 30-hour NDF digestibility (dNDF). The NDF digestibility was calculated as ([1-NDF residue/initial NDF] x 100). Crude protein (CP), starch, ether extract, and ash were determined using NIRS. Milk per ton and milk per acre were then calculated using the Milk2006 spreadsheet program.

Data were analyzed using the PROC GLM procedure of SAS. The LSD values for separating hybrid means were generated at the P = 0.10 level. Hybrids are considered above-average for calculated milk yield, milk/ton, or silage yield when the hybrid's value is 101% or more of the mean value within their RM group.

Results and Discussion: The 2007 growing season in Northern NY was generally favorable for corn growth (Table 1). Temperatures were ideal throughout most of the growing season at both sites. Although three of the four months were dry at Canton (5 miles from the Madrid site), 7.20 inches of precipitation were recorded in July, insuring a high-yielding corn crop at Madrid. At Chazy, growing conditions were almost perfect for corn growth until well into August when dry conditions set in. Nevertheless, corn yields were also excellent at Chazy.

Two hybrids at Madrid and at Chazy had above-average milk yields in the 75-85 day RM group (Tables 2 and 3). The hybrids, HL S011 from Hyland and 377BWR from Doebler's, had much above-average milk yields at both sites. The hybrid, TA240-11 from T.A. Seeds, had much above-average milk yield at Madrid. The hybrid, 286XRR from Doebler's, had much above-average milk yields at Chazy. When averaged across sites, HL S011, TA240-11, and 377BWR had much-above-average silage yields. The six hybrids in the 75-85 day RM group averaged 27.4 tons/acre at Madrid and 23.1 tons/acre at Chazy.

Five hybrids at Madrid and at Chazy had above-average milk yields in the 86-90 day RM group (Tables 2 and 3). The hybrids, HL S034 from Hyland, 38N87 from Pioneer, HL SR35 from Hyland, and 8866RR from Garst, had above-average milk yields at both sites. The hybrid, TA270-11 from T.A. Seeds, had much above-average milk yields at Madrid. The hybrid, 52P81 from Dyna-Gro, had above-average milk yields at Chazy. When averaged across sites, HL S034, HL SR35 and 38N87 had much above-average silage yields, and 38N87 had above-average milk/ton values. The seven hybrids in the 86-90 Day RM group averaged 28.0 tons/acre at Madrid and 25.2 tons/acre at Chazy.

Nine hybrids at Madrid and at Chazy had above-average milk yields in the 91-95 day RM group (Tables 2 and 3). The hybrids, TMF2N422 from Mycogen, TA310-02F from T.A. Seeds, 38K47 from Pioneer, 946LRR from LICA, 53K69 from Dyna-Gro, and TMF2L416 from Mycogen, had above-average milk yields at both sites. The hybrids, EX2604 from Growmark FS, DKC45-82 (RR2), a DEKALB brand, and N29-A2, an NK brand, had above-average milk yields at Madrid. The hybrids, 53B04 from Dyna-Gro, N27-B5, an NK brand, and DKC41-57 (YGPL/RR2), a DEKALB brand, had above-average milk yields at Chazy. When averaged across sites, TMF2N422, TA310-02F, 38K47, 946LRR, TMF2L416, 53K69, and EX2604 had above-average silage yields in the 91-95 day RM group. When averaged across sites, TMF2N422 and N29-A2 had above-average milk/ton values. The 18 hybrids in the 91-95 day RM group yielded 27.4 tons/acre at Madrid and 24.1 tons/acre at Chazy.

Four hybrids at Madrid and two hybrids at Chazy had above-average milk yields in the 96-100 day RM group (Tables 2 and 3). The hybrids, DKC50-48 (YGCB/RR2), a DEKALB brand, and 964L from LICA, had above-average milk yields at both sites. The hybrids, 99 S7 and 98 BS7 from LICA had above-average milk yields at Chazy. When averaged across sites, 964L, DKC50-48 (YGCB/RR2), and 99 S7 had above-average silage yields in the 96-100 day RM group. When averaged across sites, DKC50-48 (YGCB/RR2) and 98 BS7 had above-average milk/ton values. The six hybrids in the 96-100 day RM group averaged 28.5 tons/acre at Madrid and 24.4 tons/acre at Chazy. Overall, the 96-99 day RM group yielded the highest at Madrid and the 86-90 day RM group yielded the highest at Chazy.

Conclusions: The 2007 growing season in Northern NY was very favorable for corn growth through July, but then became very dry during August. Nevertheless, yields were exceptionally high at both sites. The results from this study reflect well the yield and quality of corn silage that was planted during the first half of May of 2007 on well-drained soils in Northern New York.

The results of this study indicate that excellent corn silage yields can be obtained by growing 75-100 day hybrids in Northern NY. At one site, the 86-90 day hybrids had higher average yields than the 96-100 day hybrids probably because the dry conditions in August hurt the later-maturing hybrids more than the earlier hybrids. At the other site, the 96-100 day hybrids yielded the best, but only 1 ton/acre more than the 75-85 day hybrids. Dry conditions often occur in Northern NY in August so growers in Northern NY could consider selecting hybrids that are shorter than 95 days in length to avoid some of the droughty conditions that can occur in late August/early September. Hybrids shorter than 95 days in length also increase the probability of a timely harvest before the first fall frost.

Outreach: The results of the two sites (Madrid and Chazy) were used to recommend corn silage hybrids in Northern NY for the 2008 growing season in our **What's Cropping Up?** newsletter that was published in December of 2007 (Vol.17, No.4, p.5-7, on our web site at : www.fieldcrops.org.). Furthermore, the results will be incorporated into the recommended corn silage tables in our **2009 Cornell Guide for Integrated Field Crop Management**. We only list hybrids that have above-average relative calculated milk yields in their hybrid RM group (i.e. 86-90, 91-95 day RM, etc.). We also list the relative silage yields and milk/ton values for the recommended hybrids.

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Table 1. Monthly rainfall and growing degree days (GDD) at the two test sites in 2007.

	PRECIPTATION		GDD	
Month	Madrid	Chazy	Madrid	Chazy
May	2.26	2.42	296	318
June	1.76	3.80	519	541
August	0.90	1.22	570	568
Total	**12.12**	**13.38**	**1920**	**1978**

Table 4. Silage yield, milk/ton, and calculated milk yield for corn silage hybrids at Madrid, NY in 2007.

Madrid NY, 2007 **Brand/ Company**	**Hybrid**	Silage Yield	Moisture	NDF	30 hour dNDF	CP	Starch	Milk2006 Milk/ton	Milk2006 Milk Yield
		tons_65	%DM	%DM	%	%DM	%DM	lbs/ton	lbs/acre
				74 to 85-d RM					
TA Seeds	TA 240-11	34.2	54.8	42.4	55.5	7.9	36.1	3182	38147
Hyland	HL S011	33.8	60.6	46.6	57.7	8.5	30.0	3120	36861
Doebler's	377 BWR	31.4	62.5	42.2	58.7	7.9	34.9	3251	35721
Hyland	HL SR22	25.7	60.2	45.7	57.7	8.7	30.2	3108	27929
Doebler's	286 XRR	22.4	64.0	44.5	56.7	8.5	30.7	3150	24674
Garst	8986 YG1/RR	16.8	62.8	44.0	55.4	8.5	31.4	3107	18250
				86 to 90-d RM					
Hyland	HL S034	32.3	62.7	44.6	58.7	8.0	32.3	3172	35818
Pioneer	38N87	32.0	60.2	42.6	55.9	8.1	33.9	3168	35361
TA Seeds	TA 270-11	30.2	54.4	44.8	57.2	7.6	34.2	3144	33191
Hyland	HL SR35	30.4	63.0	46.3	59.4	7.9	30.7	3100	32950
Garst	8866 RR	29.4	59.4	45.8	55.5	7.5	32.5	3051	31346
Mycogen	TMF2Q296	23.7	64.1	43.1	57.0	8.7	31.2	3140	26080
DynaGro	52P81	18.0	64.8	41.9	58.7	8.4	33.7	3258	20555
				91 to 95-d RM					
Mycogen	TMF2N422	33.1	63.1	44.7	61.7	7.5	33.2	3263	37796
Growmark FS	EX 2604	31.2	63.2	40.8	59.4	7.5	37.5	3313	36114
Pioneer	38K87	31.9	60.2	41.9	56.4	7.8	35.6	3229	36056
TA Seeds	TA 310-02F	32.6	61.8	45.6	58.1	8.2	30.9	3156	35966
DynaGro	53K69	29.8	62.4	42.8	58.5	7.7	35.3	3210	33525
DEKALB	DKC45-82	29.8	65.2	43.3	55.4	7.8	33.3	3116	32503
LICA	946 L RR	28.4	61.6	46.2	60.2	7.4	31.5	3182	31635
Mycogen	TMF2L416	28.2	60.9	44.8	58.9	8.1	32.1	3164	31172
NK Brand	N29-A2	27.3	55.5	42.1	57.1	7.9	37.0	3242	30967
Hyland	HL S041	25.9	64.2	42.5	61.2	8.2	33.5	3275	29668
NK Brand	N27-B5	26.6	55.9	43.1	56.8	7.8	35.1	3193	29659
Hyland	HL SR42	25.7	65.2	41.8	60.3	8.3	34.2	3276	29431
Fielders Choice	4095 ND	26.0	60.0	45.7	57.6	8.4	31.6	3145	28538
TA Seeds	TA 451-11	25.1	57.6	43.0	55.1	7.6	35.7	3138	27532
DynaGro	53B04	24.1	64.1	41.8	59.0	8.0	35.4	3264	27421
Chemgro	5434 RR	25.5	61.4	47.0	56.6	8.6	28.5	3041	27134
Growmark FS	4453 XRR	22.4	62.8	42.2	56.6	8.0	35.2	3217	25161
DEKALB	DKC41-57	20.8	64.8	41.6	57.7	8.4	34.4	3235	23486
				96 to 99-d RM					
DEKALB	DKC50-48	31.4	66.2	41.1	59.1	7.6	36.0	3292	36179
LICA	99 S7	32.2	63.2	44.4	59.0	7.8	31.9	3192	36080
LICA	98 BS7	31.0	63.7	43.3	62.9	7.9	33.1	3324	36065
LICA	964 L	31.8	61.5	46.5	56.5	8.0	30.7	3038	33922
LICA	UFO 996 B	22.2	62.8	43.0	73.1	8.3	33.5	3556	27732
TA Seeds	TA 465-13	22.4	59.3	46.0	55.5	8.0	31.4	3054	23861
	LSD 0.10	**3.20**	**2.55**	**2.03**	**1.31**	**0.43**	**1.84**	**94**	**3947**
	Overall Mean	27.7	61.6	43.8	58.3	8.0	33.2	3191	30932

Table 5. Silage yield, milk/ton, and calculated milk yield for corn silage hybrids at Chazy, NY in 2007.

Chazy NY, 2007 Brand/ Company	Hybrid	Silage Yield	Moisture	NDF	30 hour dNDF	CP	Starch	Milk2006 Milk/ton	Milk2006 Milk Yield
		tons_65	%DM	%DM	%	%DM	%DM	lbs/ton	lbs/acre
				74 to 85-d RM					
Doebler's	286 XRR	25.0	68.5	43.5	57.1	8.5	32.1	3256	28527
Doebler's	377 BWR	24.1	69.6	41.6	60.7	8.0	35.5	3367	28417
Hyland	HL S011	24.9	65.6	44.8	57.2	8.3	31.2	3208	27923
TA Seeds	TA 240-11	22.4	64.9	41.5	57.1	7.3	37.3	3312	25943
Garst	8986 YG1/RR	21.3	68.1	41.6	57.5	8.1	35.4	3319	24733
Hyland	HL SR22	20.9	67.6	43.2	58.7	8.4	32.7	3279	24038
				86 to 90-d RM					
Hyland	HL SR35	27.4	69.4	44.4	58.5	8.0	31.6	3232	30946
Hyland	HL S034	27.3	68.6	45.8	58.5	7.4	31.3	3221	30775
Pioneer	38N87	25.7	66.7	41.0	55.7	7.8	36.0	3283	29508
Garst	8866 RR	25.8	68.3	43.7	57.1	7.4	34.0	3254	29355
DynaGro	52P81	24.7	66.8	40.8	59.4	7.8	36.9	3385	29274
TA Seeds	TA 270-11	23.0	67.3	42.6	57.3	7.4	35.1	3306	26641
Mycogen	TMF2Q296	22.3	67.5	41.4	57.9	8.2	35.0	3301	25838
				91 to 95-d RM					
Mycogen	TMF2N422	28.7	69.4	44.2	62.4	7.4	33.2	3380	34017
TA Seeds	TA 310-02F	27.9	68.9	45.7	60.2	7.7	30.8	3246	31761
LICA	946 L RR	26.9	70.0	45.8	62.8	7.5	31.6	3347	31495
Pioneer	38K87	27.3	68.3	42.4	57.1	7.6	34.1	3255	31117
Mycogen	TMF2L416	26.0	69.9	44.0	60.3	7.8	32.6	3310	30151
DynaGro	53K69	24.8	69.2	42.0	58.4	7.2	35.9	3312	28752
DynaGro	53B04	24.6	69.2	41.8	59.2	7.6	35.6	3330	28676
NK Brand	N27-B5	24.4	69.0	41.7	57.6	7.7	35.6	3323	28367
DEKALB	DKC41-57	24.4	67.9	41.3	56.6	7.8	36.5	3292	28148
Growmark FS	EX 2604	23.7	69.5	42.5	57.5	7.2	35.4	3274	27165
NK Brand	N29-A2	23.1	68.7	41.3	58.6	7.8	36.1	3352	27113
Growmark FS	4453 XRR	23.7	69.1	44.1	58.4	7.7	32.4	3260	27045
DEKALB	DKC45-82	23.7	70.2	42.0	56.3	7.9	33.9	3231	26869
TA Seeds	TA 451-11	23.1	69.3	41.1	56.5	7.8	35.4	3278	26502
Hyland	HL SR42	21.3	71.3	41.3	61.4	8.4	33.5	3359	25049
Hyland	HL S041	20.7	70.9	42.3	61.0	8.3	33.5	3367	24391
Chemgro	5434 RR	21.2	68.7	45.1	58.8	8.0	31.3	3234	23958
Fielders Choice	4095 ND	17.5	70.8	43.5	59.1	8.6	32.0	3320	20247
				96 to 99-d RM					
LICA	964 L	27.1	69.4	44.7	60.8	7.9	31.6	3301	31319
DEKALB	DKC50-48	25.7	70.3	42.7	58.9	7.5	34.3	3297	29595
LICA	99 S7	25.2	70.8	45.2	59.0	7.9	29.5	3227	28483
LICA	98 BS7	24.2	71.9	44.6	61.7	7.9	30.5	3322	28074
TA Seeds	TA 465-13	24.0	68.5	44.5	56.2	7.8	32.2	3182	26745
LICA	UFO 996 B	20.2	72.3	40.9	74.1	8.1	34.8	3691	26118
	LSD 0.10	**2.15**	**1.28**	**1.11**	**1.72**	**0.30**	**1.49**	**68**	**2638**
	Overall Mean	24.2	69.0	43.0	59.1	7.8	33.7	3303	27921

Northern NY Agricultural Development Program
2006-2007 Project Report

Project Title: **Corn Grain Hybrid Testing Program for Northern New York**

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Cooperating Producers:
Jon Greenwood, St. Lawrence County
Ron Robbins, Jefferson County

Background

Corn is the primary row crop grown in northern New York (NNY), harvested from about 121,000 acres and providing essential feed for the dairy industry. Roughly 34,000 acres of this total were harvested as grain in 2006 – over one quarter of NNY's total corn acreage. When ethanol production facilities in NY are completed, the increased demand for corn grain as ethanol feedstock will provide new grain marketing opportunities for NNY farmers and increase interest in corn production for grain in this region. The grain produced by corn hybrids is a major contributor to silage yield, so grain yield evaluation provides an indication of which hybrids would be good candidates for silage use. It is important to evaluate silage quality on these hybrids as well, but seed companies will often enter their hybrids into grain evaluation trials as a first step in determining what is worth marketing at all in the region. Thus grain yield evaluations of commercial hybrids provide essential comparative information to farmers interested in grain production in NNY and to seed companies who make marketing decisions based initially on performance in grain yield trials, and may or may not do subsequent silage evaluations.

Methods:

During 2007, we summarized the results of early and medium-early maturity corn grain testing done in 2006 and tested a new set of hybrids in each of these maturity groups at NNY locations. Seed companies marketing corn in New York were contacted to request entry of commercial and near-commercial hybrids into these evaluation tests. We evaluated 14 early maturing hybrids (1400-1900 growing degree days, 70-90 days relative maturity) at two locations in NNY: one at the Miner Institute's research farm in Chazy, Clinton County, and one at Jon Greenwood's farm in Madrid, St. Lawrence County. In addition, we evaluated 29 medium-early maturing hybrids (1900-2400 growing degree days, 85-100 days relative maturity) at Ron Robbins's farm in Sackets Harbor, Jefferson County. These evaluations were designed to identify hybrids that can meet the grain and silage needs of farmers in the region.

Each hybrid was planted in three replications per location, with each replication consisting of a two-row plot, 17.5' long and thinned to a density of 28,000 to 30,000 plants/acre. Data was collected at thinning time (late June to early July) on plant counts and unusually good or poor plant vigor. In September, plots were evaluated for reaction to any disease or insect pests that occur at each site, for unusually tall or short plants (indicative of potential value as a silage hybrid), and for early-season stalk lodging, root lodging, and animal damage. At harvest time (November), data was collected on final stalk and root lodging, animal damage, grain weight, grain moisture, and test weight. These data were used to calculate grain yield per acre and yield:moisture ratio (a measure of hybrid efficiency in producing high yield under short-season conditions). Results of 2006 testing were published in the 2006 Hybrid Corn Grain Performance Trial Report (Plant Breeding Mimeo 2007-1) and were incorporated into the tables of recommended hybrids in the 2008 Cornell Guide for Integrated Field Crop Management (Cornell University, 2007). These results are available for farmer and seed company use in selecting hybrids best adapted to the challenging soils and climates of NNY. Results from 2007 trials, which were harvested during October and November, will soon be available in the 2007 Hybrid Corn Grain Performance Trials Report (Plant Breeding Mimeo 2008-1) and will be incorporated into the tables of recommended hybrids in the 2009 Cornell Guide for Integrated Field Crop Management (to be published by Cornell University in fall 2008).

Results:

In 2007, we started off with generally dry weather in May that helped with getting the corn crop in the ground in a timely manner. June was fairly warm (due to a hot spell at the end of the month) but had adequate rainfall in some locations (Chazy and Madrid) but not at Sackets Harbor, where a droughty spell began in June and lasted for much of the growing season. Cooler wetter weather prevailed in July, just before and during flowering. Dry conditions returned throughout most of the state in August, with exceptionally dry conditions at Sackets Harbor during August and into September. October tended to be warmer than normal, helping the crop to mature. Although the 2007 growing season in the state as a whole was warmer and drier than long-term averages, the cooler wetter July weather resulted in a high state average yield of 127 bu/acre – just 2 bu/A below last year's record. At our NNY locations, average yields for our hybrid tests were very good and ranged from 169 bu/acre to 190 bu/acre.

Results from all three hybrid evaluation trials are shown in Tables 1, 2, and 3 below. The quality of our testing data this year was excellent, as reflected in the low coefficients of variation (CVs) for yield in the trials (9% at Chazy, 13% at Madrid, and 11% at Sackets Harbor). These low CVs indicate that the values in these tables are quite reliable and not overly influenced by random variation in the testing fields. These results include information on a broad array of commercially available hybrids, allowing farmers and seedsmen to compare productivity and adaptation of hybrids from various seed companies.

Table 1. 2007 Early Maturity Hybrids, Chazy, Clinton County.

Brand	**Hybrid**	**Yield, bu/A**	**% Mois-ture**	**Yield: Moisture Ratio**	**% Stalk Lodging**
Hytest	HT17-07	165	21.8	7.6	0
Hyland	HLR228	171	23.1	7.4	2
Growmark FS	3967XRR	172	23.3	7.4	10
Hyland	HLB264	144	23.8	6.1	10
NK	N20-R7	184	24.0	7.7	5
Hyland	HLB256	153	24.5	6.2	0
Growmark FS	3676XRR	161	24.6	6.5	1
TA Seeds	TA290-11	193	25.7	7.5	17
Dekalb	DKC41-57(VT3)	175	25.8	6.8	6
TA Seeds	TA303-13	139	25.8	5.4	13
Hyland	HLB33R	166	26.1	6.4	9
Doebler's	286XRR	172	26.9	6.4	1
Hyland	HLB266	181	27.0	6.7	6
Hytest	HT7220	185	28.9	6.4	6
	Mean	169	25.1	6.7	6
	CV	9	2.8		
	LSD	24	1.2		
	SD	15	0.7		

Table 2. 2007 Early Maturity Hybrids, Madrid, St. Lawrence County.

Brand	Hybrid	Yield, bu/A	% Moisture	Yield: Moisture Ratio	Standability, 1-9 scale*	% Stalk Lodging	Test Weight, lb/bu	Stay Green (1-5 scale*)	Early Vigor (1-5 scale*)	Rust (1-5 scale*)
Hyland	HLR228	183	20.8	8.8	8.3	0	55	3.7	2.7	3.8
Hytest	HT17-07	165	20.9	7.9	8.3	0	57	3.7	2.3	3.5
Hyland	HLB264	196	21.0	9.3	8.7	1	54	3.5	3.0	2.5
TA Seeds	TA290-11	211	21.0	10.0	8.3	0	54	3.7	4.0	1.5
Hyland	HLB256	146	21.2	6.9	7.7	2	57	4.7	3.5	1.7
NK	N20-R7	205	21.3	9.6	8.3	0	56	3.3	2.2	2.5
Hyland	HLB266	209	21.4	9.8	8.0	0	53	3.5	3.7	0.7
Dekalb	DKC41-57(VT3)	214	21.4	10.0	8.3	1	54	3.8	3.3	2.3
Growmark FS	3676XRR	196	21.4	9.2	8.3	1	57	3.5	3.7	1.7
Growmark FS	3967XRR	173	21.8	7.9	8.7	0	56	3.5	3.7	2.7
Hyland	HLB33R	189	21.9	8.6	8.3	0	54	3.2	3.3	0.8
TA Seeds	TA303-13	155	22.6	6.9	8.3	0	55	3.0	3.3	1.7
Hytest	HT7220	238	22.8	10.4	8.7	0	55	3.3	2.3	3.5
Doebler's	286XRR	177	23.0	7.7	8.7	0	54	2.8	2.5	2.7
	Mean	190	21.6	8.8	8.4	0.4	55	3.5	3.1	2.3
	CV	13	2.2		7.0		3			
	LSD	42	0.8		1.0		3			
	SD	25	0.5		0.6		2			

* Standability is rated on a 1-9 scale with 9=strong resistance to breakage when pushed and 1=very weak and easily broken stalks; 1-5 rating scales for stay-green and rust have 1=completely green plants or no rust on leaves and 5=completely dead plants or many rust lesions on many leaves; for early vigor, a rating of 5=big vigorous plants and 1=small weak plants.

Table 3. 2007 Medium-early Maturity Hybrids, Sackets Harbor, Jefferson County.

Brand	Hybrid	Yield, bu/A	% Mois-ture	Yield: Mois-ture Ratio	Stand-Ability, 1-9 scale*	% Stalk Lodg-ing	Test Weight, lb/bu	Stay Green (1-5 scale*)	Early Vigor (1-5 scale*)	Plant Height (1-5 scale*)
TA Seeds	TA461-13	173	17.4	9.9	8.7	4	56	3.5	2.8	2.8
Dyna-Gro	54P55	169	17.5	9.7	8.3	4	57	3.8	2.3	2.7
Hyland	HLCBR54	159	17.6	9.0	8.0	13	56	3.7	3.2	3.0
Hyland	HLB286	164	17.6	9.3	7.3	10	57	3.7	3.0	3.5
NK	N29-A2	174	17.7	9.8	8.0	9	57	4.3	2.7	1.7
Hytest	HT7398	168	17.8	9.4	8.3	10	56	3.8	2.7	3.3
TA Seeds	TA451-11	193	17.8	10.8	8.3	8	57	4.2	2.7	2.8
Growmark FS	4861XRR	185	17.9	10.3	8.3	1	57	4.0	2.7	1.8
Hyland	HLB282	148	18.0	8.2	7.3	16	58	3.8	3.0	2.3
Doebler's	377BWR	136	18.1	7.5	8.0	8	58	3.3	3.0	2.0
Growmark FS	4464XRR	140	18.2	7.7	8.7	6	60	3.3	3.0	2.3
Hytest	HTEXP3824	165	18.1	9.1	8.3	6	58	4.0	3.7	3.0
Dyna-Gro	54T42	158	18.2	8.7	7.7	27	57	3.8	2.7	3.7
Hyland	HLB38R	205	18.2	11.3	9.0	4	57	3.5	2.5	2.7
Doebler's	468RB	174	18.2	9.6	8.3	3	58	3.2	2.5	3.8
TA Seeds	TA500-00	171	18.2	9.4	8.3	5	56	3.2	3.7	3.8
Dekalb	DKC45-82(RR2)	177	18.3	9.7	8.0	5	57	3.7	3.2	2.0
Growmark FS	4819XRR	199	18.3	10.9	9.0	4	57	3.5	2.3	3.3
Hytest	HT7428	179	18.3	9.8	8.0	2	57	3.7	2.3	2.7
Dekalb	DKC49-35(RR2)	207	18.4	11.3	8.7	1	57	4.0	2.2	3.3
Golden Harvest	H6455CB	179	18.4	9.7	8.0	9	57	4.0	3.5	1.8
Golden Harvest	H7436CB	150	18.5	8.1	7.7	7	57	3.8	3.3	2.5
Dyna-Gro	55V18	160	18.6	8.6	8.3	6	58	3.3	3.0	2.7
NK	N39-Q1	178	18.7	9.5	8.3	13	59	3.7	3.0	3.8
Golden Harvest	H7540	200	18.7	10.7	7.3	11	56	3.5	2.8	2.8
Dekalb	DKC46-60(VT3)	170	19.2	8.9	8.3	3	57	3.0	2.3	2.5
	Mean	172	18.2	9.5	8.2	8	57	3.7	2.9	2.8
	CV	11	2.7		7.3		2.7			
	LSD	31	0.8		1.0		2.5			
	SD	19	0.5		0.6		1.5			

* Standability is rated on a 1-9 scale with 9=strong resistance to breakage when pushed and 1=very weak and easily broken stalks; 1-5 rating scale for stay-green has 1=completely green plants and 5=completely dead plants; for early vigor and plant height, a rating of 5=big vigorous or tall plants and 1=small weak or short plants.

Conclusions/Outcomes/Impacts: (Recommendations, guidelines, application[s] to NNY agriculture etc, including **negative results**. Production guidelines/suggested management practices etc. that flow from the research. If farmers are involved in the research or demonstration, provide information on their impressions on the importance of the work its usefulness at the farm level and benefits they are seeing.)

Data in the hybrid production tables in this report shows a number of hybrids that had excellent performance in NNY in 2007. However, hybrid choices should always be made based on the most comprehensive data available, usually multi-year and/or multi-location data. Multi-year data is available in the Cornell Guide for Integrated Field Crop Management and this publication should be consulted, in combination with the individual test data presented here, when making hybrid choices.

Outreach:

Results of 2006 testing were published in the 2006 Hybrid Corn Grain Performance Trial Report (Plant Breeding Mimeo 2007-1) and were incorporated into the tables of recommended hybrids in the 2008 Cornell Guide for Integrated Field Crop Management (Cornell University, 2007). These results are available for farmer and seed company use in selecting hybrids best adapted to the challenging soils and climates of NNY. The publications are distributed through extension offices and at various extension and outreach meetings. Results from 2007 trials, which were harvested during October and November, will soon be available in the 2007 Hybrid Corn Grain Performance Trials Report (Plant Breeding Mimeo 2008-1) and will be incorporated into the tables of recommended hybrids in the 2009 Cornell Guide for Integrated Field Crop Management (to be published by Cornell University in fall 2008).

Next steps if results suggest continued work is needed in the areas of research, demonstration and/or education.

In future years, we will plan to continue testing hybrids in the NNY region to ensure that farmers and seed companies have a solid basis for their choices of corn grain hybrids for this important region of the state. In addition, we aim to evaluate starch content of different hybrids grown in these trials to assess the potential ethanol yield from each hybrid.

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Reports and/or articles in which the results of this project have already been published.

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NNY Agricultural Development Program
2006-2007 Project Report

Project Title: Cereal Grain Variety Trials for Grain and Straw

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Background

Grain Production Trials:
Small grain variety trials have been conducted at the Cornell University E.V. Baker Research Farm since the 1980's. Trials of spring and winter wheat, spring and winter triticale, winter rye, barley, and oat varieties provide northern New York farmers with evaluations of the performance of available varieties grown under local conditions.

The size of the spring and winter wheat variety trials has grown considerably in recent years with the increased regional interest in organic bread wheat production. Champlain Valley Milling, a specialty organic flour mill located in Westport, NY, provides local farmers with a premium market for organically grown wheat. As specialty flour markets have very specific quality standards, it is essential that we be able to identify varieties that will meet the requisite standards when grown in northern New York. Our wheat trial entries include established varieties from area seed companies, in addition to promising advanced lines from private company breeding programs, Mark Sorrells' breeding program at Cornell, and public breeding programs from the Upper Midwest (primarily North Dakota State University).

Winter Cereal Straw Production Trials:
High demand coupled with the premium prices paid for good quality straw, have generated increased farmer interest in growing small grains just for straw. Typically, straw is harvested after the grain has been combined; the lower stalk provides most of the dry matter, while the threshed heads remain in the field. Small grains grown just for straw can be "pre-cut" – harvested after the crop has headed out and the stem is fully elongated, but *before* the grain has filled. Yields for pre-cut straw are higher because the entire stem and immature head are included in the harvest. Harvesting heads before the grain heads fill adds a further advantage in that it reduces the potential for lodging, and pre-cut straw is generally cleaner and of higher quality than straw harvested after grain combining. Winter triticale and rye tend to be tall plants

that produce quality straw, and may be ideal candidates for pre-cut straw production in northern New York.

Objectives

(1) To test the agronomic performance of available varieties of spring and winter wheat, spring and winter triticale, spring barley, and oats when produced under northern New York growing conditions.
(2) To evaluate winter hardiness and straw production potential for winter triticale and rye varieties grown on NNY farms.

Methods

Replicated variety trials for spring wheat, spring barley, oats, winter wheat, winter triticale, winter rye, and winter barley for grain, and winter triticale and rye for straw, were conducted at the Baker Research Farm in Willsboro, NY. A randomized complete block design was employed with three replications for each trial except the winter triticale-rye pre-cut straw trial, which had four replications. Plots were located on a Rhinebeck clay loam soil with subsurface tile drainage. 200 lb/acre 6-24-24 was broadcast applied and incorporated with a spring-tooth harrow prior to planting each trial. Additionally, the winter wheat, winter triticale, and winter rye plots all received a topdress application of ammonium nitrate (33-0-0) at a rate of 70 lbs nitrogen per acre on April 23, 2007. No herbicides were used on any of the trials.

Results

Table 1. Northern New York 2007 Winter Wheat Variety Trial Results

Brand/Company Source	Hybrid/Variety Name	Market Class	Yield	Test weight	Moisture	Plant height	Lodging
			bu/a	lb/bu	%	inches	1-10
		Trial Mean	97.5	57.4	14.0	34.4	0.6
		LSD	11.3	1.0	0.5	1.6	1.0
		LSD P >	0.05	0.05	0.05	0.05	0.05
		CV	7.0	1.1	2.1	2.8	105.4
		F Test	0.0001	0.0001	0.0001	0.0001	0.0001
Agriculver	7730R	SRW	106	59.7	14.1	32	0.3
Cornell	Freedom	SRW	104	56.3	13.8	35	1.0
Agriculver	Ashlund	SRW	103	56.0	14.0	34	0.7
JGL Inc.	HR45-104J	HRW	103	52.3	12.8	28	0
JGL Inc.	Gryphon	HRW	103	59.7	14.2	36	0.3
Cornell	NY 88024	SW	103	57.0	14.0	39	0.3
JGL Inc.	HR45-063J	HRW	103	57.3	13.9	28	0
JGL Inc.	Harvard	HRW	103	60.3	14.6	36	0.3
JGL Inc.	Kristy	SRW	102	56.7	14.1	32	0
Pioneer	Piovar25W33	SW	101	56.7	13.9	38	0.3
Cornell	99-53	SRW	100	56.3	13.4	31	1.7
JGL Inc.	CM98091	HRW	100	58.7	14.2	33	0.7
Agriculver	Harus	SW	98	57	13.8	36	1.3
Agriculver	Genesis	SRW	98	56	13.7	35	2.0
Agriculver	Richland	SW	96	56.7	13.9	38	0.3
Cornell	NY Batavia	SW	96	56.3	13.9	37	0.7
Cornell	Geneva	SW	96	56.3	13.9	38	0.7
JGL Inc.	Maxine	HRW	94	58.7	14.2	31	0
JGL Inc.	HR45014J	HRW	93	57.3	14.2	31	0
Cornell	Lindon	HRW	91	59.3	14.3	37	1.3
Agriculver	Caledonia	SW	87	55.0	14	28	0
Agriculver	AC Morley	HRW	87	59.7	14.2	40	0.7
Cornell	Cayuga	SW	81	59.3	14.6	40	1.3

Winter Wheat Trial: The 2007 winter wheat trial consisted of eight soft white (SW), six soft red winter (SRW), and nine hard red winter (HRW) varieties (Table 1). Plots were planted at a 2 bu/acre rate on September 27, 2006, and harvested August 1, 2007.
Yields were excellent and ranged from 81 bu/acre to 106 bu/acre with a trial mean of 97.5 bu/acre. There was little to no lodging in the winter wheat trial. The top 17 yielding varieties did not differ significantly at the 0.05 level, and included soft red winter, soft white winter, and hard red winter entries (Table 1). *7730R* and *Freedom*, two soft red winter varieties, had the highest mean yields in the entire test at 106 bu/acre and 104 bu/acre, respectively. Four entries from JGL Inc. topped the hard red winter wheat rankings with *HR45-104J*, *Gryphon*, *HR45-063J*, and *Harvard* all averaging 103 bu/acre. The top yielding soft white winter entry was *NY88024* with a mean yield average of 103 bu/acre. *NY88024* is from Mark Sorrells' breeding program at Cornell. The soft white winter variety Cayuga had the lowest mean yield at 81 bu/acre, which was significantly less than all but three other winter wheat entries.

Table 2. Northern New York 2007 Spring Wheat Variety Trial Results

Source	Hybrid/Variety Name	Market Class	Yield	Test weight	Moisture	Plant height
			bu/a	lb/bu	%	inches
		Trial Mean	64.7	56.0	14.5	30.6
		LSD	6.3	2.6		1.1
		LSD P >	0.05	0.05		0.05
		CV	5.9	2.8	2.1	2.1
		F Test	0.0001	0.0012	0.0819	0.0001
JGL Inc.	HRS6002J	HRS	79	57.0	14.7	36
Cornell	Stoa	HRS	75	55.0	14.2	26
NDSU	2375	HRS	72	55.0	14.5	27
Champlain Valley Milling	Russ	HRS	71	54.7	14.4	33
JGL Inc.	HRS45-025J	HRS	70	55.7	14.6	30
JGL Inc.	HRS45-035J	HRS	69	58.0	14.4	29
JGL Inc.	Profit	HRS	66	55.7	14.3	25
Champlain Valley Milling	Freyr	HRS	65	56.3	14.8	30
Champlain Valley Milling	Hannah	HRS	65	57.0	14.5	34
NDSU	Alsen	HRS	65	56.0	14.2	29
JGL Inc.	HRS6001J	HRS	64	55.3	14.4	30
NDSU	Butte 86	HRS	64	54.7	14.2	32
Champlain Valley Milling	Knudson	HRS	63	56.7	14.5	25
NDSU	Parshall	HRS	62	58.3	14.8	32
JGL Inc.	CM606	HRS	62	59.7	14.6	30
Champlain Valley Milling	Gunner	HRS	61	56.0	14.6	35
Champlain Valley Milling	Coteau	HRS	57	55.0	14.0	36
NDSU	Dapps	HRS	57	56.3	14.3	36
JGL Inc.	SD45-015J	HRS	46	52.0	14.5	26

Spring Wheat Trial: Spring grain trial plots were planted April 25, 2007 and harvested August 15, 2007. The seeding rate was 2.5 bu/acre for all nineteen entries. No lodging was observed in any of the plots. Mean yields ranged from 46 bu/acre to 79 bu/acre with an overall trial mean of 64.7 bu/acre. *HRS6002J* topped the spring wheat yield ranking for the second consecutive year. The hard red spring wheat entry from JGL Inc. produced significantly higher yields (79 bu/acre) than all other entries except *Stoa* in 2007, and out-yielded all other entries in 2006 with a 77 bu/acre average. The consistent high performance of *HRS6002J* is especially encouraging given that growing conditions in 2007 were excellent, while the 2006 season was very wet and the growing conditions were only fair. On the low end of the ranking, *SD45-015J* (entry from JGL Inc.) was an outlier and yielded significantly less than all other entries at 46 bu/acre.

Table 3. Northern New York 2007 Winter Triticale Variety Trial Results

Source	**Hybrid/Variety Name**	**Yield**	**Test weight**	**Moisture**	**Plant height**	**Lodging**
		lbs/a	lb/bu	%	inches	Scale 0-10
	Trial Mean	4706	48.1	12.9	45.4	4.7
	LSD	707	2.2	0.6	2.8	5.2
	LSD P>	0.05	0.05	0.05	0.05	0.05
	CV	8.0	2.4	2.3	3.3	59.5
	F Test	0.0001	0.0001	0.0001	0.0001	0.0144
Agriculver seeds	Trical 102 lot# T521	2635	44.3	12.2	55	8.7
Agriculver seeds	Trical 103BB T412B	3081	42.0	11.8	54	9.0
Agriculver seeds	Trical 336	6162	53.0	13.7	40	0
Agriculver seeds	Alzo	5915	50.0	13.3	39	3
Agriculver seeds	Trical 815	5736	51.3	13.6	39	2.6
Winter barley entry	McGregor	5981	44.7	11.5	28	1.7

Winter Triticale (and Barley) Trial: Five winter triticale varieties and one winter barley variety were included in the 2007 test. Plots were seeded 9/27/06 and harvested 8/01/07. The planting rate was 2 bu/acre for both triticale and barley. The 2006-2007 winter was relatively mild through mid-January, and provided good snow cover from mid-January to mid-March. As a result no winterkill was observed in the plots (even the winter barley entry survived). 2007 results were consistent with those observed in 2006. *Trical 336*, *Alzo*, and *Trical 815* (first year in the trial) were markedly shorter, had less lodging problems, much higher yields, and higher test weights than *Trical 102 lot #T521* or *Trical 103BB T412B*. *McGregor*, the lone winter barley entry, performed well with a mean yield of 133 bu/acre, and had no lodging or disease problems.

Table 4. Northern New York 2007 Spring Barley Variety Trial Results

Source	Hybrid/Variety Name	Yield	Test weight	Moisture	Plant height	Lodging
		bu/a	lb/bu	%	inches	Scale 0-10
	Trial Mean	87.5	46.7	14.3	26.1	0
	LSD	11.6	1.0		1.7	
	LSD P>	0.05	0.05		0.05	
	CV	7.0	1.2	1.3	3.5	
	F Test	0.0001	0.0001	0.455	0.0001	
Mark Sorrells	Sterling	103	49.0	14.3	24	0
Mark Sorrells	Bullock	103	48.0	14.4	22	0
Mark Sorrells	AC Malone	96	47.7	14.1	28	0
Mark Sorrells	Island	96	46.7	14.2	27	0
Mark Sorrells	AC Klinck	39	42.0	14.3	29	0

Spring Barley: Five spring barley varieties were included in the 2007 trial (Table 4). Plots were planted 4/25/07 at a seeding rate of 2 bu/acre, and harvested 8/15/07. For the first time in several years the barley plots managed to mature without any significant bird damage. The 2007 field season provided timely rains, growing conditions were generally excellent, and most varieties performed well. The one outlier was *AC Klinck* which yielded poorly in all three replications, averaging 39 bu/acre. The other four entries had much higher yields that did not differ significantly. No lodging, disease, or insect problems were observed in the plots.

Table 5. Northern New York 2007 Spring Oat Variety Trial Results

Source	Hybrid/Variety Name	Yield	Test weight	Moisture	Plant height	Lodging
		bu/a	lb/bu	%	inches	Scale 0-10
	Trial Mean	97.0	31.6	9.3	34.8	0
	LSD		3.5	0.4	3.3	
	LSD P>	0.05	0.05	0.05	0.05	
	CV	18.0	6.7	2.4	2.2	
	F Test	0.3	0.0190	0.0468	0.0001	
Mark Sorrells	Blaze	115.0	34	9.6	35.4	0
Mark Sorrells	Ogle	101.9	31	9.4	33.5	0
Mark Sorrells	Esker	101.9	32	9.2	33.5	0
Mark Sorrells	Spurs	95.1	34	9.6	33.9	0
Mark Sorrells	Drumlin	94.1	33	9.5	36.2	0
Mark Sorrells	Kame	93.0	30	9.2	32.3	0
Mark Sorrells	Newdak	90.7	31	9.2	35.0	0
Mark Sorrells	Rodeo	84.4	30	9.0	38.4	0

Oats: Oat variety trial plots were planted on field block 12-4 on April 25 and harvested August 15, 2007. The seeding rate was 3 bu/acre. There was a significant (0.0001) replication block effect on yield as the mean yields for replication blocks 2 and 3 were almost twice the yields in replication block 1. Yield data from the outlier replication block 1 was removed from the data set, so the yield averages presented in Table 5 just represent the results from replication blocks 2 and 3. Mean yields ranged from a low of 84.4 bu/acre for *Rodeo* to a high of 115 bu/acre for *Blaze,* with an overall mean of 97.0 bu/acre. No lodging, disease, insect, or bird damage was noted in the trial.

Table 6. 2007 Winter Triticale and Rye for Straw Trial

Source	Hybrid/Variety Name	Straw Yield Dry Matter Per acre (lbs)	Moisture At Harvest %	Plant height inches	Lodging Scale 0-9
	Trial Mean	6256	10.5	42.2	2.28
	LSD	441.9	2.2	1.7	2.8
	LSD P>	0.1	0.1	0.1	0.1
	CV	5.4	16.0	3.2	94.0
	F Test	0.0667	0.0004	0.0001	0.039
Agriculver	Alzo	6043	15.8	37.6	3.88
Agriculver	Trical 336	6623	9.0	36.0	0.25
Agriculver	Trical 815	5939	8.2	39.9	0.5
Agriculver	Winter rye	6420	9.1	55.3	4.5

Winter Triticale and Rye for Straw Trial: Three winter triticale and one winter rye entry were included in the 2007 straw production test. Plots were seeded 9/27/06 in field block 12-1, and harvested 7/31/07. The planting rate was 2 bu/acre for both triticale and rye. Dry matter yields ranged from 5939 lbs/acre to 6623 lbs/acre with a trial mean of 6256 lbs/acre (Table 6). Among the triticale varieties, *Trical 336* had markedly higher yields than either *Alzo* or *Trical 815*. *Trical 336* also had a higher mean yield than winter rye, although differences were not statistically significant. *Trical 336* had the shortest mean height in the trial and almost no lodging issues. *Alzo*, in contrast, had significant lodging problems, and the relatively high percent moisture levels in the *Alzo* staw at harvest were likely related to the fact that many of the plants had lodged. The winter rye entry was much taller than any of the triticale varieties, and had the highest mean lodging score in the trial (slightly higher that *Alzo*). It was interesting to note that the percent moisture levels in the rye straw at harvest were similar to those of the un-lodged triticale entries even though many rye plants had lodged.

These results illustrate that winter triticale straw yields can be comparable to winter rye, and in regions where triticale can reliably survive the winter, winter triticale offers a viable alternative to rye for straw production. Winter triticale survival in Willsboro Farm trials has been inconsistent. The 2005-2006 and 2006-2007 winters were relatively mild and winter triticale survival was excellent in both years. However, winter triticale plots all winterkilled in both

2003-2004 and 2004-2005. Given the uncertainty of winter triticale survival, winter rye would generally be considered a safer bet for straw production from a winter grain. An additional advantage of winter rye is that it can be successfully planted later in the fall than winter triticale.

Outreach

Tabulated trial results will be posted on the Northern New York Agricultural Development Program website www.nnyagdev.org and in the variety trial section of the online journal Plant Management Network www.plantmanagementnetwork.org. Results will also be presented at regional extension meetings and wheat production workshops.

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Photo: Small Grain Variety Trial Plots at the Cornell E.V. Baker Farm (photo by Michael H. Davis)

NNY Agricultural Development Program
2006-2007 Project Report

Project Title: **Developing New Cropping System Options for Organic Grain Production in Northern New York**

Project Leader:

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Background:

Organic grain production is one strategy that Northern New York farmers could use to diversify their operations and increase profitability. Fifteen to twenty percent annual increases in the organic food market coupled with the premium prices paid for certified organic grains have prompted many farmers to explore the organic option, and the amount of NNY acreage committed to organic field crop production has increased significantly in recent years.

Cropping system work in the organic rotations at the Cornell E.V. Baker Research Farm has primarily focused on the production of spring and winter wheat, grain-type soybeans, sweet corn, and alfalfa/grass hay. Solid regional markets for certified organic wheat and soybeans have helped to encourage local farmers to experiment with organic cropping systems, and most of the certified organic grain production in the area thus far has focused on these two crops. The challenge now is to find additional crop options that can be effectively and profitably inserted into the rotations. Sunflowers, flax, specialty grain corn, and dry beans have been suggested by organic farmers or marketers as possible options.

Objectives:

(3) To develop cropping system strategies to insert sunflowers, organic flax, and dry beans into the organic rotations at the Cornell E.V. Baker Research Farm.
(4) To acquire and test the agronomic performance of available sunflower, flax, and dry bean varieties in replicated, organically managed trials.

Baker Farm Organic Rotations:

A six acre field at the Baker Research Farm in Willsboro has been certified organic since 1993. The six acres were divided into ten equal blocks that have been allocated to two five-year rotations (a '*Wheat-Alfalfa/timothy*' rotation and a '*New Crop*' rotation). The *New Crop* rotation initially involved three years of alfalfa/timothy sod, followed by one year of food-grade soybeans, and one year of sweet corn. Two to three years of alfalfa/timothy sod has formed the heart of all our organic rotations. The perennial sod serves to recharge soil health as it provides an extended period without tillage, fibrous grass roots contribute significant organic matter to the soil system, and alfalfa root nodules fix nitrogen. Weed seed banks are also reduced when the sod is mowed or hayed at regular intervals.

In an effort to diversify the cropping and marketing options in the New Crop rotation, food-grade soybeans were replaced with dry beans, sunflowers replaced sweet corn, and flax followed the sunflowers (essentially taking the place of one year of alfalfa/timothy sod). Inserting sunflowers (*Asteraceae* family) and flax (*Linaceae* family) into the rotation adds two new plant families to the system and could function to reduce the incidence of pathogen and pest problems. The advantage to adding a third annual grain crop to the rotation is that it could improve economic returns over a five year period. The downside of having three annual crops and only two years of alfalfa/timothy sod, is that the soil system has less time to recharge and soil health could potentially be compromised.

Organic Flax Trials

Flax trials were conducted on *New Crop* rotation blocks 12-O-6 in 2006, and 12-O-9 in 2007. Fields had a Rhinebeck clay loam soil with subsurface drainage.

Experimental Designs

2006: Untreated seed for five flax varieties was obtained from the Flax Institute at North Dakota State University. The variety trial employed a randomized complete block design with six replications. Plots were 10' wide, 20' long, and planted at a 7" row spacing. Target seeding depth was 1", and the seeding rate was 56 lbs/acre (1 bu/acre). Three tons per acre composted chicken manure and 500 lbs/acre granulated organic fertilizer (North Country Organics 5-3-4) were applied to the field in 2005. No additional fertilizer was applied. The 2006 trial was planted May 8 and harvested October 10.

2007: Six flax varieties were included in the 2007 trial, which followed a plowed down alfalfa/timothy sod in the rotation. Additionally, a topdress fertilizer treatment was incorporated into the study. Fertilized plots received a 500 lb/acre broadcast application of OMRI approved *Northcountry Organics 5-3-4 Pro Gro* granulated fertilizer ten days after crop emergence. A split plot experimental design with four replications was used with the topdress application as the whole plot treatment, and variety as the split plot treatment. Plot size, seeding rate, row spacing, and target planting depth were the same as in 2006. The 2007 trial was seeded May 25 and harvested October 5.

Weed Control

Flax does not compete well for either above or below ground resources, so it is essential to minimize weed pressure. As flax is seeded at a narrow (7") row spacing, few post emergent cultivation options are available, and our strategy was to control the weeds as much as possible prior to seeding the crop. In both trials a late summer fallow period was imposed the year prior to trial establishment. Block 12-O-6 was fallowed following the failed 2005 sweet corn crop; this appeared to greatly reduce annual and perennial weed pressure ahead of the 2006 flax crop. Similarly, in preparation for the 2007 trial, rotation block 12-O-9 was plowed in August 2006 and fallowed for the remainder of the growing season to kill the alfalfa/timothy sod, any perennial weeds that had become established in the sod, and any annuals that may have germinated after the field was plowed.

In addition to the late season fallow periods, an early season stale seedbed strategy was employed to take out the first flush of spring annual weeds prior to establishing the trials in May. With a stale seedbed strategy the field is disced and dragged as soon as the field can be worked in the spring to encourage the germination of spring annual weed seeds. Germinated weeds are then killed by cultivation just prior to seeding the flax. No weed control measures were taken after planting, and weed control in the plots was excellent in both years.

It was interesting to note that in the 2007 trial where there were some "planter skips" at the ends of some of the plots, clusters of annual weeds became established. These weed clusters highlighted the importance of having a dense, solid crop stand to suppress weed growth during the season, even when working with a fairly non competitive crop like flax.

Results and Discussion

Entries:

The 2006 flax trial included four brown seeded varieties and one yellow seeded ("golden") variety (Table 2). A second golden flax variety, *Carter* was also included in the 2007 trial. While yellow and brown seeded varieties do not differ in their composition, the yellow color is considered more desirable for human consumption.

Flax Yields:

2006 mean yields ranged from 636 lbs/acre for *Pembina* to 738 lbs/acre for *Omega*, but yield differences were not statistically significant (Table 1). In 2007, the mean yield for *Pembina* was significantly lower than all other entries except *Carter* (Table 1). None of the other varieties differed significantly in yield in 2007.

2007 yields were markedly higher than 2006 yields (Table 1). Higher yields in 2007 may have resulted from greater soil fertility associated with the plowed down alfalfa/timothy sod that preceded 2007 trial, and/or more favorable growing conditions. The months of May and June were exceptionally wet in 2006 (Table 3), and waterlogged clay soils during the first part of the growing season may have resulted in reduced yields.

2006 yields differed significantly with replication block (Figure 1). Yields were significantly higher in replication blocks 1-3 than in blocks 4-6. Blocks 4-6 were located in a lower and wetter section of the field. Lower production in blocks 4-6 is consistent with the idea that wet soils reduced flax yields.

The topdress fertilizer treatment did not effect yields in 2007, indicating that the plowed down alfalfa/timothy sod provided sufficient fertility for the crop.

Variety Heights:

Mean plant heights were greater in 2007 than in 2006 (Table 2). Taller plants in the 2007 trial accompanied higher yields and are indicative of more favorable growing conditions. Mean plant height differed with variety in both 2006 and 2007. *Nekoma* and *Pembina* were consistently among the tallest entries, while *York* was one of the shortest varieties in both years.

In 2007, the topdress fertilizer treatment significantly increased plant height (Figure 2), indicating that the organic fertilizer application influenced plant growth, even if it didn't impact yields.

Summary

Seed flax varieties bred for upper Midwest growing conditions performed well in northern New York trials in 2006 and 2007. Yields were comparable to those reported for identical entries in NDSU trials (www.ag.ndsu.nodak.edu/willisto/), indicating that these varieties are suitable for production in the northeast. Most varieties did not differ significantly in yield. *Pembina* was the exception as it yielded significantly less than all the other entries except *Carter* in 2007, and had the lowest mean yield in the 2006 trial.

Flax fit nicely into established organic grain rotations at the Cornell Baker Research Farm. A late summer fallow period the year prior to planting, coupled with an early season stale seedbed provided good weed control in both years. No disease, insect or lodging problems were observed in either year.

Flax growth and yield were influenced by weather conditions and rotation sequence. Yields were markedly lower in the 2006 trial which experienced an exceptionally wet May and June, and followed sweet corn in the rotation. In contrast, the 2007 trial followed a plowed down alfalfa/timothy sod and received timely rains. We hypothesized that the heavy rains in 2006 flushed much of the early season available nitrogen out of the soil, so an organic fertilizer topdress treatment was incorporated into the 2007 trial. While the fertilizer application significantly increased plant heights, it did not influence yield as the decomposing alfalfa/timothy sod provided sufficient fertility for the crop.

VARIETY	2006 MEAN YIELDS (lbs/acre)	2007 MEAN YIELDS (lbs/acre)
Rahab94	654 a	1200 a
York	656 a	1195 a
Omega	739 a	1187 a
Nekoma	676 a	1100 a
Carter		1094 ab
Pembina	636 a	896 b
	LSD 0.05 = 134	LSD 0.05 = 204

Table 1. Mean yields for flax varieties in 2006 and 2007.

VARIETY	SEED COLOR	2006 MEAN PLANT HEIGHTS (cm)	2007 MEAN PLANT HEIGHTS (cm)
Nekoma	Brown	52.0 ab	73.4 a
Pembina	Brown	52.0 ab	72.0 a
Rahab94	Brown	50.2 b	66.1 b
Carter	Yellow		64.6 b
York	Brown	48.0 b	63.8 b
Omega	Yellow	54.8 a	59.0 c
		LSD 0.05 = 4.4	LSD 0.05 = 3.3

Table 2. Seed color and mean plant heights for flax varieties in the 2006 and 2007 trials.

	Monthly Rainfall Totals on the Cornell Baker Farm (inches)			
Year	May	June	July	August
2006	4.08	4.81	2.73	1.83
2007	1.53	1.81	4.72	0.34

Table 3. Monthly rainfall totals during the 2006 and 2007 growing seasons.

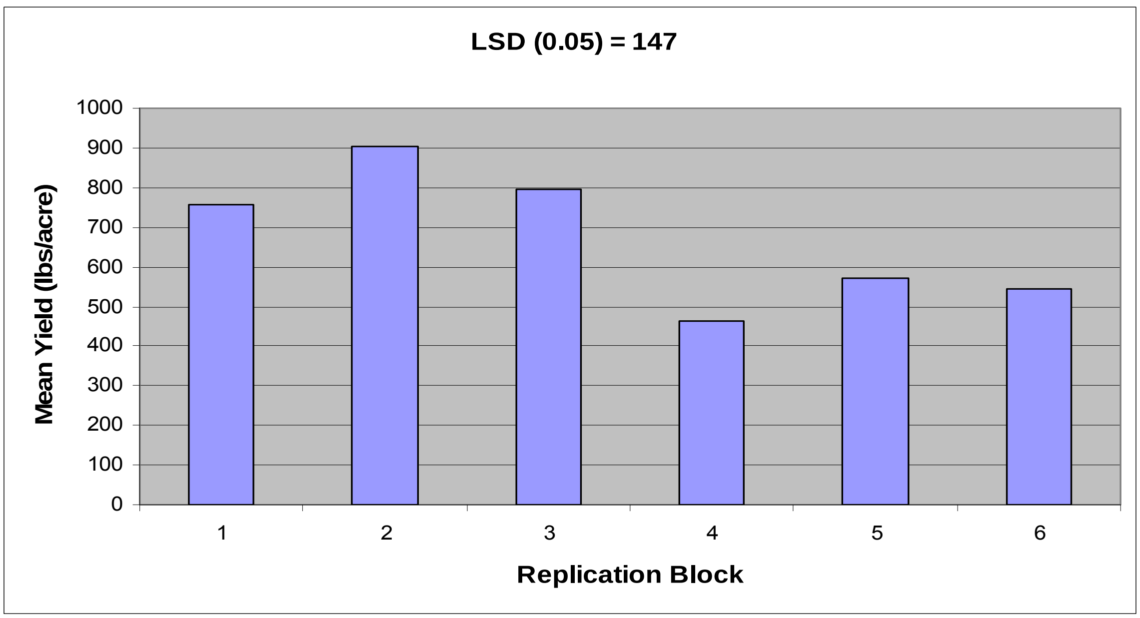

Figure 1. 2006 flax trial replication block mean yields.

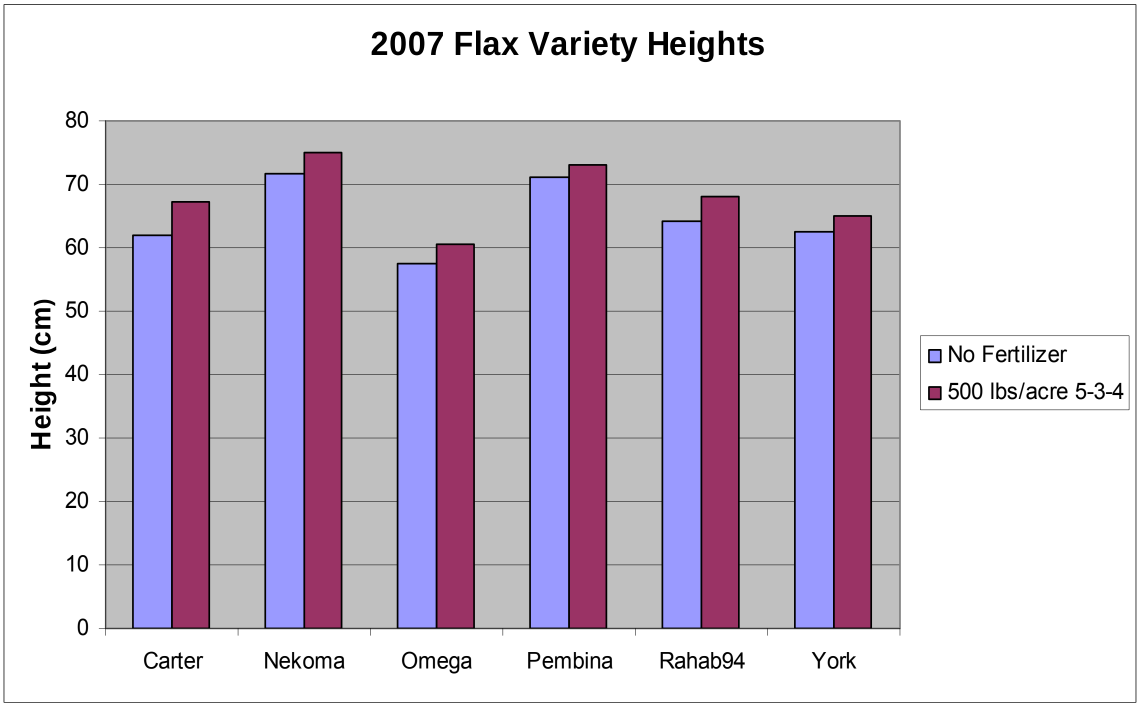

Figure 2. Variety plant heights with and without the fertilizer treatment in 2007

Photo: 2006 Organic Flax Trial Plots at the Cornell E.V. Baker Farm (photo by Jerry Cherney)

Photo: Organic Flax Trial Harvest at the Cornell E.V. Baker Farm (photo by Michael Davis)

Organic Dry Bean Production

Dry beans replaced food-grade soybeans in the organic 'New Crop' rotation at the Cornell University Willsboro Research Farm in 2006 and 2007. Dry bean trials were conducted on certified organic fields with a Rhinebeck clay loam soil and subsurface tile drainage. The 2006 trial followed a plowed down alfalfa/timothy sod in the rotation and was located on block 12-O-8. The 2007 trial was conducted on block 12-O-7 and followed sunflowers in the rotation.

Trial Establishment

Certified organic seed of four dry bean varieties (Table 4) was obtained from High Mowing Seed Company in Vermont. A randomized complete block trial was designed with six replications in 2006 and four replications in 2007. Trial plots were 10' wide and 20' long, and consisted of four rows with a 30" row spacing between the rows. Target planting depth was 1" and all seed was inoculated with the appropriate *Rhizobium* sp. prior to planting. The 2006 trial was planted on June 16 (seeding was delayed by exceptionally wet weather) and harvested by hand on November 1, 3 and 6. The 2007 trial was planted May 30 and hand harvested October 22.

Weed Control

The weed control strategy for dry beans included both pre-plant and post-emergent cultivation techniques. We always work to control the weeds as much as possible before seeding the crop using late season fallow periods and/or early season stale seedbeds. With dry beans planted at a 30" row spacing, post-emergent blind cultivations with a rotary hoe and between row cultivations with a variety of sweeps can also be employed.

In preparation for the 2006 trial, block 12-O-8 was plowed in August 2005 and fallowed the remainder of the growing season to kill the sod and reduce perennial and annual weed populations. Additionally, a stale seed bed strategy was used to take out two flushes of annual weeds in the spring. In a normal spring the beans would have been planted by mid May, and there wouldn't have been enough time to germinate and cultivate a second flush of weeds, but the delayed planting in 2006 allowed for an additional stale period prior to seeding. Wet weather continued after planting and there were no opportunities to do any blind cultivating with a rotary hoe. The plots were cultivated using sweeps between the rows on July 6, 2006. Weed control in the plots was generally good, primarily due to the effectiveness of the late season fallow period and stale seedbed.

The 2007 trial followed sunflowers in the rotation, so a late season fallow period was not an option. Block 12-O-7 was plowed in November following the sunflower harvest. The field was then disced and dragged in late April 2007 to create a stale seedbed, which was dragged again just prior to seeding the trial on May 30. Plots were cultivated with a rotary hoe (two passes in opposite directions) when the plants were about 4" tall and had their first set of true leaves. This blind cultivation effectively controlled germinating seedlings within and between the dry bean rows. An additional between row cultivation with sweeps was conducted in mid summer.

Results and Discussion: Deer browsing damage was observed in the dry bean plots in both 2006 and 2007. Plot damage in 2006 was relatively light and the impact of the deer browsing on bean yields was difficult to assess. In 2007 deer browsing damage was extensive and severe: many plots were completely destroyed, and the plots that were harvestable had markedly reduced yields (Table 4). Three strands of electrified tape surrounded the entire trial in both seasons, but clearly failed to deter the deer in 2007.

Yields varied significantly between the entries in 2006 with Black Turtle averaging over twice the yield of any other variety (Table 4). While we didn't have enough plot samples to run statistical tests on yields in 2007, black turtle yields were again much greater than any of the other varieties.

All four varieties set some pods very close to the ground, making it impossible to mechanically combine the plots without leaving significant numbers of pods in the field. Our inability to mechanically harvest any of the dry bean varieties suggests that they may not be suited to larger scale plantings. Black Turtle has the most potential for mechanical harvesting as it was taller than the other varieties and fewer pods would be missed by a combine.

Source	Variety	2006 Mean Yields (lbs/acre)	2007 Mean Yields (lbs/acre)	2007 Mean Plant Heights (cm)
High Mowing Seeds	Black Turtle	2113.5	1019.4	31
High Mowing Seeds	Soldier	953.4	327.9	27
High Mowing Seeds	Maine Yellow Eye	685.7	327.9	23
High Mowing Seeds	Jacobs Cattle	784.3	287.4	24
	Trial Mean	1134.2	539.9	26.6
	LSD(0.05)	149.6		

Table 4. Mean dry bean variety yields for 2006 and 2007, and mean variety heights in 2007.

Organic Sunflower Production

Fertility

Sunflowers replaced sweet corn in the organic 'New Crop' rotation in 2006 and 2007. Since sunflowers, like sweet corn, are considered fairly heavy feeders, our fertilizer program included both compost and a granular organic fertilizer blend. Three tons/acre composted chicken manure ("Giroux Doo" with an NPK of 2-2-1.5) was broadcast onto the field and incorporated with a disc prior to fitting the field for planting. An additional 200 lbs/acre Northcountry Organics 5-3-4 Pro Gro granular fertilizer was broadcast applied to the plots thirty to forty days after planting.

Trial Establishment

Untreated seed of one edible seed variety (*Mammoth*) and one oil seed variety (*Black Oil*) was obtained from Albert Lea Seedhouse in Minnesota. Two hybrid oil seed varieties, *6949* and *Defender HO* were contributed by Seeds 2000 (Minnesota organization). A randomized complete block test design with four replications was employed. Plots were 10' wide, 20' long, and consisted of 4 rows with 30" between row spacings. Sunflowers were planted with a two row cone planter (two passes per plot) on May 31 in 2006 and May 30 in 2007. Final plot evaluations and harvest data were taken on November 6, 2006 and October 22, 2007.

Weed Control

The weed control game plan for the sunflowers included spring stale seedbeds and between row cultivations with sweeps. In 2006, extensive rains after planting prevented timely cultivations of germinating weeds and the plots were not cultivated with sweeps until 40 days after planting; some between row weeds were set back by this cultivation, but significant weed populations persisted, especially within the row. The 2007 trial received two between row cultivations with sweeps before the crop became too tall to clear with our Allis Chalmers G cultivating tractor.

We did not attempt any blind post-emergent cultivations with the sunflowers. It would be interesting to experiment with either a rotary hoe or a spring tine weeder harrow, to see if they could effectively reduce within row weed populations without damaging the sunflower seedlings. In plots with good crop stands, the sunflowers competed well with the within row weeds that managed to persist.

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Results and Discussion

In both years, all four varieties grew well in plots that had good stand establishment. Mammoth was almost twice as tall as the three oil seed varieties (Table 5). Selected heads were hand harvested in the fall, but extensive bird damage to the heads made it impossible to collect meaningful yield data from either test. If sunflower trials are to be conducted in the future, it will be essential to protect the plots with bird netting. The sunflowers appeared to mature slowly and many heads started to mold and rot before they had dried enough to combine. It is possible that these varieties are either too late maturing for the Northern New York growing season, or they are not well adapted to the climate conditions.

Other sunflower growers in NNY report reduced bird damage with late planted sunflowers (planted at the end of June), claiming that the seeds mature after many of the birds have already migrated south for the winter. A late planting strategy may have some merit for larger scale (multi-acre) plantings, especially given the extended growing seasons we've experienced the past two years. In our relatively small (quarter acre) test plots, however, I would expect the bird pressure to remain high well into the fall.

Source	Variety	Seed Type	2006 Mean Heights (cm)	2007 Mean Heights (cm)
Albert Lea Seeds	Mammoth	Edible	189.6	274.0
Albert Lea Seeds	Black Oil	Oil Seed	156.9	145.8
Seeds 2000	6946 (hybrid)	Oil Seed	166.1	166.3
Seeds 2000	Defender HO (hybrid)	Oil Seed	150.6	174.0
		Trial Means:	189.6	190.0

Table 5. Seed type and mean variety heights for the 2006 and 2007 sunflower variety trials.

Photo: *Mammoth* sunflowers at harvest (10/26/06) at the Cornell E.V. Baker Farm (photo by Michael H. Davis)

Outreach

Tabulated trial results will be posted on the Northern New York Agricultural Development Program website www.nnyagdev.org, and included in regional extension publications and meetings. A workshop on the organic flax production was presented at the NOFA-NY winter conference in Syracuse, NY, January 27, 2007.

Acknowledgments:

Organic cropping systems research was funded by a grant from the Northern New York Agricultural Development Program.

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NNY Agricultural Development Program
2006-2007 Project Report

Project Title: **Forage Soybean Advanced Breeding Line Evaluations**
&
Food Grade Soybean Variety Trials

Project Leaders:
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Michael Hunter, CCEof Jefferson County
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Collaborators:

Thomas Devine, , USDA Sustainable Agriculture Systems Lab, Beltsville, MD
Jerry Cherney, Dept. of Crop and Soil Sciences, Cornell University

Forage Soybean Trials:

Background

Forage soybeans may be a viable alternative legume crop for Northern New York dairy farms that have difficulty growing alfalfa. Soybeans historically functioned as a forage crop, and some Northern New York farmers have recently experimented with harvesting grain-type soybeans for forage, but more widespread adoption of soybeans as a forage crop in the future will depend on the development of regionally adapted forage-type varieties that have desirable agronomic characteristics.

Dr. Thomas Devine, a USDA soybean breeder based in Beltsville, Maryland, started developing forage-type soybeans in the 1980's, and field evaluations of advanced lines from his program were first conducted in the Cornell Chazy research plots in 1995. Dr. Devine's early breeding work with forage-type soybeans produced very tall, relatively late maturing (maturity groups V – VIII) lines that generated high shoot biomass, but few seeds when grown at northern latitudes. Several advanced lines in the 1998 Chazy test were over 8' tall and yielded more than 10 tons/acre dry matter. Two major problems with the large, later maturity lines were

(1) high NDF levels – a low proportion of which was digestible. While the yields with these lines were impressive, the thick stems required to hold the plants up resulted in forage with undesirably high fiber levels. Tall lines without thick stems tended to have a viney growth habit that produced a tangled, lodged canopy. Dense, thick canopies are difficult for some machinery to handle, and may also result in lower canopy conditions that favor white mold growth.

(2) Lower crude protein levels. When grown in Northern New York, the late maturing varieties didn't produce much seed, and as a result crude protein levels were consistently lower than those in early maturing grain-type soybeans harvested for forage at the R6 (full seed) stage.

In an effort to address these limitations and develop lines that are well suited for production in more northerly latitudes, Dr. Devine crossed some of the original forage-type lines with earlier maturing varieties. Promising advanced lines, identified in 2005 and 2006, were selected for the 2007 test.

Objective

To support efforts to develop forage-type soybean varieties that are well adapted to Northern New York growing conditions by evaluating the agronomic performance of elite forage soybean breeding lines in replicated field trials.

Methods

Nine advanced breeding lines and two named forage-type varieties from Dr. Devine's forage soybean breeding program, plus two grain-type varieties from Iowa were included in the 2007 tests. Entries ranged from maturity group (MG) II to MG VI. Field trials were established at three sites in Northern New York: the Cornell research plots at the W.H. Miner Institute in Chazy, the CCE St. Lawrence County Research Farm in Canton, and an on-farm research location in Jefferson County.

Chazy Trial:
A randomized complete block experimental design with four replications was employed. Plots were located on a Roundabout silt loam soil with tile drainage (Field range 8). 200 lbs/acre 6-24-24 was broadcast applied and incorporated with a spring-tooth harrow prior to planting. Broadstrike+Dual herbicide was also pre-plant applied. Four-row plots were planted with 30" row spacings on May 23, 2007. All seed was inoculated prior to planting. Final harvest occurred on September 20, 2007. Entries were scored for plant height, maturity, leaf type, and lodging. In each plot two 20' long rows were chopped with a Carter harvester, weighed, and oven dried for yield and dry matter determinations. An additional five plants per plot were sampled for quality analysis. Quality sample plants were run through a chopper and immediately dried in ovens at 60^{o} C.

Results

2006 results are tabulated in Tables 1&2, and 2007 results are presented in Tables 3&4.

2007 Entry Notes:

Donegal (check)—Donegal, one of the first tall, forage-type varieties released from Dr. Devine's breeding program, is a maturity group V soybean with large leaves. The variety has a viney growth habit that tends to result in a tangled canopy and accounts for its high lodging scores.

Donegal produced the highest mean yield in the 2007 trial. Its performance was consistent with past years as it reached the R5 development stage by harvest, had an average yield of 3.7 tons/acre dry matter, NDF of 40.5%, and 16.7% crude protein.

Tara (check)—Tara is also a tall, large leaved, maturity group V release from Dr. Devine's program. Tara stands well and had few lodging problems in the 2007 trial. Reduced lodging problems are accompanied by a slightly higher mean NDF reading (42.3) compared to *Donegal*. *Tara* yields were similar to *Donegal*.

XB17—A large leaved, relatively tall entry that is listed a maturity group III line. In Chazy trials it has consistently matured with *Donegal* and *Tara*, which are both listed as maturity group V. *XB17* has exhibited a viney growth habit in previous trials, especially toward the top of the plant, and as a result has tended to have some lodging problems. In the 2007 trial it was shorter than previous years and did not lodge. The yields were also lower (mean of 3.1 tons/acre) than in previous trials.

97NYCZ33-1—A tall, large leaved selection that stands well and had no lodging problems. *97NYCZ33-1* is listed as a maturity group III, but matured slightly behind *Donegal*, *Tara*, and *XB17*, and had not reached the R5 development stage at harvest. Forage quality was similar to *Donegal* and *Tara*, but the line yielded less than the two checks.

IA2068—This Iowa grain type variety is a short, stocky maturity group II entry with relatively small leaves. *IA2068* was the shortest and earliest maturing entry in the trial. It reached development stage R6 by the late harvest, had no lodging, yielded in the middle of the pack (3.1 tons/acre dry matter average), and very favorable quality measures (NDF at 37.1, 20.3% crude protein).

IA3023—A relatively short, maturity group III grain type variety from Iowa with large leaves and no lodging in 2007. *IA3023* developed just slightly behind *IA2068* and *4-1#3* and did not quite reach R6 by harvest. This entry yielded with the taller, later maturing entries in 2006 (4.1 tons/acre dry matter), but had one of the lowest mean yields in the 2007 trial (2.9 tons/acre). Quality measures were favorable at 21% crude protein, an NDF of 38.5, and NDFD of 51.8.

F558—A new MG VI entry that only reached R2 at harvest. Lack of seed development resulted in low crude protein levels (16.2%), an NDF of 42.4% and an NDFD of 40.8%. The high fiber levels and low fiber digestibility is consistent with the lines tall stature and low lodging scores. *F558*, while a tall, late maturing variety, had one of the lowest mean yields at 2.9 tons/acre.

1GH12-1-1—A late maturing, MG VI entry that was similar in height to *Donegal*, but stood well and had few lodging problems. This line yielded with *Tara* and *Donegal*, reached an R stage of 3.0 at harvest, and had 16% crude protein. NDF was slightly higher and NDFD was significantly lower than *Donegal* or *Tara*.

SG13#53—Another tall, MG VI entry that produced only fair yields (3.1 tons/acre). *SG13#5* reached R2 by harvest and had the lowest crude protein levels (14.6%) in the trial. NDF and

NDFD were similar to *1GH12-1-1*, and consistent with the lines tall stature and good lodging resistance.

AWS#4—The tallest entry in the 2007 trial (179.8cm), *AWS#4* was also among the top yielders. The MG VI line reached R2 by harvest and had low crude protein (15.0%) and high fiber levels (45.3% NDF and 40.8% NDFD).

97NYCZ26-1—Taller than the Iowa grain soybean varieties, but among the shortest forage-type entries, *97NYCZ26-1* stood well and had no lodging. Mean yield (2.9 tons/acre) was one of the lowest in the trial. This line was fairly early maturing as it reached R5.5 at harvest, and had decent forage quality measures: 18.1% crude protein, 40.7% NDF, and 47.5%NDFD.

4-1#3—Very early maturing, the line reached R6 at harvest. Height, yield, and lodging resistance were comparable *to 97NYCZ26-1*, *F5#15*, and *F5#16* with respectable crude protein levels (18.7%) and fiber measures similar to the grain-type entries (37.6% NDF and 49.5%NDFD).

F5#15&F5#16—Two closely related selections that were similar in yield, height, lodging resistance, and quality measures to *4-1#3*, even though they matured somewhat behind *4-1#3*. *F5#15* had similar fiber levels to *F5#16* and *4-1#3*, but noticeably lower NDFD.

Forage Soybean Trial Discussion

Fourteen entries were included in the 2007 trial. Six entries, including the two checks, *Donegal* and *Tara* (both MG V), the two grain-type lines from Iowa, *IA2068*(MG II) and *IA3023* (MG III), and two promising selections, *XB17* (MG III) and *97NYCZ33-1* (MG III) were repeats from 2006. New additions in 2007 included one MG II line, two MG III lines, one MG IV line, and four MG VI lines (Table 3).

The 2007 trial had a lower overall mean dry matter yield (3.2 tons/acre) than the 2006 trial (3.9 tons /acre), even though the 2007 trial had many more tall, later maturing (and theoretically higher yielding) entries. *Donegal* and *Tara* (both MG V), along with two new MG VI selections, AWS#4 and 1GH12-1-1, had the highest mean yields (Table 3). Crude protein levels of the four top yielding entries were in the 16-17% range, which is typical for later maturing forage-type lines that have very little seed filling prior to harvest. 2007 results provided another illustration of the trade-off between lodging resistance in the tall, forage-type soybean lines and fiber levels. *Donegal*, with its characteristic viney growth habit and associated high lodging scores, had more favorable fiber quality measures (lower NDF and higher NDFD) than the other three high yielding entries. *AWS#4*, *Tara*, and *1GH12-1-1* all stood well, but had higher fiber (NDF), a lower proportion of which was digestible.

In 2006, the two short, early maturing Iowa grain-type varieties appeared to defy the inherent trade-offs associated with maturity group, yield, percent crude protein levels, and fiber, as they produced yields comparable to the taller, later maturing, forage-type lines, but had much higher crude protein levels, lower NDF, and higher NDFD than the forage-type entries. The 2006 performance was not repeated in 2007 when the Iowa grain-type lines produced superior forage quality measures, but had significantly lower yields than the forage-type entries.

Food Grade Soybean Trials:

Background

Demand for high quality food grade soybeans continues to grow. Regional soybean processors are paying $18.00 per bushel for organically certified, and $10.00 per bushel for conventionally grown non-GMO soybeans, with additional price premiums paid for high protein varieties (varieties with a favorable 3:1 protein to oil ratio). Northern New York farmers have considerable experience growing grain-type soybeans, and could significantly enhance their profit potential by incorporating food grade soybeans into their field crop rotations. If growers are going to be successful with food grade soybean production, it is essential that we identify food grade soybean varieties that are well adapted to Northern New York growing conditions and meet the quality specifications and requirements of the regional processors.

Objective

To test the agronomic performance of available varieties of food grade soybeans when produced under northern New York growing conditions.

Methods

Twelve commercially available food grade soybean varieties were included in the 2007 trial. A randomized complete block experimental design with four replications was employed. Food grade soybeans were grown on tile drained, certified organic fields with a Rhinebeck clay loam soil at the Cornell University Willsboro Research Farm. Trial plots were 10’ wide and 20’ long, and consisted of four rows with a 30” spacing between the rows. Target planting depth was 1” and all seed was inoculated with the appropriate *Rhizobium* sp. prior to planting. Plots were seeded May 30. 2007 and harvested October 18, 2007. Weed control measures included cultivation with a rotary hoe (two passes in opposite directions) when the plants were approximately 4” tall and had their first set of true leaves, and an additional between row cultivation with sweeps in mid summer (sweeps were mounted on an Allis Chalmers G tractor).

Food Grade Soybean Trial Results

The 2007 field season provided timely rains, and growing conditions were generally excellent. Most of the food grade soybean varieties performed well with an overall trial mean yield of 41.5 bu/acre (Table 5). *1F61* and *21YP7* produced the highest mean yields of 45.9 bu/acre and 45.6 bu/acre, respectively. Most of the other entries yielded between 39 and 43 bu/acre. The one low outlier was *OAC Prudence* with a mean yield of 34.0 bu/acre. No disease or lodging problems were observed in the trial. Some shattering was observed with *OAC Champion* and its yield would likely have been higher if it had been harvested earlier. An additional one or two years of testing is needed to confidently assess the potential of these food grade varieties.

Outreach

Tabulated trial results will be posted on the Northern New York Agricultural Development Program website www.nnyagdev.org, and presented at regional extension meetings and field days.

Acknowledgments:

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Person(s) to contact for more information (including farmers who have participated:

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Table 1. Stage of development and forage quality means at the early and late harvests in 2006.

	R stage		NDF		% Crude Protein		9/15/06	
Entry	Early Harvest 8/24/06	Late Harvest 9/15/06	Early Harvest 8/24/06	Late Harvest 9/15/06	Early Harvest 8/24/06	Late Harvest 9/15/06	% Fat	Rel. Feed Value
IA3023	4	6	35.8	35.1	20.2	21.4	3.9	178
97NYCZ33-1	2	4	40.6	41.0	17.7	17.0	2.4	147
IA2068	5	6	37.0	34.4	19.0	20.6	4.6	183
XB17	3	5	38.9	45.7	18.1	17.2	2.3	128
Tara	3	5	38.4	39.8	16.7	18.1	2.5	154
Donegal	2.5	5	39.5	40.8	17.0	17.9	2.3	149

Table 2. Mean mid-season relative maturity and lodging scores, final height, and yield for 2006 forage soybeans.

		Scale 1-10	Scale 1-10*		(tons/acre)
Entry	Ht. (cm) 9/15	Maturity Score on 8/9/06	Lodging Score on 8/9/06	Percent Dry Matter on 9/15/06	Dry Matter Yield on 9/15/06
IA3023	97.5	10.0	1.0	22.7	4.1
97NYCZ33-1	138	5.3	1.0	21.3	3.1
IA2068	92	9.3	1.0	25.6	3.8
XB17	166.3	5.1	1.8	22.9	4.2
Tara	161.8	6.3	1.3	23.3	4.1
Donegal	179.5	4.3	3.5	19.9	4.0

*1=no lodging, 10=completely lodged

Table 3. Northern New York 2007 Forage Soybean Trial Results

Variety/Selection Line	**Maturity Group**	**Dry Matter Yield**	**Moisture at Harvest**	**Plant Height**	**Lodging**
		tons/a	%	CM	Scale 0-10
	Trial Mean	3.2	73.6	136.3	0.9
	LSD	0.5	1.42	12.7	0.8
	LSD P>	0.1	0.1	0.1	0.1
	CV	14.5	1.6	7.8	68.8
	F Test	0.1605	0.0231	0.0001	0.0001
97NYCZ26-1	II	2.9	73.1	128.8	0
IA2068	II	3.1	72.8	90.0	0
IA3023	III	2.9	74.4	96.3	0
XB17	III	3.1	73.6	139.8	1.0
97NYCZ33-1	III	3.1	74.7	134.0	0.3
4-1#3	III	3.1	72.8	129.5	0.3
F5#15	III	2.9	73.5	126.0	0
F5#16	IV	3.0	72.6	126.5	0
Tara	V	3.5	73.1	145.3	0.3
Donegal	V	3.7	74.9	167.3	8.0
AWS#4	VI	3.5	73.1	179.8	2.0
1GH12-1-1	VI	3.5	72.3	161.0	0.8
SG13#53	VI	3.1	74.4	142.0	0.3
F558	VI	2.9	75.2	146.0	0.5

Table 4. 2007 Forage Soybean Trial Forage Quality Results

Variety/Selection Line	Maturity Group	R-Stage At Harvest	Crude Protein	NDF	NDFD
		R-stage	%	%	%
	Trial Mean	4.5	17.4	40.9	45.2
	LSD	0.2	1.6	3.5	4.9
	LSD P>	0.1	0.1	0.1	0.1
	CV	4.3	7.5	7.3	9.1
	F Test	0.0001	0.0001	0.0011	0.0009
97NYCZ26-1	II	5.5	18.1	40.7	47.5
IA2068	II	6.0	20.3	37.1	44.0
IA3023	III	5.9	21.0	38.5	51.8
XB17	III	5.0	17.1	42.2	42.8
97NYCZ33-1	III	4.9	15.9	41.1	48.3
4-1#3	III	6.0	18.7	37.6	49.5
F5#15	III	5.4	19.1	37.8	43.8
F5#16	IV	5.1	19.4	37.9	49.0
Tara	V	5.2	16.3	42.3	46.3
Donegal	V	5.0	16.7	40.5	48.0
AWS#4	VI	2.4	15.0	45.3	40.8
1GH12-1-1	VI	3.0	16.0	43.7	41.0
SG13#53	VI	2.3	14.6	45.1	39.5
F558	VI	2.0	16.2	42.4	40.8

Table 5. 2007 Food Grade Soybean Trial Results

Variety	Yield	Moisture	Plant Height	Lodging
	Bu/acre	%	inches	0-9 scale
Trial Mean	41.5	12.8	33.3	0
LSD	3.9		2.0	
LSD P>	0.1		0.1	
CV	7.8	9.2	8.9	
F Test	0.0018	0.3051	0.0001	
1F61	45.9	13.2	28.2	0
21YP7	45.6	12.9	35.5	0
OAC Oxford	42.8	11.7	35.7	0
2F11	42.6	13.3	27.2	0
CFO703	42.3	13.4	36.4	0
IA24	42.0	12.9	27.9	0
OAC Champion	41.8	13.0	32.0	0
SO8-80	41.6	13.6	32.9	0
SO3W4	40.4	12.5	33.4	0
1F44	40.2	11.5	34.4	0
Boyd	39.1	13.2	43.9	0
OAC Prudence	34.0	12.4	31.9	0

Photo:

Forage soybean advanced line test at the Cornell Research Plots in Chazy, NY.

NNY Agricultural Development Program
2006-2007 Project Report

Project Title: **Improving growth of sugar maples in Northern NY**

Project Leader(s):

Brian Chabot, Cornell University,
Michael Farrell, Uihlein Forest, Lake Placid, NY

Collaborator(s):

Peter J. Smallidge, Dept. of Natural Resources, Cornell University,

Stephen Childs, Dept. of Natural Resources, Cornell University

Cooperating Producers:

Burnham Family (Jefferson County)
Jason and Barbara Zehr (Lewis County)
Jim and Christine Mueller (Franklin County)
Joeseph and Irene Schork (Franklin County)
Kim LaDuke (Essex County)
Art Person (Essex County)
Parker Family Maple (Clinton County)
Northwood School (Essex County)

Background:

The two objectives of this project are 1) to evaluate ways to improve the growth of maple trees in order to increase yield of sap sugar, and 2) to improve sugarbush/forest management practices in NNY. Maple sugar is a high value crop in all counties in NNY and is a sustainable use of the natural resource base for this area.
Even though fast growing trees are known to produce more sugar, recommendations on how to manage trees for fast growth in the NNY environments are poorly developed. Also, the relation between sugar yield per tree and sugar yield per acre under different tree stocking densities has not been established anywhere. Developing this relationship is essential in being able to recommend forestry practices that maximize syrup production per acre.

The success of any maple operation begins with the ability of trees to produce sap, remain healthy, and sustain production over a long period of time. We intend for this research to lead to better recommendations about how manage the NNY maple resource to maximize sugar yield and net income to the producer. We also will seek ways to improve tree health and sustainable sap yields.

Methods:

Research on the effects of thinning on maple growth and sap sweetness is underway at the Uihlein Forest and 8 producer locations throughout Northern NY. Many other locations were visited and rejected either because of forest condition or because there was not enough uniformity to have replicated plots. We added the Northwood School as a new cooperator. In addition to participating in the forest management research, students will be involved in learning about maple sugar production.

Three plots were established at each location representing two levels of thinning and one control. The thinning produced two levels of residual basal area, one representing a light thinning and the other a heavier cut. The forests are reasonably close in age and structure. Prior to undertaking thinning, the project leaders were trained in chain saw safety and use in directional felling through the Game of Logging program. The benefits of directional felling techniques became evident to the cooperating maple producers.

Participants measure sap volume and sugar concentration along with tree growth and tree health each year. We are in the early stages of a long-term research project, so the data being collected now will be used for comparison purposes in 5-10 years.

Results:

We learned there is a wide range of forest management practices from those undertaking regular thinning based on a documented management plan to many who are not doing any regular forest management. Most NY sugarbushes are over-stocked with too many trees having minimal growth. Thinning in most forests should have happened years before we arrived. Many trees below the 10 inch dbh limit are being tapped and many trees are being over-tapped. Density management works best if started when trees are less than 10 inches in diameter.

Measuring sap sugar content and volume was done in the 2007 sap season. Producers were given the necessary instrumentation and took measurements that will serve as baseline data. Acquiring this baseline data on individual trees is essential when making comparisons with the same trees several years from now, after the effects of thinning are realized. Some adjustments will be made for the 2008 season to make the data collection process easier.

In 2007, we developed and tested a method of quantifying taphole closure that provides a reasonable low cost/low effort assessment of tree growth and health. It will be used in 2008 to assess all of the experimental treatments and to engage additional producers in assessing forest management practices.

Conclusions/Outcomes/Impacts:

Results addressing the primary objective of the research will not be known for a few years at least. However, we learned quickly during the implementation that many maple forests in NYY are not well managed and that the owners were not particularly knowledgeable about approaches and methods of proper management. So the immediate impact was with the maple producers involved in the project where they were able to learn proper management techniques in their own woods. Subsequent workshops have built on these initial experiences to extend information to a broader group of producers.

Outreach

At each location we educated the producers about techniques of forest inventory, tree measurement, selecting trees for removal, and using the thinning tables to reach target residual basal area. What we learned from these activities has been incorporated into presentations for larger audiences in winter maple schools. Forest management presentations were made in January 2007 at three NNY workshops in Lewis, St. Lawrence and Warren Counties, for maple producers.

The following workshops and presentations occurred:

Smallidge, P.J. 2007. Sugarbush management basics. Lewis County Maple Workshop. Western NY Maple Workshop.
Smallidge, P.J. 2007. Sugarbush Thinning. Lewis County Maple Workshop
Farrell, M. 2007. Sugarbush Thinning. Maple Expo-St. Lawrence County
Smallidge, P.J. 2007. Strategies for sugarbush thinning. CUCE Franklin County and NYFOA woodswalk, Garth Steven's property, Franklin County.
Smallidge, P.J. and M.L. Farrell. 2007. Strategies and considerations when thinning your sugarbush. NNY Maple Meeting, Plattsburgh, NY. Parker Sugarbush.

Next steps if results suggest continued work is needed in the areas of research, demonstration and/or education.

This is a multiyear project. During 2008, we will be monitoring tree response to thinning treatments along with sap sugar and volume. This will be done using the producer cooperators so as to give them additional experience with research techniques.

Workshops on forest management will occur in 2008 at the Maple Schools in NNY. We are planning three forest management workshops at producer cooperator locations. Thinning workshops are being scheduled for Essex County in August, Lewis County in September, and Franklin County in October 2008. Direct engagement in the woods is the most useful learning technique, so we hope to reach over 50 producers through these hands-on workshops.

Acknowledgments:

In addition to funding through the Northern NY Agricultural Development Program, this project has received financial support from the McIntire-Stennis Program of the U.S.D.A. and the Cornell Maple Program.

Reports and/or articles in which the results of this project have already been published.

Farrell, M. 2007. Increasing maple production through landowner cooperatives. Pipeline 4(3):4
Farrell, M. 2007. Sugarbush Thinning Project Well Underway. Appeared in CCE newsletters of the 6 county NNY region in January 07.

Person(s) to contact for more information (including farmers who have participated:

(see project leaders, collaborators, and participants above)

NNY Agricultural Development Program
2006-2007 Project Report

Title of project: **Cold Hardy Willsboro Wine Grape Cultivar Trial - Stage Two.**

Project Leader(s): Kevin Iungerman, CCE Northeast NY Commercial Fruit Program.

Collaborator(s): Grape Growers and Extension Associations of CCE's NENY Commercial Fruit Program (Albany, Clinton, Essex, Saratoga, Washington Counties). The Lake Champlain Grape Growers Association. The Cornell Willsboro Baker Farm. Steven Lerch, Cornell Grape Program, Geneva. Ben Gavitt, Cornell Wine Analytical Lab, Geneva.

Cooperating Producers: (Include a list of producers who participated in the project. List producers by county.)

County	Producer	Farm/Vineyard	City/Town	State
Albany	Mike DiCrescenzo	Altamont Vineyard	Altamont	NY
Clinton	Phil Favreau	Stone House Vineyard	Mooers	NY
Clinton	Richard Lamoy	Lamoy Vineyard	Morrisonville	NY
Clinton	Rob McDowell	Purple Gate Vineyard	Plattsburgh	NY
Essex	William & Kathryn Reinhardt	Blue Stone Vineyards	Willsboro	NY
Essex	Libby Treadwell	Bessboro Farm	Westport	NY
Saratoga	Michael Spiak	Kayaderosseras Vineyard	Greenfield Center	NY
Washington	Paul Dallemagne	Mountain View Winery	Cambridge	NY
Washington	Kenneth Denberg	Natural Selection Farm	Cambridge	NY
Washington	Andrew Farmer	Slyboro Cidery, Hicks Orchard and	Granville	NY
		Northeast Vine Supply	Poultney	VT
Orange	Ed Lincoln	Maple Gate Farm	Randolph	VT
Windsor	Robert Stevens	BowVineyard	Weathersfield	VT

Background:

The Willsboro Grape project succeeded in establishing a unique, 300-vine vineyard trial of 25 cold-hardy-wine-grape-cultivar prospects with the help of private and land-grant collaborators and also the NYFVI and NNADP funding assistance.

Planted in 2005, vine performance differences were extensive in the first year, not because of site or climate factors, but because of initial vine variability. These differences arose as a result of challenging procurement issues: the uniqueness of the vines; the many varied nurseries providing vines; the different planting forms available (bare root, softwood cuttings, grafts, plugs) and their requisite multiple planting dates; and delayed order placement stemming from uncertainty surrounding funding support and the cooperative consultative process of establishing the trial.

Despite these initial obstacles, the trial was put in place in record-time (comparable to similar evaluative trials) and in 2006; growth performance and vine pruning and training practices largely leveled initial differences. Small amounts of crop were carried to ensure that overall vine acclimation would not be compromised going into the 2006-2007 dormant period. Retained crop was utilized for purposes of identification, and also grower education and tasting.

Overall, vines were in very good condition in late fall of 2006, and it was hoped that typical winter conditions would afford a fair comparison of winter acclimation and subsequent growth and survival performance going into the 2007 growing season. Such was not the case. In point of fact, winter climatic factors since our 2005 planting have not provided sufficient stresses to evoke distinct adaptive plant responses. Contrary to expectations, virtually all of the grapes in the trial did quite well and virtually all of the cultivars produced fruit.

In 2007, differences in crop load and quality were noted, and these will serve as a basis of comparison in 2008 when more selective pruning practices (cluster thinning, cane placement and removal) will be carried out on the by then mature vines. Beginning in mid-August, weekly tasting and brix readings were initiated, and periodic juice sample evaluations also. These practices helped to establish a relative maturity sequence, which sets the stage for full cropping and finished wines during 2008.

The fall 2007 acclimation period was outstanding, superior to 2006, and indeed this was the case across all of NY. Once more, it is hoped that rather extreme - but historically normal - winter temperatures will occur over the 2007-2008 dormant season. Otherwise, mild winters may markedly undermine one major purpose of this trial, namely establishing the relative cold hardiness merits of the different vines being evaluated for our regional conditions.

Methods:

At several points in the spring, information on dormancy, bud break, cane growth, and cluster growth were noted across the different cultivars using the Eichorn-Lorenz Growth Stages format as guides. Vine mortality, and incidence of blank versus live buds was noted. These exercises provided an approximation of the relative mortality and overwintering outcomes for the different vines. Cane prunings weights were also collected on two replications in connection with dormant pruning, and this effort suggested their prior season vigor and growth as reflected by 2006 wood production.

Over the course of the growing season, these and all normal horticultural practices required to maintain the vines was carried out as follows: Eichorn-Lorenz Growth Stage evaluations: Iungerman. Basic vine tying, pruning, and training: researchers (i.e. Iungerman and Lerch) and volunteers. Cane pruning weights: Iungerman and Lerch. Vine health (pest, and growth condition monitoring, pesticide applications):Iungerman. Crop protection (bird netting): Researchers and volunteers. Grape maturity progression from mid-August into early September (weekly evaluation of veraison and brix): Iungerman, local grower Will Reinhardt. Harvest of grapes: Researchers and volunteers. Grape berry samples: Researchers and volunteers. Grape juice sample preparation and shipping: Iungerman. Juice sample analysis: Ben Gavitt, Cornell Wine Analysis Lab. Recording of data and preliminary summary: Iungerman.

Results:

The 2007 growing season did disclose comparative differences of harvest dates, field brix levels, yield, berry weights, and information about juice sample brix, ph, and titratable acidity values for most of the grapes in the trial. Because of costs, and coordination of volunteer labor, juice samples were not taken on all cultivars. A table summarizing this information is attached. (See the appended table: "Willsboro Wine Grape Trial - 2007. Preliminary Field Information".)

The information presented in the table is regarded as preliminary because final crop load management was not engaged in 2007, as full cropping was not intended, and relative harvest timing was still being worked out for the site. Both aspects are expected to impact final results overall when applied in 2008, Still, we can see that harvests began on September 8 and extended until September 29, and indications of Brix readings and fall conditions suggests some grapes could have hung longer. Yields, on the basis of 12 vines totals, suggest that productivity differences will be important, as they ranged from 15.6 to 186 kg. However, final grape quality, value for wine, and demand, will also play a final assessment role, particularly as more selective crop load management and maturity evaluation mediate results.

Conclusions/Outcomes/Impacts:

Though cumulative winters (2005-2006; 2006-2007) haven't leveled the field as much as was hoped, we are filling-in much of the information void that existed previously about hardy hybrid grapes in this region. We are thereby moving from anecdotal lore to much more credible information as it is based upon side-by-side comparisons of many cultivars grown at a single site right here in this region.

What's more, local and regional grape enthusiasts are not only learning about different grapes, they are learning more about vineyard management and wine making needs. Notably, the site and process are fully accessible. People are learning by seeing, doing, and tasting. A number of our volunteers - from Albany, Clinton, Essex, Saratoga, and Washington counties, and one person in Vermont - are conducting adjunct wine making trials with this season's production run-up to the 2008-cropping year.

Serendipitously, in 2007, we seem to have hit upon a novel way for dramatically reducing conventional weed control measures in young vineyards, and having participants regularly on the spot went a long way toward convincing folks of its utility.

Our weed control regimen involved a combination of raised-bed and the use of plastic mulch at planting, and alley mowing and weed-whipping missed edges. In 2007, we choose instead to arrest vegetation between the mulch and the mowed alley via a single roundup application when the vegetation edge was approximately 7- 15 inches high. Subsequent alley mowing discharges aided in toppling the killed grass over on to the mulch; there, together with the mower clippings, this comprised a further plant-based mulch atop the plastic, and so shaded the plastic, screening it from exposure to ultraviolet light and photo-degradation. The end result is that the preplant plastic from 2005 was still functioning as an effective weed control through 2007, and likely will into 2008. (See accompanying photo.)

Outreach:

Regular volunteers, and also particular-event sequence visitors, participated throughout the season via the "working" seminars, when we tackled spring pruning and training, and later, shoot positioning, tying, and then crop evaluation and maturity onset, the pre-emptive application of bird netting for crop protection, and finally the series of berry sampling in connection with harvest characterization, juice sample preparation, and finally, the series of different cultivar harvests.

After weighing of crop, each harvest was divided among the volunteers, and seven cooperators planned to make wine from the grapes for a follow-up tasting and evaluation session to be announced early in 2008. In all, eleven group "working" seminar sessions were coordinated in support of both the trial and in support of viticulture skill development, and in generally responding to participant questions regarding the activity, or more broadly related questions. Thirteen cooperator volunteers formed the backbone for the "working seminars", and another 18 persons attended and assisted at various times.

Separately, the Statewide Extension Viticulture Program inaugurated a series of telecom distance-learning sessions for winemaking in June and July of 2007. One successfully registered class was in Westport, Essex County, and it was nearly exclusively composed of volunteers with the Willsboro Wine Grape Trial. The information broadened the interest and support for allied educational and cooperative ventures.

Early in 2008, a follow-up planning meeting is envisioned to look ahead to 2008 needs and supportive programming, including education, demonstration, and vineyard and winery visits. We will also gather the "adjunct" wines and wine makers together for a review and taste of the 2007 season - and its winemaking legacy.

Next steps if results suggest continued work is needed in the areas of research, demonstration and/or education.

Next year we will shift to more rigorous crop and cluster care in anticipation of the finished wines to be made under the auspices of the Cornell Wine Lab. Minimally, the Wine Lab will make five finished wines. Additionally, as in 2007, but more extensively, local and regional wine makers will also make wine from the 2008 harvest. The project was been fortunate to have had the support of a half-dozen stalwart volunteers, particularly over the course of numerous weekend afternoons during the harvests of September and October 2007. We will work to continue this partnership.

All of the efforts as included in the "Measures" section above will be repeated in 2008, so that cumulative findings can provide base-line information profiles for the different cultivars over the course of this trial. This information will pertain to flowering onset, berry and cluster formation incidence, and maturity and yield component indices (via limited, sequenced weekly berry sampling and development evaluation in August and September). The hiring of an on-site, part-time seasonal assistant in 2008 will greatly enhance this task in 2008. It will also allow the project leader to expand and coordinate related on- and off-site learning activities supportive of further viticultural practices skill development.

All of this cumulative information will be available for correlation with degree-day and weather records, and contrasting observations on bud break and survival, vigor, and other measures.

Acknowledgments: (Project sponsors/funders; including Cornell sources, like the CUAES, as well as external sponsors.

In closing, my thanks once again, to Steve Lerch, Cornell Grape Program, Geneva; Mike Davis and the Cornell Willsboro Baker Farm Staff; the Lake Champlain Grape Growers Association, volunteers Richard LaMoy, Rob McDowell, Mike Spiak, and a number of others; and Anita Deming, CCE Essex County; who have assisted me in carrying out this year's work at the Willsboro Trial. Thanks too, to the Growers and CCE Extension Associations of CCE’s NENY Commercial Fruit Program; CCE; and the Northern New York Agricultural Development Program, who provided the funding support allowing this work to be undertaken.

Reports and/or articles in which the results of this project have already been published. (Include department publications, handouts at CCE inservice, popular farm press etc.)

Iungerman's report to the CORNELL RECENT ADVANCES IN VITICULTURE AND ENOLOGY (CRAVE) CONFERENCE. 2007 PROGRAM THEME: “THIS IS WHAT I DO”. November 15, 2007, Cornell Cooperative Extension Ag Inservice, Ramada Inn, Ithaca, NY.

Article in Adirondack Life, September 2007, by Ham Davis, about wine grapes in the Adirondacks, which included information on the Willsboro Trial.

Person(s) to contact for more information (including farmers who have participated: (Include US postal addresses, phone numbers email addresses and/or web sites if applicable.)

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Rob McDowell	Purple Gate Vineyard	Plattsburgh,NY	redwine@charter.net
William & Kathryn Reinhardt	Blue Stone Vineyards	Willsboro, NY	willkath@willex.com
Libby Treadwell	Bessboro Farm	Westport, NY	Momandabe@aol.com
Michael Spiak	Kayaderosseras Vineyard	Greenfield Center, NY	spiaker@yahoo.com
Paul Dallemagne	Mountain View Winery	Cambridge, NY	boogernfo@msn.com
Kenneth Denberg	Natural Selection Farm	Cambridge, NY	krdenberg@logical.net
Ed Lincoln	Maple Gate Farm	Randolph, VT	hvacr@sover.net
Robert Stevens	BowVineyard	Weathersfield, VT	rasteve@comcast.net
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Peter Rowley	Edgewater Farm	Willsboro, NY	ewfarm38@airmail.net
Janice & Mark Stainken		Willsboro, NY	JS@Voitra.com

Willsboro Wine Grape Trial - 2007. Preliminary Field Information									
	Grape Cultivars	Harvest Dates	Brix (Near Harvest)	Yield (kg)	Berry weights (g)	Juice Sample Results Brix • pH • TA/ g/L		
1	Baco	10/13/07	19.0 b	91.1	1.11 j	20.2 h	2.91	19.00
2	Cayuga White	9/29/07	15.5 b	59.3	2.36 j	17.0 h	2.81	11.40
3	Edelweiss	9/14/07	16.0 a	133.8	-	14.9 e	3.10	6.50
4	ES 6 - 16 - 30	9/14/07	13.5 a	78.7	2.45 k	18.4 e	3.00	8.80
5	Foch	9/14/07	21.0 a	61.3	0.97 k	20.3 e	2.97	13.60
6	Frontenac	9/29/07	20.2 b	100.4	1.19 j	22.2 g	3.04	14.50
7	Frontenac Gris	9/29/07	19.5 a	97.2	-	-	-	-
8	GR7	9/29/07	19.5 b	102.1	1.13 j	21.7 g	3.11	9.73
9	LaCrescent	9/14/07	16.0 c	58	1.10 k	21.9 e	2.93	15.80
10	LaCrosse	10/13/07	17.0 b	69.9	1.47 j	18.6 f	2.84	11.70
11	Landot	9/29/07	18.0 b	19.4	1.76 j	20.7 g	3.01	9.54
12	Leon Millot	10/14/07	18.0 c	109.4	-	22.5 i	3.15	na
13	Louise Swenson	9/29/07	17.0 b	77.8	2.19 j	18.4 g	3.15	6.69
14	Marquette	9/14/07	20.0 b	55.2	1.66 k	20.8 e	2.97	14.10
15	MN 1200	9/8/07	23.0 a	31.2	0.77	23.3 d	3.05	10.80
16	Niagara	9/29/07	17.2 a	186.0	-	-	-	-
17	Noiret	9/22/07	17.4 b	57.6	1.37 j	17.7 f	2.81	13.90
18	NY 76.844.24	9/29/07	16.8 b	73.1	1.50 j	20.8 g	2.83	9.60
19	Petiteamie	9/29/07	18.0 b	15.6	2.00 j	18.1 f	2.95	9.90
20	Prairie Star	9/29/07	18.5 b	91.5	1.34 j	21.7 g	3.36	8.12
21	"Unknown"	10/13/07	11.5 a	80.2	-	-	-	-
22	Sabrevois	9/14/07	17.5 a	73.5	1.86 k	17.1 e	2.78	13.50
23	St Croix	9/29/07	17.0 b	86.1	1.80 j	18.6 f	3.14	7.02
24	St. Pepin	9/14/07	22.0 a	46.6	1.67 k	20.2 e	2.92	12.90
25	Vignoles	Nov ?	19.5 b	nya	1.39 j	19.9 f	2.82	17.10

NOTES: **Brix readings** are relative to harvest date as follow: a) 9/6/07. b) 9/22/07. c) Brix of 8/31/07 use, as it, and reading at harvest indicated likely sampling error on 9/7/07. **Juice sample values** are related to harvest dates as follows: d) 9/8/07. e) 9/14/07. f) 9/22/07. g) 9/29/079. h) Indicates the final juice values were unavailable at this writing. Juice sample values of 9.22.07 are presented as interim guidance. i) These single results are derived from field determination by a cooperator rather than through the Cornell wine lab test. **Berry Weights**: j) Indicates weights derived on 9/22/07. k) Weights from 9/14/07.Other: "nya" means not yet available. "- ' Indicates juice samples were not taken. Prepared by K. Iungerman, CCE NE NY Fruit Program, 10/18/2007.