



## Northern NY Agricultural Development Program 2013 Project Report

### Winter-Forage Small Grains to Boost Feed Supply: Not Just a Cover Crop Anymore!

#### **Project Leader:**

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- NY On-Farm Research Partnership:  
<http://nmsp.cals.cornell.edu/NYOnFarmResearchPartnership/index.html>

#### **Collaborators:**

- Joe Lawrence, Lowville Farmers Co-op, Lewis County
- Mike Hunter, Cornell Cooperative Extension of Jefferson and Lewis County)
- Peter Barney, Barney Agricultural Consulting, St Lawrence County
- Eric Bever and Mike Contessa, Champlain Valley Agronomics, Eastern NNY
- Cornell collaborators include Jerry Cherney (Crop and Soil Sciences), Karl Czymmek (Animal Science; PRODAIRY), Greg Godwin, Shona Ort and Sheryl Swink (NMSP)

#### **Cooperating Producers:**

- Clinton County: B.C.S. Farms and Happy Haven Farm
- Lewis County: Grace-Way Farm and Thunder Lane Dairy
- Jefferson County: Plessis Farm and Sheland Farm
- St. Lawrence County: Brandy View Farm and Chambers Farms, LLC
- Non-NNY sites funded by Federal Formula Funds and USDA Conservation Innovation Grant for the Upper Susquehanna Watershed: Chemung County: USDA NRCS Big Flats Plant Material Center. Columbia County: Cornell Valatie Research Farm. Cortland County: East River Dairy and Cornell University Ruminant Center (CURC; formerly known as the Cornell Teaching and Research Center). Delaware County: Hanselman Farm. Genesee County: Branton Farm, Hy Hope Dairy, Stein Farms, LLC. Livingston County: Edgewood Farms, LLC, Thornapple Farm, Gary Swede Farms Inc. Madison County: Chris Hughes, White Eagle Farms. Oneida County: Pritchard Farm. Ontario County: Lightland Farms, Will-O-Crest Farm. Orleans County: Darryl Sommerfeldt, Mike and Cindy Van Lieshout. Rensselaer County: Swartz Dairy and Produce. Steuben County: Karr Dairy Farms, Lincoln Crest Dairy, Schumacher Dairy Ops, LLC, C.K. Slayton,

LLC. Tioga County: AA Dairy. Tompkins County: Cornell University Ruminant Center (CURC; formerly Cornell Teaching and Research Center). Wyoming County: Breezy Hill Dairy, Gary Swede Farms Inc. Van Slyke's Dairy Farm, LLC. Yates County: Horst Dairy Farm.

## **Background**

### *Part 1: On-farm Nitrogen Response Trials*

Due to the challenging weather conditions of the 2012 growing season, many northern NY dairies needed to rebuild forage inventory going into 2013. The data from the fall of 2011 and spring of 2012 show that when properly managed, these winter cereals can supply 2-4 tons of dry matter per acre even with little growth in the fall. However, questions remain related to N management of such a double crop.

This project was based on a main question identified by Northern NY farmers and researchers alike: how much fertilizer N is needed at green-up to grow high yielding and high quality winter cereals for forage, for fields with and fields without a manure application history (fall application). Data from a 2011-2012 study conducted at the Valatie Research Farm in eastern NY suggested the application of N at green-up contributed to higher forage yields for both wheat and triticale. Fields with a manure history and manure applied shortly after the planting of the winter cereal are not expected to need any starter fertilizer, but the data suggest that for optimum yield, the crop might need some additional N when dormancy breaks in the spring. Farmer practices to apply 50-100 pounds of actual N seem to work well, but no data were available to conclude how much N is needed at green-up for either manured or non-manured fields.

We proposed to conduct this research through on-farm trials in the spring of 2013 and to continue in 2014.

### *Part 2: Lewis County Demonstration Trial and Field Day*

In the fall of 2011, cover cropped fields were sampled in Northern New York as part of a NNYADP funded project (part 1), and statewide with additional federal formula funds. This sampling round generated data from 20 NNY fields and 42 fields from other regions in the state. Most of these fields were resampled for spring biomass at cover crop termination or at forage harvest time (part 2). Species selection depended on local conditions, but included triticale, cereal rye, and/or wheat, the three major overwintering cover crops. The fall uptake of 20-30 lbs N/acre was consistent with previous data collected in the fall of 2010, statewide, for various different species, including oats, barley and tillage radishes. However, no side by side comparisons of species were done.

We conducted a fully replicated trial (4x) at Thunder Lane Dairy in Castorland, Lewis County, in September of 2012 comparing fall biomass and N accumulation of three species (radishes, oats, and cereal rye).

## **Materials and Methods**

### *Part 1: On-farm Nitrogen Response Trials*

In spring 2013, we conducted N rate studies on 45 double crop fields including eight cereal rye fields, 33 triticale fields and four wheat fields. Of the 45 trials, eight were located in Northern New York. The selection of sites was determined by collaborators and interest of the producers.

Sites were 65 by 80 feet with 4 replications of 5 different N fertilizer rates (0, 30, 60, 90, and 120 lbs of N/acre) applied at time of green-up. Soil samples were taken prior to fertilizer application. The soil samples were then dried, ground, and analyzed for general fertility. In May, above ground biomass was sampled by taking 3 frames (8 by 38.5 inch) at a height of 4 inches from each plot. Above ground biomass was dried and weighed to determine biomass yields (tons/acre) before being ground and analyzed for C, N, and forage quality. Optimum N rates, based on achieving optimum economic yield, were then determined for each of the sites.

### *Part 2: Lewis County Demonstration Trial and Field Day*

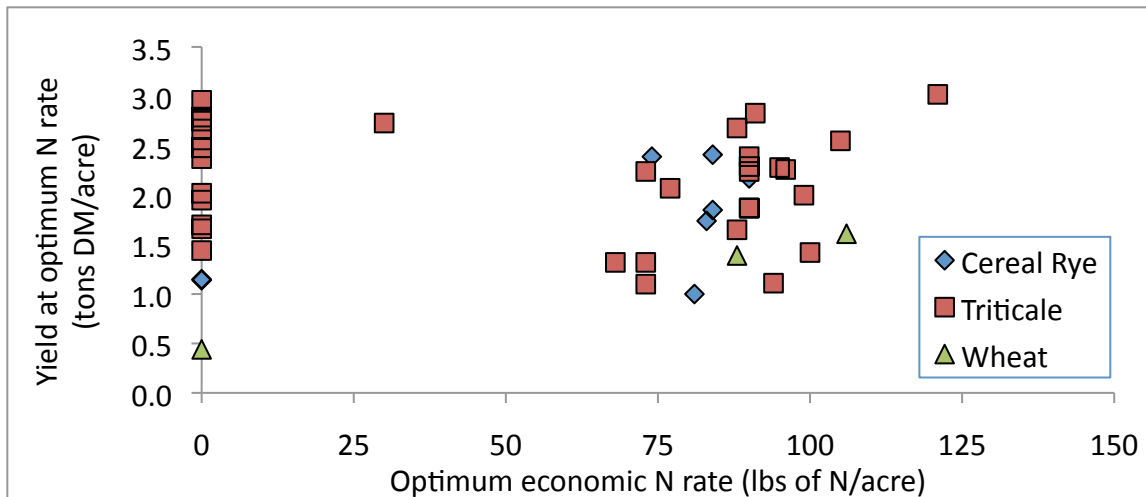
The trial was conducted at Thunder Lane Dairy, Lewis County. Cereal rye, oats, and tillage radishes were seeded in 9/17/2012. Fall above and below ground biomass samples were taken on 11/11/12. Cover crops were uprooted so that both above and below ground biomass could be determined. Samples were then washed to remove soil and root and shoot portions were separated, dried, weighed to determine DM. Biomass subsamples were then ground, and analyzed for C and N content.

## **Results**

### *Part 1: On-farm Nitrogen Response Trials*

#### Yields and optimum N rate:

Optimum N rates ranged from 0-120 lbs N/acre (Figure 1). The average yield across all 45 sites was 2.00 tons DM/acre. Overall, 30% of all sites showed no yield benefits to N addition (where the optimum N rate was zero) and 44% of all sites had an optimum N rate between 75 and 100 lbs N/acre (Figure 1). The optimal N rates for Northern NY sites ranged from 0 to 88 lbs N/acre while yields at optimum N rates ranged from 1.11 to 2.73 tons DM/acre, averaging 1.76 tons DM/acre across the sites (Table 1).



**Figure 1: Forage yield (tons DM/acre) at optimum N by optimum economic N rate (lbs of N/acre) for cereal rye, wheat, and triticale sites across NY in the 2013 double crop study. Yield at optimum N rate was determined at a price of \$0.50 per lb of N and \$250 per ton of forage.**

**Table 1: Yields at each N rate, optimal N rate, and yield at optimal N rate for each Northern NY site in the 2013 double crop study.**

County	Site	Crop	Yield					Optimum N rate	Yield at optimum N rate
			N application rate						
			0	30	60	90	120	Lbs/acre	Tons/acre
Tons dry matter/acre									
St. Lawrence	1	Triticale	1.47	1.76	1.61	1.77	1.70	1.66	
St. Lawrence	2	Triticale	2.09	2.65	2.79	2.57	2.89	2.73	
Clinton	3	Cereal rye	1.25	1.47	1.67	1.75	1.77	1.75	
Clinton	4	Cereal rye	1.17	1.04	1.22	1.13	1.16	1.14	
Jefferson	5	Triticale	1.59	1.92	2.40	2.16	2.19	2.25	
Jefferson	6	Triticale	0.53	0.85	1.05	1.14	1.04	1.11	
Lewis	7	Triticale	1.52	1.66	1.73	1.92	1.71	1.70	

Yield at optimum N rate was determined at a price of \$0.50 per lb of N and \$250 per ton of forage.

These results show that both low and high yields can be obtained under Northern NY growing conditions. Of the seven sites, three had an optimal N rate of 0 lbs N/acre (i.e. did not respond to N fertilizer addition), while another three needed 75-100 lbs N/acre for optimum economic yield. For the highest yielding triticale site the optimum N rate was 30 lbs N/acre. Various field characteristics such as soil fertility, planting date, and manure history could possibly explain the variation in yields and optimal N rates. Further evaluation of the dataset is ongoing.

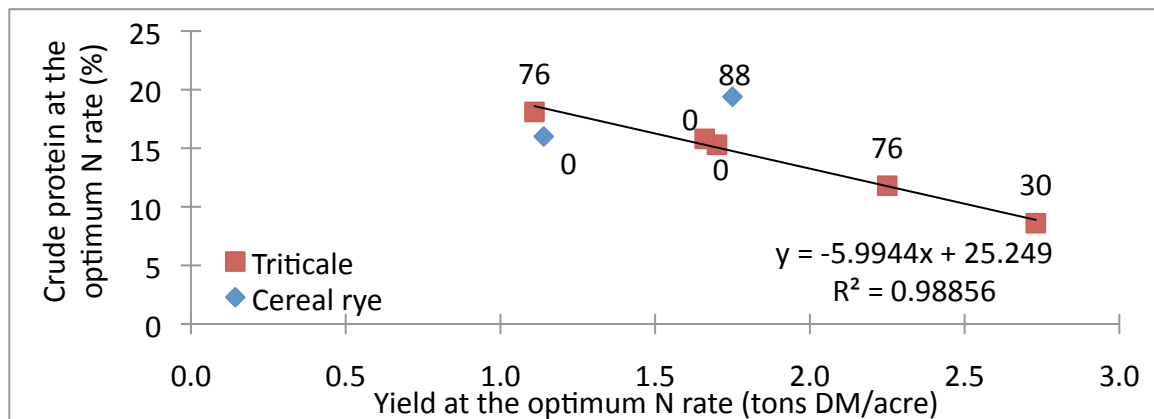
Forage quality:

Crude protein (CP) content of the double crop forage increased with increasing fertilizer N addition; from 8.6 to 18.1% for Northern NY sites, comparable to 12-13% CP without

N addition to 18-20% with the highest N rates statewide. However, CP levels without N addition showed a wide range among sites, from a low of 7.5% to a high of 19% CP (statewide), showing that fertilizer N is not necessarily needed to increase CP to desirable levels. The CP content at the optimum N rate decreased with yield (Figure 2). All other forage parameters were not significantly altered with N application, but did vary among sites as indicated below in the Northern NY subset (Table 2).

**Table 2: Crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), in vitro digestion (IVTD), and neutral detergent fiber digestibility (NDFD) content of double crop forage (harvested at flag leaf stage) at optimal N rate for Northern NY sites in the 2013 double crop study.**

County	Site	Species	CP	NDF	ADF	IVTD	NDFD
			% DM	% DM	% DM	% DM	% NDF
St. Lawrence	1	Triticale	8	56.1	30.6	85.0	73.3
St. Lawrence	2	Triticale	8	58.1	34.6	80.8	66.9
Clinton	3	Cereal rye	4	52.5	28.9	86.6	74.5
Clinton	4	Cereal rye	0	51.1	25.5	90.9	81.5
Jefferson	5	Triticale	1	49.3	25.8	89.0	77.8
Jefferson	6	Triticale	3	48.2	24.6	90.5	80.2
Lewis	7	Triticale	8	48.2	26.3	90.5	80.2



**Figure 2: Crude protein levels of triticale and cereal rye at the optimum economic N rate as a function of the yield at that same optimum economic N rate for the different Northern NY sites. Numbers listed with datapoints are the optimum N rates in lbs N/acre.**

Soil fertility:

Soil fertility did not differ among plots within a site, but fertility did vary greatly among sites across the state. Northern NY sites had similar soil pH, but there was large variation in the other soil fertility parameters (Table 3 and 4). The impact of these soil parameters, as well as others, on yields and optimal N rates are currently being investigated.

**Table 3: Soil type, soil pH, phosphorus (P), potassium (K), and organic matter (OM) for each Northern NY sites in the 2013 double crop study. Sampling depth was 8 inches.**

County	Site	Soil Type	Soil pH	Cornell Morgan P		Cornell Morgan K		OM
					lbs/acre	lbs/acre	%	
St. Lawrence	1	Swanton	6.2	5	Medium	196	Very high	3.8
St. Lawrence	2	Hogansburg	6.5	53	Very high	212	Very high	4.1
Clinton	3	Shaker	6.3	8	Medium	83	Medium	2.1
Clinton	4	Hailesboro	6.9	45	Very high	343	Very high	5.8
Jefferson	5	Kingsbury	6.6	129	Very high	860	Very high	5.5
Jefferson	6	Hinckley	6.8	4	Medium	135	High	3.7
Lewis	7	Nellis	6.6	12	High	169	Very high	6.3

**Table 4: Illinois soil nitrogen test (ISNT), critical ISNT, soil nitrate- and nitrite-N(NO<sub>3</sub>-N and NO<sub>2</sub>-N) and ammonium-N(NH<sub>4</sub>-N) contents for Northern NY sites in the 2013 double crop study. Sampling depth was 8 inches.**

County	Site	ISNT	Critical ISNT	ISNT Interpretation	NO <sub>3</sub> -N and NO <sub>2</sub> -N	NH <sub>4</sub> -N
		ppm			ppm	ppm
St. Lawrence	1	314	306	Marginal	3.7	31.2
St. Lawrence	2	381	308	Optimal	4.9	27.6
Clinton	3	205	246	Low	3.5	23.3
Clinton	4	394	332	Optimal	9.1	23.3
Jefferson	5	429	331	Optimal	6.3	27.3
Jefferson	6	289	297	Marginal	2.4	25.2
Lewis	7	532	335	Optimal	8.0	22.6

*Part 2: Lewis County Demonstration Trials and Field Day*

Radishes had the greatest root, shoot, and total biomass accumulation among the three species, whereas oats and cereal rye did not differ in biomass accumulation (Table 5). Nitrogen accumulation by radishes averaged 28 lbs N/acre versus 17 lbs/acre for cereal rye and 11 lbs N/acre for oats. These N accumulation values are consistent with studies in the previous two years that showed an N accumulation of 20-30 lbs N/acre for cover crops seeded after corn silage. Radishes winterkill so N accumulation will not increase beyond what was measured in this study. Similarly, oats typically winterkill in Northern NY winters. In contrast, cereal rye will overwinter and accumulate additional biomass in the spring, typically averaging about 1.5 times the total amount of N accumulated in the fall.

**Table 5: Biomass (tons/acre), percent carbon (C), percent nitrogen (N), carbon to nitrogen to carbon ratio (C:N), total C accumulation (lbs/acre), and total N accumulation (lbs/acre) for root, shoot, and total portion of radish, oats, and cereal rye sampled 11/11/2012 at Thunder Lane Dairy in Lewis County, NY.**

	Biomass	C	N	C:N	Total C	Total N
	tons/acre	%	%	.	lbs/acre	lbs/acre
Roots						
Radish	0.0452 a	36.4 b	3.7 a	9.8 c	33.0 a	3.3 a
Oats	0.0231 b	41.1 a	2.2 c	18.7 a	19.0 ab	1.0 b
Cereal rye	0.0201 b	40.3 a	2.7 b	14.8 b	16.2 b	1.1 b
p-value	0.0262	<0.0001	<0.0001	<0.0001	0.0446	0.0010
Shoots						
Radish	0.2699 a	33.2 b	4.6 a	7.4 b	90.6 a	24.4 a
Oats	0.1032 b	40.3 a	4.6 a	8.7 a	41.6 b	9.5 b
Cereal rye	0.1549 b	40.4 a	5.2 a	7.8 b	62.5 ab	16.1 ab
p-value	0.0107	0.0074	0.1826	0.0136	0.0461	0.0142
Total						
Radish	0.3151 a	.	.	.	123.6 a	27.8 a
Oats	0.1263 b	.	.	.	60.6 b	10.5 b
Cereal rye	0.1750 b	.	.	.	78.7 ab	17.2 ab
p-value	0.0124	.	.	.	0.0488	0.0113

\* This trial was planted 9/17/2012.

### **Conclusions/Outcomes/Impacts:**

#### *Part 1: On-farm Nitrogen Response Trials*

The forage yields of doubles crops were 2.00 and 1.76 tons/acre for the statewide study and Northern NY portion of the study, respectfully. Optimal N rates across all site ranged from 0 to 120 lbs of N/acre. In Northern NY, three out of seven locations did not show a yield response to N addition while another three locations needed 75-100 lbs N/acre to reach optimum yield. Crude protein levels increased with increasing N fertilizer rates, with no or inconsistent impact of N rate on all other forage quality parameters that were measured in the study. Additional work is ongoing to determine what factors (planting date, manure history, soil types, etc.) could explain the differences in yield, crude protein content and optimum N rates across sites. More sites are planned to be added to this dataset in 2014.

#### *Part 2: Lewis County Demonstration Trial and Field Day*

In this study, radishes accumulated the most biomass and total N but averaged only 27 lbs N/acre when a hard frost occurred. Uptake of N for cereal rye averaged 17 lbs N/acre versus 11 lbs/acre for oats. These total N uptake values are similar to what was reported for various cover species in previous years (20-30 lbs N/acre). Because neither radishes nor oats overwinter, cereal rye is a better choice if the goal is to accumulate biomass and cereal rye will accumulate biomass in the spring once the soils start warming up, and likely exceed the fall N accumulation of radishes and oats.

## **Outreach:**

Website (part of the NY On-Farm Research Partnership):

1. <http://nmsp.cals.cornell.edu/NYOnFarmResearchPartnership/CoverCrops.html>.
2. <http://nmsp.cals.cornell.edu/NYOnFarmResearchPartnership/DoubleCrops.html>.

Impact Statements, written by Lisa Fields:

1. Crop advisor's collaboration with NMSP promotes double cropping in Northern New York. Nutrient Management Spear Program, Animal Science, Cornell.  
<http://nmsp.cals.cornell.edu/publications/impactstatements/EricBeaverDoubleCrops.pdf>
2. Grazing specialist teams up with NMSP for double crop study at Schumacher Dairy-Ops. Nutrient Management Spear Program, Animal Science, Cornell.  
<http://nmsp.cals.cornell.edu/publications/impactstatements/JonathanBarterDoubleCrops.pdf>
3. Crop advisor explores double crop concept with NMSP nitrogen rate study at AA Dairy. Nutrient Management Spear Program, Animal Science, Cornell.  
<http://nmsp.cals.cornell.edu/publications/impactstatements/JeffWilliardDoubleCrops.pdf>
4. Northern NY crop advisor and NMSP initiate double crop field research. Nutrient Management Spear Program. Animal Science, Cornell.  
<http://nmsp.cals.cornell.edu/publications/impactstatements/PeterBarneyDoubleCrops.pdf>
5. Oneida county extension specialist explores double-cropping with NMSP field study. Nutrient Management Spear Program, Animal Science, Cornell.  
<http://nmsp.cals.cornell.edu/publications/impactstatements/JeffMillerDoubleCrops.pdf>
6. New field crops specialist dives into collaborative double-cropping research with NMSP. Nutrient Management Spear Program, Animal Science, Cornell.  
<http://nmsp.cals.cornell.edu/publications/impactstatements/BillVerbetenDoubleCrops.pdf>

Oral presentations:

1. Ketterings, Q.M., S. Ort, B. Verbeten, T. Kilcer, G. Godwin, and S. Swink (2014). Managing nitrogen for winter cereals grown as double crops for forage. Northern New York Crop Congress. Miner Institute and Canton, February 18 and 19, 2014. 1 hour. ~100 people.
2. Ketterings, Q.M., S. Ort, and B. Verbeten (2013). Winter cereals as double crops in corn rotations. Experiences from the 2013 growing season. Field Crop Dealer Meetings, December 12, 2013. Syracuse, NY. 40 min. ~60 people.
3. Ketterings, Q.M., S. Ort, and B. Verbeten (2013). Managing nitrogen for winter cereals grown as double crop for forage. Northeast Region Certified Crop Advisor Annual Training. Advanced Training. December 5, 2013. Syracuse, NY. 50 min. 42 people.
4. Ketterings, Q.M. and team (2013). Nutrient management update. 2013 Agricultural Inservice. Ithaca, NY. November 19, 2013. 2 hours. ~20 people.



5. Ketterings, Q.M. (2013). Winter-forage small grains to boost feed supply: from cover crop to double crop. Big Flats Plant Material Center 5<sup>th</sup> Annual Cover Crop Workshop. Big Flats, NY, November 14, 2013. 45 min. ~130 people.

A field day was held in Lewis County at Thunder Lane Dairy, Castorland, on October 24<sup>th</sup> 2012 where three crops had been planted (cereal rye, oats, and tillage radishes). Focus of the field day was benefits and challenges to growing cover crops and their adaptability to Northern New York. Results of the double crop project will be presented at the 2014 Crop Congress on February 18 in Chazy and February 19 in Canton, NY.

### **Next steps**

*Part 1: On-farm trials:* We aim to work with four additional farms to determine yield of winter cereals as impacted by N application rate at spring green-up for a variety of soil types, expanding the database to include 11 farms in the Northern New York counties. The sites in this study will be setup and harvest by the same protocols of the 2013 study. Yield data will be analyzed to determine the economic optimum N rate for each location individually and for all locations collectively (combining 2013 and 2014 data).

*Part 2: Economic analyses:* Producers are interested in answering two questions: (1) What are the expected changes in profit associated with incorporating double crops into cropping systems?, and (2) what expected yield levels ensure that adoption of double crops will be a profitable change for farms, and for the northern region of New York State? Project team members will work with cooperating producers to develop partial budget analyses to estimate the expected changes in profit attributed to double cropping, including sensitivity analyses for key factors. Enterprise budgets that provide costs and returns for growing double crops in corn silage rotations will provide needed data for the partial budget analyses.

*Part 3: Forage quality:* Additional analyses are needed to fully evaluate the quality of winter grain forage. The proposed work includes more detailed digestibility analyses for all seven 2013 trials and the proposed 4 additional trials in 2013, plus the evaluation of double crops for dairy cattle diets. Results will be included in the economic analyses. All the findings for a site will then be summarized in individual field reports. Overall results will also be summarized and distributed through extension articles, factsheets, and field day presentations.

### **Acknowledgments:**

We received additional funding from USDA (Conservation Innovation Grant for the Upper Susquehanna Watershed) and Federal Formula Funds, allowing us to develop a statewide research program (including all farms listed) and compare results from various regions of the state. We thank all our collaborators on the project.

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

Project websites (includes protocols)

1. <http://nmsp.cals.cornell.edu/NYOnFarmResearchPartnership/DoubleCrops.html>
2. <http://nmsp.cals.cornell.edu/NYOnFarmResearchPartnership/CoverCrops.html>

## Impact Statements

1. Crop advisor's collaboration with NMSP promotes double cropping in Northern New York. Nutrient Management Spear Program, Animal Science, Cornell.  
<http://nmsp.cals.cornell.edu/publications/impactstatements/EricBeaverDoubleCrops.pdf>.
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6. New field crops specialist dives into collaborative double-cropping research with NMSP. Nutrient Management Spear Program, Animal Science, Cornell.  
<http://nmsp.cals.cornell.edu/publications/impactstatements/BillVerbetenDoubleCrops.pdf>

### **Person(s) to contact for more information (including farmers who have**

**participated:** Quirine M. Ketterings, Professor, Cornell Nutrient Management Spear Program (NMSP), Department of Animal Science, Cornell University. Email: [Qmk2@cornell.edu](mailto:Qmk2@cornell.edu). Phone: 607-255-3061. Project websites:

1. <http://nmsp.cals.cornell.edu/NYOnFarmResearchPartnership/CoverCrops.html>
2. <http://nmsp.cals.cornell.edu/NYOnFarmResearchPartnership/DoubleCrops.html>.

**Photos**



A nitrogen response trial in a rye field on B.C.S. Farm, Clinton County, 4/19/2013.  
(Photo credit: Champlain Valley Agronomics).





Nitrogen response trial with triticale in Lewis County (Photo credit Joe Lawrence).



Pete Barney setting-up a nitrogen response trial in a triticale field on Brandy View Farm, St. Lawrence County, 4/23/2013 (Photo credit: Nutrient Management Spear Program).



Heather Robison of Champlain Valley Agronomics harvesting cereal rye forage in a nitrogen response trial at Happy Haven Farm, Clinton County, 5/14/2013. (Photo credit Nutrient Management Spear Program).



Nitrogen response trial with cereal rye at Happy Haven Farm, Clinton County, 5/14/2013. (Photo credit: Nutrient Management Spear Program).





Shona Ort and Pete Barney taking notes of the triticale in the nitrogen response trial at Brandy View Farm, St. Lawrence County, 5/29/2013 (Photo credit Nutrient Management Spear Program).



Oats seeded (September 17<sup>th</sup>, 2012) after corn silage at Thunder Lane Dairy in Castorland, NY. Picture taken November 11<sup>th</sup>, 2012 (Photo credit: Joe Lawrence).



Cereal rye seeded after corn silage (September 17<sup>th</sup>, 2012) at Thunder Lane Dairy in Castorland, NY. Picture taken November 11<sup>th</sup>, 2012 (Photo credit: Joe Lawrence).





Tillage radishes seeded after corn silage (September 17<sup>th</sup>, 2012) at Thunder Lane Dairy in Castorland, NY. Picture taken November 11<sup>th</sup>, 2012 (Photo credit: Joe Lawrence).