Can Manure Replace the Need for Starter Nitrogen Fertilizer?

2009 and 2010 Results

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Background

Initial studies at a Western NY dairy farm suggested that for corn fields with a recent manure history, starter nitrogen (N) fertilizer may be eliminated without a penalty in yield or forage quality. Eliminating starter N on corn fields with a manure history has the potential to save NY dairy producers both time and money. In 2009, we initiated a 3-yr statewide project to test the need for starter N fertilizer across NY soil types and growing conditions. The objectives of this study are to assess differences in yield and forage quality between corn receiving starter N fertilizer and corn that receives none on fields with varying manure history.

Materials and Methods

In 2009, seven trials were completed, including three trials at commercial farms and four at the Aurora Research Farm (Sites 1 through 7). In 2010, starter N response trials were established at ten commercial farm locations, including the W.H. Miner Institute, and at the Aurora Research Farm where the starter N trial was superimposed on an existing experiment on manure application methods that included four different manure histories (Sites 8-21). The field history data and initial soil fertility data are shown in Tables 1 and 2, respectively. Monthly temperature and rainfall are shown in Table 3. Phosphorus (P) and magnesium (Mg) were high at all of the sites. Potassium (K) was high in all but two of the sites (one tested low and one tested medium). Seven of the 21 sites tested sufficient in Illinois Soil Nitrogen Test-N (ISNT-N), meaning that they were predicted to have enough readily mineralizable soil organic N to make them nonresponsive to additional fertilizer N, given favorable soil mineralization conditions. Farm Sites 8, 15, and 16 and Sites 9-12 (the plots at the Aurora Research Farm) showed potential for N deficiency according to the ISNT results. The Aurora plots received sidedress N (120 lbs N/acre).

The corn trials were conducted using 30-inch rows and replicated four (Sites 13–21), five (Site 8), or six (Sites 9-12) times. Plots were 6 to 8 rows wide (depending on planter width) and 100 to 300-ft long. At each location, plots receiving 30 lbs of starter N per acre at the onset of the trial were compared to those receiving none. Plots were sampled for presidedress nitrate test (PSNT), ISNT-N, end-of-season Corn Stalk Nitrate Test (CSNT), end-of-season soil nitrate test (0-12 inches), corn yield, and forage quality if harvested for silage. The various soil tests were taken at sidedress and harvest time.

Results

In 2009, Site 1 had planter problems resulting in significant differences in stand density. The yields were not significantly different and the larger variability was most likely a result of the planter malfunctioning. When population density was taken into account, the yield differences were non-existent (results not shown). At Site 2, there was no significant difference between the with and without starter treatments, but saturated soil conditions prevented the harvest and collection of yield data from two of the four plots that received no starter, reducing the statistical power of the comparison. At site 3, elimination of the starter did not impact yields either. Sites 4, 5, 6, and 7 were all located at the Aurora Research Farm on somewhat poorly drained soils. The wet spring caused drainage problems that impacted yield and caused irregular stands in all of the treatments (Table 4). Of these four Sites, Site 5 was the only location where a statistically significant yield response was measured. At this Site, 8,000 gallons of manure had been spring-applied and chisel-incorporated for the past five years (no manure history prior to the first applications in 2005). Although similar trends of higher yield in the starter plots were seen for Site 6 (no manure) and Site 7 where 8,000 gallons/acre of manure had been surface-applied and not incorporated, the means were not statistically different. At Site 4, which received 8,000 gallons/acre of manure via an aerator, there were no significant differences in yield.

In 2010, the only locations that showed a yield increase with starter N application were the plots at the Aurora Research Farm with a limited manure history, and the plots in Jefferson County (Site 18) where the stand density was less than 25,000 plants/acre and yields were very low due to excessive bird damage. At all other sites, the use of starter N did not result in a significant yield response, despite visual differences in early growth stages at some locations.

There were 13 silage trials in the dataset and 8 grain trials. Of the silage trials, two locations showed a significant increase in crude protein with starter N addition. Soluble protein increased at one location, although the difference was very small (an increase of 0.1% in soluble protein) and decreased at one site (Site 18, the location with heavy bird damage). The difference at location 18 could have resulted from disparities in bird damage. Only one site showed a change in NDF (decrease, Site 21) or NDF digestibility (increase, Site 2) with starter N addition. Lignin and starch were not impacted. Elimination of starter N did not result in significant differences in milk per acre estimates. There was no significant difference in milk per ton with starter addition at any of the sites.

The soil nitrate data could explain the lack of a response to starter N at most but not all locations in 2009 and 2010. At two locations in 2009 (Sites 1 and 3), PSNT results indicated sufficient N was available (Table 7). At Site 1, there was a statistically significant difference in PSNT-N between the two treatments, but both with and without starter N, the PSNT values indicated sufficient N (i.e., no additional N was needed). The CSNT data also reflected that N was not limiting production at Sites 1 and 3 in 2009 (Table 7).

The PSNT values of the other five trials in 2009 were all below 21 ppm, indicating potential N deficiency (or slow N mineralization under the growing conditions of the spring of 2009), consistent with low CSNT values for these five locations as well. These results indicate a potential N deficiency at these five locations, reflecting the exceptionally wet 2009 growing season for most locations. Soil nitrate levels at harvest were low for four of the five sites (Sites 4-7), consistent with high rainfall during May, June, July and August. The small starter N application at these locations might not have been enough to overcome the lack of N later in the season. For Site 2, the field was so wet at harvest time that two of the eight plots could not be harvested.

In 2010, PSNT results indicated sufficient N was available at all locations with the possible exception of Site 21 where the PSNT results for both with and without starter N were borderline sufficient—greater than 21 ppm, but less than 25 ppm. There were no significant differences in PSNT results between treatments at any of the 2010 locations. Although PSNT values for both treatments at Site 18 indicated sufficient N available, the end of season CSNT values for both treatments showed N deficiency. Although there was no statistically significant difference between the CSNTs of the two starter N treatments (Table 7), there was a statistically significant difference in the yield at this site (Table 4). Since this is the location where bird damage resulted in lowest yields among the sites and stand densities were suboptimal, it is possible that this site was N limiting, but no conclusions can be drawn since yields were compromised by other factors than N supply. At Site 8, there was a statistically significant difference in CSNT results between the two starter N treatments; but since the CSNT values for both treatments were in the optimal range, it is not surprising that there were no significant differences in yields.

At locations where PSNT values indicated a potential N deficiency without sidedressing of N, CSNT values confirmed the deficiency. For all but three locations, CSNT values were optimal or excessive if PSNT values were sufficient. The exceptions are three 2010 locations with a manure history at the Aurora Research Farm; at these trials (Sites 10, 12, and 13) PSNT values indicated sufficient N was available while CSNT data at harvest indicate a N deficiency that year. The ISNT values for these sites were all below the critical value line (insufficient), indicating N addition (beyond what the soil supplies) would be needed for optimum production. At the location where N was sidedressed, the yield was higher and the CSNTs were in the optimum range, another indication that sidedress application was needed for optimal growth.

At three locations with a manure history (Sites 15, 20 and 21), a sidedress N application was done. At each of these three locations, the CSNT levels were excessive and PSNTs indicated sufficient N without the sidedress application. This suggests that the sidedress N application can be eliminated, especially at the two locations with high ISNTs (Sites 20 and 21). These are also the sites with the highest crude protein levels, also indicating N is not limiting yield.

Conclusions

Elimination of starter N did not result in a yield or quality penalty for sites with a manure history. The locations with no or limited manure histories (Aurora Research Farm) tended to be responsive to starter N addition. Results reflected a lack of response under conditions of sufficient or excess N (Sites 1, 3 and 8-17, 19-21), a significant lack of N in both the starter and no starter plots (all other trials), or in-field challenges such as bird damage or planter problems (Sites 2 and 18). In 2011, the final year of this project, we hope to add another 5-10 locations to this dataset before drawing final conclusions.

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Table 1: Soil series, cropping history, planting and harvest dates, and manure history for seven starter N trials in NY.

Site	County	Soil Series	Soil Series Description	Cropping History	Planting Date	Harvest Date	Manure History* (gallons/acre)			Sidedress N*
							2009/2010	2008/2009	2007/2008	2009/2010
1	Rensselaer	Pittstown-Nassau	Coarse-loamy, mixed, active, mesic Aquic Dystrudepts; Loamy-skeletal, mixed, active, mesic Lithic Dystrudepts	Alfalfa(2006) Corn (2007) Corn (2008)	11 May 2009	8 September 2009	8,000 Aerator Spring	8,000 Aerator Spring	8,000 Spring	No
2	Lewis	Farmington	Loamy, mixed, active, mesic Lithic Eutrudepts	Alfalfa(2006) Alfalfa(2007) Alfalfa(2008)	8 June 2009	16 October 2009	None	None	None	No
3	Washington	Hoosic	Sandy-skeletal, mixed, mesic Typic Dystrudepts	Corn (2006) Corn (2007) Corn (2008)	5 May 2009	24 September 2009	6,000 Incorpo-rated Spring	None	10,000 Surface Spring	No
4	Cayuga	Lima	Fine-loamy, mixed, active, mesic Oxyaquic Hapludalfs	Corn (2006) Corn (2007) Corn (2008)	12 May 2009	13 November 2009	8,000 Aerator Spring	8,000 Aerator Spring	9,500 Aerator Spring	No
5	Cayuga	Lima	Fine-loamy, mixed, active, mesic Oxyaquic Hapludalfs	Corn (2006) Corn (2007) Corn (2008)	12 May 2009	13 November 2009	8,000 Chisel Spring	8,000 Chisel Spring	9,500 Chisel Spring	No
6	Cayuga	Lima	Fine-loamy, mixed, active, mesic Oxyaquic Hapludalfs	Corn (2006) Corn (2007) Corn (2008)	12 May 2009	13 November 2009	None	None	None	Yes
7	Cayuga	Lima	Fine-loamy, mixed, active, mesic Oxyaquic Hapludalfs	Corn (2006) Corn (2007) Corn (2008)	12 May 2009	13 November 2009	8,000 Surface Spring	8,000 Surface Spring	9,500 Surface Spring	No
8	Steuben	Howard	Loamy-skeletal, mixed, mesic Glossoboric Hapludalfs	Alfalfa-Grass (2007) Corn (2008) Corn (2009)	7 May 2010	26 August 2010	5,000 Chisel Spring	5,000 Chisel Spring	5,000 Chisel Spring	No

Site	County	Soil Series	Soil Series Description	Cropping History	Planting Date	Harvest Date	Manure History* (gallons/acre)			Sidedress N*
							2009/2010	2008/2009	2007/2008	2009/2010
9	Cayuga	Lima	Fine-loamy, mixed, active, mesic Oxyaquic Hapludalfs	Corn (2007) Corn (2008) Corn (2009)	11 May 2010	31 August 2010	8,000 Aerator Spring	8,000 Aerator Spring	8,000 Aerator Spring	No
10	Cayuga	Lima	Fine-loamy, mixed, active, mesic Oxyaquic Hapludalfs	Corn (2007) Corn (2008) Corn (2009)	11 May 2010	31 August 2010	8,000 Chisel Spring	8,000 Chisel Spring	8,000 Chisel Spring	No
11	Cayuga	Lima	Fine-loamy, mixed, active, mesic Oxyaquic Hapludalfs	Corn (2007) Corn (2008) Corn (2009)	11 May 2010	31 August 2010	None	None	None	Yes
12	Cayuga	Lima	Fine-loamy, mixed, active, mesic Oxyaquic Hapludalfs	Corn (2007) Corn (2008) Corn (2009)	11 May 2010	31 August 2010	8,000 Surface Spring	8,000 Surface Spring	8,000 Surface Spring	No
13	Albany	Angola	Fine-loamy, mixed, mesic Aeric Ochraqualfs	Sod (2007) Corn (2008) Corn (2009)	27 May 2010	7 September 2010		10,000 Incorpor ated	4,000 Incorpor ated	No
14	Rensselaer	Occum-Barbour	Coarse-loamy/coarse-loamy over sandy or sandy skeletal, mesic Fluventic Dystrochrept	Sod (2007) Corn (2008) Corn (2009)	10 May 2010	7 September 2010	8,000 Surface Spring	9,000 Surface Spring	9,000 Surface Spring	No
15	Columbia	Occum	Coarse-loamy, mixed, mesic Fluventic Dystrochrepts	Corn (2007) Corn (2008) Corn (2009)	11 May 2010	8 September 2010	4,000 Chisel Spring	20 t/ac	20 t/ac	Yes
16	Washington	Vergennes	Very fine, illitic, mesic Glossaquic Haplaudalfs	Corn (2007) Corn (2008) Corn (2009)	28 May 2010	15 September 2010	11,000 Oct 2009 2,200 Disc>5d Spring	12,000 Disc>5d	10,00 Disc>5d	No
17	Lewis	Croghan	Sandy, mixed, frigid Aquic Haplorthods	Corn (2007) Corn (2008) Corn (2009)	17 May 2010	16 September 2010	6,000 Chisel Spring	6,000 Chisel Spring	6,000 Chisel Spring	No

Site	County	Soil Series	Soil Series Description	Cropping History	Planting Date	Harvest Date	Manure History* (gallons/acre)			Sidedress N*
							2009/2010	2008/2009	2007/2008	2009/2010
18	Jefferson	Vergennes	Very fine, illitic, mesic Glossaquic Haplaudalfs	Corn (2007) Corn (2008) Corn (2009)	22 May 2010	20 September 2010	10 t/ac Surface Spring	10 t/ac Surface Oct 08-Apr 09	10 t/ac Surface Oct 07-Apr 08	No
19	St. Lawrence	Swanton	Coarse-loamy over clayey, mixed, nonacid, frigid Aeric Haplaquepts	Alfalfa-Grass (2007) Alfalfa-Grass (2008) Corn (2009)	4 May 2010	24 September 2010	11,440 Injection Spring	None	7,378 Surface Aug 2008	No
20	St. Lawrence	Malone	Coarse=loamy, mixed, nonacid, frigid Aeric Haplaquepts	Sod (2007) Sod (2008) Corn (2009)	29 May 2010	23 September 2010	1,900 Chisel Spring	2,000 Chisel Spring	6,000 Surface June-Sep	Yes
21	Clinton	Malone	Coarse-loamy, mixed, nonacid, frigid Aeric Epiaquepts	Corn (2007) Corn (2008) Corn (2009)	10 May 2010	17 September 2010	17 t/ac Surface Dec 2009	16,000 Surface Nov 2008	5 t/ac Surface Oct 2007	Yes

*First year in header for manure and sidedress applications applies to 2009 trials (Sites 1-7), the second year applies to 2010 trials (Sites 8-21).

Table 2. Initial soil fertility status (0-8 inch depth) for each of the 21 sites included in a starter N project. All soils were analyzed for pH, organic matter (OM) by loss-on-ignition, Morgan extractable P, K, Mg, Ca, Al, Mn, Zn, and Illinois Soil Nitrogen Test (ISNT, S = sufficient and D = deficient). Trials at Sites 1-7 were conducted in 2009. All other trials were conducted in 2010.

Site	pH	OM	P		K		Mg		Ca	Al	Mn	Zn	ISNT	
		%	----------	----------	----------	----------	lbs/acres	----------	----------	----------	----------	----------	ppm	
1	6.6	4.2	12	High	245	Very High	367	Very High	3174	26	41	1.0	302	D
2	7.2	6.0	40	Very High	133	High	336	Very High	12414	27	44	1.9	449	S
3	6.4	4.9	94	Very High	960	Very High	426	Very High	3563	30	34	5.7	341	S
4	7.8	3.5	28	High	215	Very High	741	Very High	5941	11	27	1.3	261	D
5	7.8	3.3	28	High	210	Very High	696	Very High	5666	12	28	1.1	252	D
6	7.7	3.1	15	High	127	High	661	Very High	5271	11	26	0.8	224	D
7	7.8	3.3	31	High	224	Very High	705	Very High	5611	10	29	1.2	253	D
8	6.1	3.3	10	High	198	High	444	Very High	2138	33	19	0.5	235	D
9	7.7	3.7	31	High	268	Very High	685	Very High	5611	9	39	1.2	257	D
10	7.7	3.5	29	High	244	Very High	667	Very High	5751	9	39	1.1	248	D
11	7.7	3.3	17	High	116	High	623	Very High	5476	9	36	0.6	230	D
12	7.7	3.5	34	High	263	Very High	686	Very High	5892	9	38	1.1	245	D
13	6.6	3.5	71	Very High	334	Very High	323	Very High	4428	18	22	1.4	290	S
14	6.9	4.0	35	High	609	Very High	423	Very High	3736	28	33	3.1	315	S
15	6.4	2.8	80	Very High	777	Very High	383	Very High	2981	20	53	3.4	216	D
16	7.0	4.1	25	High	244	Very High	584	Very High	5348	35	39	1.4	247	D
17	6.8	4.5	11	High	373	Very High	349	Very High	3849	135	5	3.1	327	S
18	5.5	5.3	11	High	323	Very High	993	Very High	4915	86	52	5.3	372	S
19	7.0	4.2	16	High	149	Medium	923	Very High	5231	16	25	1.7	334	S
20	7.0	4.1	16	High	64	Low	624	Very High	4596	19	22	1.0	344	S
21	6.9	4.3	50	Very High	576	Very High	549	Very High	3434	24	25	3.7	344	S

Table 3. Monthly precipitation in total inches and temperature in degrees F for seven sites (four fields) where starter N trials were conducted in NY in 2009 and fourteen sites (ten fields) where starter N trials were conducted in NY in 2010. Data for Sites 4-7 and 9-12 were obtained from an on-site weather station and for the other sites from weather stations in close proximity (data for all sites taken from the Northeast Regional Climate Center CLIMOD database in 2009, 2010). The average monthly temperature is derived from calculated daily averages. The 30-year* average is from 1979 through 2008 for Sites 1-7, and 1980 through 2009 for 2010 research Sites (8-21).

Month		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Site 1 Rensselaer Co. (Sta. BSKN6, Buskirk)													
Rainfall	2009	2.51	1.27	3.26	1.59	4.79	4.63	5.67	5.99	2.18	5.05	2.34	2.64
	30-year	2.73	2.11	3.04	3.44	3.91	4.28	4.49	4.08	3.66	3.65	3.50	2.89
Temperature	2009	14.4	24.4	32.8	46.9	55.4	63.2	66.5	68.0	57.5	45.6	41.0	24.5
	30-year	23.1	25.5	34.7	47.9	59.2	68.3	73.2	71.7	63.4	51.1	41.0	29.7
Site 2 Lewis Co. (Sta. 304912, Lowville)													
Rainfall	2009	2.63	2.05	2.50	1.87	5.62	2.37	5.82	4.48	2.18	3.67	1.58	-
	30-year	3.43	2.42	2.78	3.22	3.25	3.28	3.44	3.70	4.09	4.11	4.00	3.57
Temperature	2009	10.7	20.2	29.8	43.7	53.4	60.8	64.7	66.6	56.1	44.3	39.6	-
	30-year	16.9	18.5	28.2	42.2	54.1	63.0	67.4	65.8	57.7	46.3	35.7	23.6
Site 3 Washington Co. (Sta. 309389, Whitehall)													
Rainfall	2009	2.72	1.63	2.54	1.59	3.73	3.88	8.18	3.16	1.96	5.32	3.25	4.34
	30-year	3.19	2.44	3.05	3.23	3.66	3.84	4.20	4.14	3.78	3.67	3.48	3.11
Temperature	2009	15.5	25.1	36.3	50.3	60.0	66.4	70.2	72.5	61.3	47.9	44.1	20.7
	30-year	21.0	23.1	33.6	47.1	59.3	68.2	72.8	70.8	62.2	50.6	39.5	27.4
Site 4-7 Cayuga Co. (Sta. 300331, Aurora Research Farm)													
Rainfall	2009	-	0.44	3.38	1.89	3.77	4.75	2.43	3.64	2.61	3.32	1.42	1.63
	30-year	2.05	1.75	2.51	3.31	3.01	3.75	3.44	3.12	4.20	3.29	3.26	2.37
Temperature	2009	18.9	28.6	35.2	48.0	58.1	64.5	67.6	70.6	61.0	47.5	43.2	27.5
	30-year	24.3	25.3	33.3	45.8	57.0	66.5	70.8	69.4	62.3	50.7	40.7	30.0
Site 8 Steuben Co. (Sta. 300448, Bath)													
Rainfall	2010	2.43	1.91	2.40	1.39	3.95	3.99	3.24	2.93	1.22	6.83	1.5	-
	30-year	1.66	1.49	2.20	2.79	2.80	3.71	3.29	3.00	3.42	2.53	2.72	2.49
Temperature	2010	22.5	24.9	37.2	48.9	59.2	67.3	72.0	69.4	61.0	49.3	38.4	-
	30-year	22.7	24.3	31.5	44.3	54.6	63.7	68.1	66.4	59.5	48.1	38.2	27.7

Month		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sites 9-12 Cayuga Co. (Sta. 300331, Aurora Research Farm)													
Rainfall	2010	1.38	1.90	1.95	1.97	2.22	5.24	4.26	5.83	2.57	5.84	2.36	-
	30-year	1.87	1.73	2.57	3.28	3.05	3.80	3.50	3.05	4.13	3.25	3.22	2.31
Temperature	2010	22.8	24.2	38.4	51.0	60.8	67.2	72.5	70.1	62.0	50.4	40.0	-
	30-year	24.4	26.2	33.5	46.2	57.1	66.6	70.8	69.6	62.4	50.7	40.7	29.9
Site 13 Albany (Sta. 300042, Albany AP)													
Rainfall	2010	1.75	3.99	2.69	1.25	1.88	4.69	2.88	1.69	3.44	7.10	3.53	-
	30-year	2.54	2.09	3.26	3.22	3.58	3.80	4.11	3.62	3.26	3.52	3.27	2.87
Temperature	2010	24.4	28.0	41.7	51.9	61.2	67.6	74.9	72.0	64.6	50.3	39.6	-
	30-year	22.8	25.9	34.8	47.6	58.2	67.0	71.6	70.0	61.8	49.7	39.8	28.4
Site 14 Rensselaer Co. (Sta. 308600, Troy L&D)													
Rainfall	2010	1.66	4.78	2.49	1.77	3.29	5.40	2.94	1.81	0.96	9.43	-	-
	30-year	2.23	1.93	2.98	3.26	3.74	4.17	4.55	4.09	3.32	3.64	3.09	2.55
Temperature	2010	25.5	27.8	42.0	52.6	-	68.9	76.5	72.4	66.8	51.4	40.4	-
	30-year	23.2	25.9	34.6	48.0	59.2	68.3	73.2	71.7	63.4	51.1	40.8	29.5
Site 15 Columbia Co. (Sta. 308746, Valatie 1 N, and *Sta. 304025, Hudson Correctional for 2010 mo where no data at Valatie; Valatie rainfall and temperatures are usually lower)													
Rainfall	2010	2.37*	4.29*	5.00*	1.54*	2.04	2.83	2.50	1.88	1.19	7.42	-	-
	30-year	2.05	1.91	2.82	3.74	4.04	4.60	4.34	4.25	3.97	4.11	3.27	2.52
Temperature	2010	26.6*	30.3*	43.9*	53.8*	64.5*	68.7	76.6*	70.9	64.5	49.7	-	-
	30-year	22.5	26.2	34.1	46.5	57.6	66.2	70.6	69.6	61.6	49.7	39.9	28.3
Sites 16 Washington Co. (Sta. 309389, Whitehall)													
Rainfall	2010	2.04	2.83	3.74	2.09	2.62	4.42	5.34	2.92	2.13	9.25	-	-
	30-year	3.01	2.52	2.99	3.22	3.67	3.89	4.46	4.16	3.72	3.72	3.55	3.22
Temperature	2010	24.3	27.8	41.2	53.2	63.2	69.2	76.0	72.5	65.3	51.2	-	-
	30-year	2.09	24.1	33.8	47.4	59.1	68.2	72.6	70.8	62.4	50.6	39.6	27.4
Site 17 Lewis Co. (Sta. 304912, Lowville)													
Rainfall	2010	2.73	1.73	1.50	1.06	2.21	6.26	4.12	6.09	2.35	8.80	2.12	-
	30-year	3.16	2.49	2.73	3.23	3.34	3.35	3.63	3.70	3.96	4.15	3.92	3.64
Temperature	2010	18.0	19.9	36.2	47.2	56.9	63.7	69.6	66.4	59.2	46.6	35.0	-
	30-year	16.7	19.1	28.1	42.4	53.8	62.9	67.2	65.8	57.7	46.2	35.6	23.3

Month		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Site 18 Jefferson Co. (Sta. 309005, Watertown Intl. Airport)													
Rainfall	2010	2.00	1.10	1.59	1.10	1.86	6.06	3.54	2.48	6.68	4.46	3.20	-
	30-year	2.63	2.22	2.35	2.99	3.02	2.76	2.69	3.13	3.67	3.66	3.77	3.14
Temperature	2010	20.4	20.0	37.3	48.7	58.4	64.1	71.2	69.4	61.4	48.4	38.2	-
	30-year	19.3	21.1	30.2	43.7	54.6	63.3	68.5	67.0	59.4	48.2	38.1	26.0
Sites 19-20 St. Lawrence Co. (Sta.301185, Canton 4 SE)													
Rainfall	2010	1.53	0.83	1.12	1.99	1.60	6.66	0.11	4.10	4.51	8.54	2.23	-
	30-year	2.10	1.81	2.13	2.90	3.06	3.26	3.86	3.67	4.18	3.86	3.37	2.51
Temperature	2010	19.1	21.0	36.5	48.8	59.2	64.4	-	68.4	-	46.9	36.9	-
	30-year	15.7	18.5	28.5	43.1	54.9	64.0	68.6	66.8	58.7	46.8	36.4	23.2
Site 21 Clinton Co. (Sta. 301401, Chazy)													
Rainfall	2010	0.32	0.65	3.02	2.96	0.89	4.95	1.85	6.45	-	-	-	-
	30-year*	1.37	1.01	0.99	2.30	3.00	3.46	3.56	3.81	3.23	3.04	2.42	0.61
Temperature	2010	23.3	26.3	40.0	51.2	61.1	66.4	74.2	70.4	61.8	47.5	36.8	-
	30-year	17.7	20.2	30.1	44.7	56.3	65.1	69.7	68.0	59.8	47.9	37.0	24.7

*This is an approximate 30-year average for rainfall for some of the months at a few of the weather stations as data was not collected every month all years.

Table 4. Stand density percent moisture content at harvest and yield as influenced by application of 30 lbs of starter N fertilizer/acre at planting in 2009 (Sites 1-7) and 2010 (Sites 8-21). In grey are sites where starter N addition increased the yield with a P value of 0.05 (95% certainty level). Corn yield is in ton/acre at 35% DM for silage (Sites 1-3, 8, 13-21) or bushel/acre at 85% DM (Sites 4-7, 9-12).

Site	Treatment	Stand density	Moisture	Corn yield		Field notes
		plants/acre	%	tons/acre	bushels/acre	
1	Starter	15,685 b	68.4 a	17.9 a	.	Stand density problems (planter malfunctioning)
	No Starter	23,192 a	69.4 a	21.3 a	.	
	p-value	0.0011	0.2775	0.0610	.	
2	Starter	28,000 a	64.6 a	17.0 a	.	Wet harvest conditions resulted in the loss of two of the plots, both no-starter plots
	No Starter	29,250 a	60.3 a	15.3 a	.	
	p-value	0.3308	0.1318	0.4805	.	
3	Starter	25,134 a	67.3 a	25.4 a	.	
	No Starter	25,014 a	65.6 a	24.9 a	.	
	p-value	0.7788	0.1090	0.6786	.	
4	Starter	28,579	18.2 a	.	112.3 a	Manure was surface applied (spring) and aerator-incorporated at 8,000-9,000 gallons/acre (5 past years).
	No Starter	28,579	17.4 a	.	108.5 a	
	p-value	n/a*	0.2159	.	0.6054	
5	Starter	29,513	18.3 a	.	118.7 a	Manure was surface applied (spring) and chisel plow-incorporated at 8,000-9,000 gallons/acre (5 past years).
	No Starter	29,513	17.6 a	.	105.0 b	
	p-value	n/a*	0.3944	.	0.0290	
6	Starter	29,394	18.1 a	.	143.7 a	No manure history. Sidedressed
	No Starter	29,394	19.0 a	.	126.3 a	
	p-value	n/a*	0.3115	.	0.0632	
7	Starter	28,885	18.5 a	.	103.0 a	Manure was surface applied (spring) at 8,000-9,000 gallons/acre (5 past years).
	No Starter	28,885	18.2 a	.	91.2 a	
	p-value	n/a*	0.5255	.	0.1162	
8	Starter	25,706 a	67.1 a	19.2 a	.	
	No Starter	25,626 a	67.0 a	20.0 a	.	
	p-value	0.9267	0.9266	0.5051	.	
9	Starter	27,885 a	16.6 b	.	150.0 a	Manure was surface applied (spring) and aerator-incorporated at 8,000-9,000 gallons/acre (5 past years).
	No Starter	24,640 b	17.2 a	.	138.2 b	
	p-value	0.0101	0.0145	.	0.0064	

Site	Treatment	Stand density	Moisture	Corn yield		Field notes
		plants/acre	%	tons/acre	bushels/acre	
10	Starter	29,124 a	16.6 a	.	160.3 a	Manure was surface applied (spring) and
	No Starter	27,863 a	16.9 a	.	151.2 a	chisel plow-incorporated at 8,000-9,000
	p-value	0.1098	0.3149	.	0.0711	gallons/acre (5 past years).
11	Starter	27,576 a	16.9 b	.	172.7 a	No manure history. Sidedressed
	No Starter	24,107 b	17.3 a	.	146.5 b	
	p-value	0.0038	0.0087	.	0.0008	
12	Starter	27,683 a	16.7 a	.	140.8 a	Manure was surface applied (spring) at
	No Starter	26,208 a	17.0 a	.	125.3 b	8,000-9,000 gallons/acre (5 past years).
	p-value	0.2216	0.2555	.	0.0264	
13	Starter	32,390 a	65.0 a	19.1 a	.	
	No Starter	31,097 a	65.8 a	20.0 a	.	
	p-value	0.3307	0.4549	0.6344	.	
14	Starter	37,952 a	59.6 a	21.2 a	.	
	No Starter	37,952 a	57.9 a	20.6 a	.	
	p-value	0.9993	0.1317	0.7581		
15	Starter	37,897 a	60.1 a	24.7 a	.	
	No Starter	37,571 a	61.2 a	24.9 a	.	
	p-value	0.8544	0.4431	0.9412	.	
16	Starter	29,442 a	68.3 a	18.0 a	.	
	No Starter	29,186 a	67.7 a	19.1 a	.	
	p-value	0.6865	0.3081	0.3882	.	
17	Starter	35,014 a	64.9 a	20.3 a	.	Could not harvest all four replications
	No Starter	32,700 a	68.0 a	16.7 a	.	due to wet field conditions.
	p-value	0.1253	0.3971	0.1661	.	
18	Starter	24,067 a	66.5 a	15.4 a	.	Bird damage all across the field.
	No Starter	24,557 a	67.4 a	12.8 b	.	
	p-value	0.5694	0.1262	0.0288	.	
19	Starter	30,492 a	49.8 a	30.3 a	.	
	No Starter	30,982 a	50.1 a	29.5 a	.	
	p-value	0.2220	0.8041	0.6737	.	

Site	Treatment	Stand density	Moisture	Corn yield		Field notes
		plants/acre	%	tons/acre	bushels/acre	
20	Starter	30,546 a	67.9 a	20.0 a	.	
	No Starter	33,106 a	66.5 a	21.1 a	.	
	p-value	0.1162	0.1176	0.2035	.	
21	Starter	31,908 a	67.9 a	23.8 a	.	
	No Starter	31,581 a	68.9 a	23.6 a	.	
	p-value	0.7154	0.3655	0.7932	.	

*Only one stand density (mean of reps) available for combined starter/no starter at this site, no statistical analysis possible.

Table 5. Crude protein, soluble protein, neutral detergent fiber (NDF), digestible NDF (dNDF), lignin and starch as influenced by an application of 30 lbs of starter N fertilizer per acre at planting in trials conducted in 2009 (Sites 1-7) and 2010 (Sites 8-21). In grey background are locations where starter N addition increased the yield with a P value of 0.05 (95% certainty level).

Site	Treatment	Crude protein	Soluble protein	NDF	dNDF	Lignin	Starch
		--------------------% of dry matter-------------------			% NDF	-----------% of dry matter----------	
1	Starter	7.7 a	1.9 a	42.1 a	66.8 a	3.0 a	32.9 a
	No Starter	7.5 a	2.0 a	42.5 a	65.7 a	3.1 a	31.3 a
	p-value	0.5065	0.4743	0.3597	0.1525	0.3866	0.3754
2	Starter	7.9 a	1.6 a	49.1 a	67.8 a	2.7 a	31.6
	No Starter	7.7 a	1.5 a	49.6 a	66.6 b	2.8 a	
	p-value	0.2450	0.4081	0.2724	0.0277	0.1881	n/a
3	Starter	8.3 a	2.4 a	42.2 a	65.2 a	3.2 a	33.6 a
	No Starter	7.3 b	2.1 b	42.5 a	64.1 a	3.0 a	34.7 a
	p-value	0.0257	0.0052	0.7806	0.4981	0.2534	0.4894
8	Starter	8.0 a	1.6 a	46.4 a	67.6 a	3.5 a	29.3 a
	No Starter	7.9 a	1.6 a	43.8 a	66.5 a	3.3 a	31.4 a
	p-value	0.7215	0.6791	0.2383	0.2583	0.1378	0.2361
13	Starter	7.8 a	1.8 a	40.5 a	69.8 a	2.8 a	34.6 a
	No Starter	7.9 a	2.0 a	39.6 a	67.3 a	2.7 a	35.6 a
	p-value	0.7291	0.5415	0.5974	0.0551	0.8233	0.1598
14	Starter	7.8 a	2.1 a	40.0 a	64.3 a	3.1 a	40.4 a
	No Starter	7.7 a	2.2 a	41.1 a	64.7 a	3.1 a	38.6 a
	p-value	0.8925	0.8315	0.4998	0.7609	0.7477	0.4181
15	Starter	8.3 a	2.2 a	47.0 a	61.2 a	3.6 a	28.7 a
	No Starter	8.3 a	2.4 a	46.1 a	60.6 a	3.5 a	30.0 a
	p-value	0.9425	0.5509	0.6867	0.7248	0.3833	0.5343
16	Starter	8.3 a	2.0 a	39.3 a	70.2 a	2.8 a	34.5 a
	No Starter	7.8 a	1.9 b	37.5 a	70.2 a	2.7 a	37.2 a
	p-value	0.1261	0.0408	0.2170	0.9890	0.1060	0.1150
17	Starter	7.8 a	2.3 a	41.2 a	66.3 a	3.0 a	35.7 a
	No Starter	8.7 a	2.6 a	40.9 a	66.3 a	3.2 a	34.8 a
	p-value	0.3142	0.1367	0.9193	0.9812	0.2585	0.7993

Site	Treatment	Crude protein	Soluble protein	NDF	dNDF	Lignin	Starch
		--------------------% of dry matter		--------------------	% NDF	-----------% of dry matter----------	
18	Starter	6.1 a	1.5 b	49.1 a	66.1 a	3.7 a	25.8 a
	No Starter	6.3 a	1.8 a	46.4 a	68.7 a	3.2 a	27.7 a
	p-value	0.3701	0.0236	0.1173	0.0586	0.1003	0.3141
19	Starter	8.1 a	1.7 a	36.4 a	74.8 a	2.4 a	43.6 a
	No Starter	8.1 a	1.8 a	34.2 a	72.1 a	2.4 a	46.1 a
	p-value	0.8729	0.3061	0.4575	0.0681	1.0000	0.4852
20	Starter	7.9 a	2.1 a	46.1 a	64.6 a	3.5 a	30.8 a
	No Starter	7.6 a	2.0 a	46.0 a	63.1 a	3.3 a	31.7 a
	p-value	0.6044	0.1351	0.9788	0.6316	0.2688	0.8375
21	Starter	9.2 a	2.5 a	35.9 b	77.5 a	2.4 a	37.9 a
	No Starter	8.9 b	2.5 a	39.6 a	77.0 a	2.5 a	34.1 a
	p-value	0.0227	0.2679	0.0484	0.7064	0.2508	0.0537

Table 6. Milk production estimate for each corn silage site (University of Wisconsin Corn Silage Evaluation System, Milk 2006), as influenced by an application of 30 lbs of starter N fertilizer per acre at planting in trials conducted in 2009 (Sites 1-7) and 2010 (Sites 8-21). In grey background are locations where starter N addition increased the yield with a P value of 0.05 (95% certainty level).

Site	Treatment	Milk per ton	Milk per acre	Field notes
		lb/ton DM	lb/acre	
1	Starter	3438 a	21,519 a	Stand density problems (planter malfunctioning).
	No Starter	3360 a	25,105 a	
	p-value	0.2933	0.1242	
2	Starter	3362 a	19,960 a	Wet harvest conditions resulted in the loss of two of the plots, both no-starter plots
	No Starter	3291 a	17,784 a	
	p-value	0.0644	0.4440	
3	Starter	3465 a	30,831 a	
	No Starter	3417 a	29,840 a	
	p-value	0.4554	0.5671	
8	Starter	3432 a	23,096 a	
	No Starter	3508 a	24,609 a	
	p-value	0.2176	0.3460	
13	Starter	3563 a	23,777 a	
	No Starter	3565 a	25,015 a	
	p-value	0.9544	0.6384	
14	Starter	3579 a	26,538 a	
	No Starter	3516 a	25,402 a	
	p-value	0.2356	0.6119	
15	Starter	3355 a	28,974 a	
	No Starter	3345 a	29,321 a	
	p-value	0.5906	0.9067	
16	Starter	3596 a	22,631 a	
	No Starter	3664 a	24,545 a	
	p-value	0.1958	0.2837	
17	Starter	3549 a	25,165 a	
	No Starter	3533 a	20,534 a	
	p-value	0.8430	0.1579	

Site	Treatment	Milk per ton	Milk per acre	Field notes
		lb/ton DM	lb/acre	
18	Starter	3154 a	17,007 a	Bird damage all across the field. Low stand density.
	No Starter	3277 a	14,661 a	
	p-value	0.1885	0.0932	
19	Starter	3695 a	39,234 a	
	No Starter	3724 a	38,477 a	
	p-value	0.8002	0.7968	
20	Starter	3423 a	23,969 a	
	No Starter	3392 a	25,041 a	
	p-value	0.7829	0.4604	
21	Starter	3706 a	30,930 a	
	No Starter	3560 a	29,453 a	
	p-value	0.0511	0.2569	

Table 7. Soil nitrate (NO_3^-) (0-8 and 0-12 inch depths), and Corn Stalk Nitrate Test (CSNT) as influenced by the amount of banded N fertilizer at planting (0 versus 30 lbs N/acre) in trials conducted in 2009 (Sites 1-7) and 2010 (Sites 8-21).

		Sidedress			Harvest			
Site	Treatment	Nitrate-N 0-8 inches lbs/acre	PSNT 0-12 inches ppm		Nitrate-N 0-8 inches lbs/acre	Nitrate-N 0-12 inches ppm	CSNT ppm	
1	Starter	58 b	28 b	Sufficient	11 a	6 a	827 a	Optimal
	No Starter	72 a	31 a	Sufficient	7 a	5 a	871 a	Optimal
	p-value	0.0153	0.0454		0.4120	0.6058	0.9449	
2	Starter	25 a	12 a	Deficient	31 a	16 a	155 a	Deficient
	No Starter	28 a	13 a	Deficient	33 a	17 a	58 a	Deficient
	p-value	0.4162	0.6871		0.5367	0.3101	0.3776	
3	Starter	60 a	34 a	Sufficient	63 a	27 a	5,154 a	Excess
	No Starter	52 a	30 a	Sufficient	47 a	27 a	5,017 a	Excess
	p-value	0.2289	0.1449		0.2497	1.0000	0.9264	
4	Starter	11 b	7 a	Deficient	23 b	5 a	94 a	Deficient
	No Starter	17 a	8 a	Deficient	27 a	7 a	90 a	Deficient
	p-value	0.0344	0.4560		0.0032	0.3789	0.6206	
5	Starter	18 a	12 a	Deficient	22 b	6 a	94 a	Deficient
	No Starter	21 a	9 a	Deficient	28 a	7 a	105 a	Deficient
	p-value	0.3483	0.0643		0.0202	0.3675	0.4889	
6	Starter	4 b	6 a	Deficient	16 a	4 a	160 a	Deficient
	No Starter	11 a	4 a	Deficient	18 a	5 a	208 a	Deficient
	p-value	0.0253	0.1103		0.0609	0.5770	0.4849	
7	Starter	14 a	9 a	Deficient	20 a	5 a	104 a	Deficient
	No Starter	14 a	7 b	Deficient	25 a	6 a	94 a	Deficient
	p-value	0.8759	0.0411		0.0519	0.5737	0.4782	
8	Starter	84 a	57 a	Sufficient	13 a	7 a	1,661 a	Optimal
	No Starter	79 a	54 a	Sufficient	10 a	5 b	463 b	Optimal
	p-value	0.7019	0.8391		0.0399	0.0474	0.0065	
9	Starter	67 a	55 a	Sufficient	21 a	15 a	182 a	Deficient
	No Starter	74 a	56 a	Sufficient	20 a	17 a	99 a	Deficient
	p-value	0.2544	0.8634		0.6830	0.1006	0.3246	

		Sidedress			Harvest			
Site	Treatment	Nitrate-N 0-8 inches lbs/acre	PSNT 0-12 inches ppm		Nitrate-N 0-8 inches lbs/acre	Nitrate-N 0-12 inches ppm	CSNT ppm	
10	Starter	63 a	61 a	Sufficient	22 a	18 a	80 a	Deficient
	No Starter	67 a	51 a	Sufficient	21 a	15 a	89 a	Deficient
	p-value	0.3820	0.0982		0.7320	0.2689	0.1107	
11	Starter	36 a	29 a	Sufficient	18 a	16 a	827 a	Optimal
	No Starter	36 a	26 a	Sufficient	18 a	14 a	669 a	Optimal
	p-value	0.8270	0.1360		1.0000	0.3611	0.6087	
12	Starter	57 a	47 a	Sufficient	21 a	15 a	129 a	Deficient
	No Starter	64 a	50 a	Sufficient	22 a	15 a	83 a	Deficient
	p-value	0.1477	0.4830		0.3548	0.9141	0.2565	
13	Starter	96 a	31 a	Sufficient	20 a	10 a	1,225 a	Optimal
	No Starter	76 a	33 a	Sufficient	24 a	9 a	818 a	Optimal
	p-value	0.2135	0.4282		0.6543	0.8791	0.7017	
14	Starter	124 a	55 a	Sufficient	42 a	18 a	10,135 a	Excess
	No Starter	117 a	53 a	Sufficient	25 b	11 a	9,164 a	Excess
	p-value	0.7003	0.5382		0.0273	0.1265	0.3067	
15	Starter	130 a	52 a	Sufficient	158 a	44 a	7,838 a	Excess
	No Starter	142 a	45 a	Sufficient	131 a	53 a	5,938 a	Excess
	p-value	0.7059	0.3637		0.1915	0.0566	0.2632	
16	Starter	66 a	33 a	Sufficient	40 a	33 a	2,552 a	Excess
	No Starter	66 a	31 a	Sufficient	31 a	25 a	1,174 a	Optimal
	p-value	1.0000	0.8301		0.2038	0.2728	0.0963	
17	Starter	60 a	28 a	Sufficient	26 a	13 a	5,486 a	Excess
	No Starter	54 a	26 a	Sufficient	25 a	14 a	2,556 a	Excess
	p-value	0.4754	0.6835		0.9667	0.3794	0.2275	
18	Starter	61 a	30 a	Sufficient	16 a	6 a	42 a	Deficient
	No Starter	61 a	27 a	Sufficient	13 a	6 a	61 a	Deficient
	p-value	0.8660	0.5026		0.2454	1.0000	0.0648	

		Sidedress			Harvest	
Site	Treatment	Nitrate-N 0-8 inches lbs/acre	PSNT 0-12 inches ppm	Nitrate-N 0-8 inches lbs/acre	Nitrate-N 0-12 inches ppm	CSNT ppm
19	Starter	80 a	59 a Sufficient	30 a	14 a	4,817 a Excess
	No Starter	81 a	66 a Sufficient	32 a	16 a	4,164 a Excess
	p-value	0.9320	0.5043	0.1895	0.0577	0.3765
20	Starter	54 a	25 a Sufficient	38 a	16 a	4,484 a Excess
	No Starter	57 a	27 a Sufficient	38 a	16 a	4,599 a Excess
	p-value	0.5149	0.6124	0.9474	0.9189	0.9385
21	Starter	42 a	24 a Borderline	67 a	24 a	9,326 a Excess
	No Starter	50 a	23 a Borderline	90 a	33 a	10,051 a Excess
	p-value	0.3155	0.6856	0.5205	0.3723	0.6809