Northern NY Agricultural Development Program
2015 Project Report

Late Summer-Planted Oats for Forage: A Viable Option for Northern New York? Year 1

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Background:
In the six-county region (Jefferson, St. Lawrence, Lewis, Franklin, Clinton and Essex) of Northern New York (NNY), a majority of the dairy and livestock farms rely on grass-based forages as a primary source of animal feed. Grass hay is the largest acreage of any crop grown, followed by corn.

Shortages of forage crops have occurred when weather conditions negatively impact productivity and/or when planting or harvesting operations are impeded. Cold, wet spring weather can delay hay and pasture seedings and corn planting while hot, dry summer weather can cause hay and pasture yields to be inadequate. In these cases, late-planted summer annual crops such as sorghum-sudangrass, teff, pearl millet and oats can be used as emergency annual forage crops.

BMR sorghum sudangrass and teff have been shown to yield well in NNY. Sorghum sudangrass requires high N fertility for maximum yields of 3-5 tons DM/acre, can be difficult to harvest due to its high moisture content at harvest, and must be managed to avoid prussic acid toxicity.

Teff yields about 2 tons DM/acre and requires much less N, but its very small seeds can present planting and establishment difficulties.

Oats grown for forage can also fit into a late-planting window with fewer seeding, fertility, harvest and toxicity concerns. Common oat (*Avena sativa*) is an annual spring grain typically grown for both livestock and human consumption. Oats grow well in cooler temperatures and are more tolerant of wet weather than other cereals, so can be particularly adapted to cool, wet summers.

Preliminary on-farm oat research conducted in 2013 and 2014 at one Jefferson County location suggested that late summer-planted oats are capable of producing high quality, high yielding forage (Tables 1 and 2). Oats yielded an average of 1.62 tons DM/acre in 2013 and 2.39 tons DM/acre in 2014.

However, it is not clear if a grain-type or forage-type oat variety should be used, or what the ideal N rate is, for this late-summer crop. Oat cultivars selected specifically for forage production are generally slower to mature than grain-type cultivars, however, this distinction is based on normal spring establishment.

Development of all cultivars is generally much slower in the fall, and differences between cultivars of different maturity classes are not well understood. It is possible that a grain oat variety may be better suited for a late summer forage crop due to its earlier maturity compared to a forage type variety.

Table 1. Summary of a preliminary on-farm forage oats trial conducted in 2013 in the Town of Alexandria, Jefferson County, NY.

Planted; July 31, 2013 with grain-type oats at 120 lbs / acre
N Fertility: 55 lbs/acre at planting or 55 lbs at planting + 55 lbs 3 weeks later
Harvested: September 20, 51 days later

Yield: Forage yield averaged 1.62 tons DM / acre, no difference between N treatments
Forage Quality:

CP	ADF	NDF	NeL	NFC	NSC	Ca	P	K
19.45	27.3	46.1	0.7	23.55	14.58	0.35	0.6	5.21

Table 2. Summary of a preliminary on-farm forage oats trial conducted in 2014 in the Town of Alexandria, Jefferson County, NY.

Planted: August 1, 2014 with forage and grain-type oats at 120 lbs / acre with or without a red clover underseeding.
N Fertility: 55 lbs/acre at planting or a Red Clover underseeding
Harvested: October 5, 65 days later

	Tons DM/acre
Grain Oats	2.47 b
Forage Oats	2.53 b
Grain Oats + Red Clover	2.19 a
Forage Oats + Red Clover	2.37 ab

a,b Values followed by the same letter are not significantly different ($P \leq 0.05$).

Methods:

A variety and N fertility field study was conducted at three locations in Northern New York in 2015 as described in Table 3. The sites are silty, loamy soil types commonly used for production of forages for dairy and livestock in Northern NY.

Average monthly temperature and precipitation totals for the closest available weather station from April through November 2015 are summarized in Figure 1 for the three trial locations. Watertown is the closest weather station to the Alexandria trial location.

Figure 1 also includes a summary of cumulative growing degree-days (GDD) for 2015 compared with historical averages. GDD were calculated using a base temperature of 50 ºF.

Table 3. Description of 3 field sites selected for a comparison of oat type and N fertility on yield and crude of oat forage in 2015.

County	Town	Farm	Soil Type	Plant Date	Harvest Date
Jefferson	Alexandria, NY	Hunter Family Farm	Kingsbury silty clay	31 July	*Failed*
St. Lawrence	Canton, NY	Extension Learning Farm	Hailesboro silt loam	4 August	8 October
Clinton	Chazy, NY	W.H. Miner Institute	Roundabout silt loam	5 August	2, 7 October

The field study at Alexandria, Canton and Chazy locations was designed as a randomized complete block with four replications. The main experimental factor was oat variety or type with N fertility managed as a split plot.

Oat varieties planted in all three trial locations were "Corral" variety oats (Seedway LLC, Hall, NY), a medium-maturity grain type, and "Foragemaker 50" variety (King's AgriSeeds, Inc., Ronks, PA), a later maturing forage type.

Oats were seeded at three locations from July 31 to August 4 at 120 lbs per acre, at a depth of 1" with a grain drill at 7" row spacing.

Plots at all sites were conventionally tilled (tandem disk) and managed with field-scale machinery throughout the experiment.

P and K fertility needs were managed at each site prior to planting according to standard recommended practices. Just after planting, N was manually surface-applied to split plots in the form of urea (46-0-0) treated with 1.6 ounces of Agrotain urease inhibitor (Koch Agronomic Services, LLC, Wichita, KS) per 50 lbs to reduce risk of ammonia volatilization. Nitrogen treatments were no N applied (0), 50 or 100 lbs /acre of total N.

No herbicides or pesticides were applied to oat plots during the experiment.

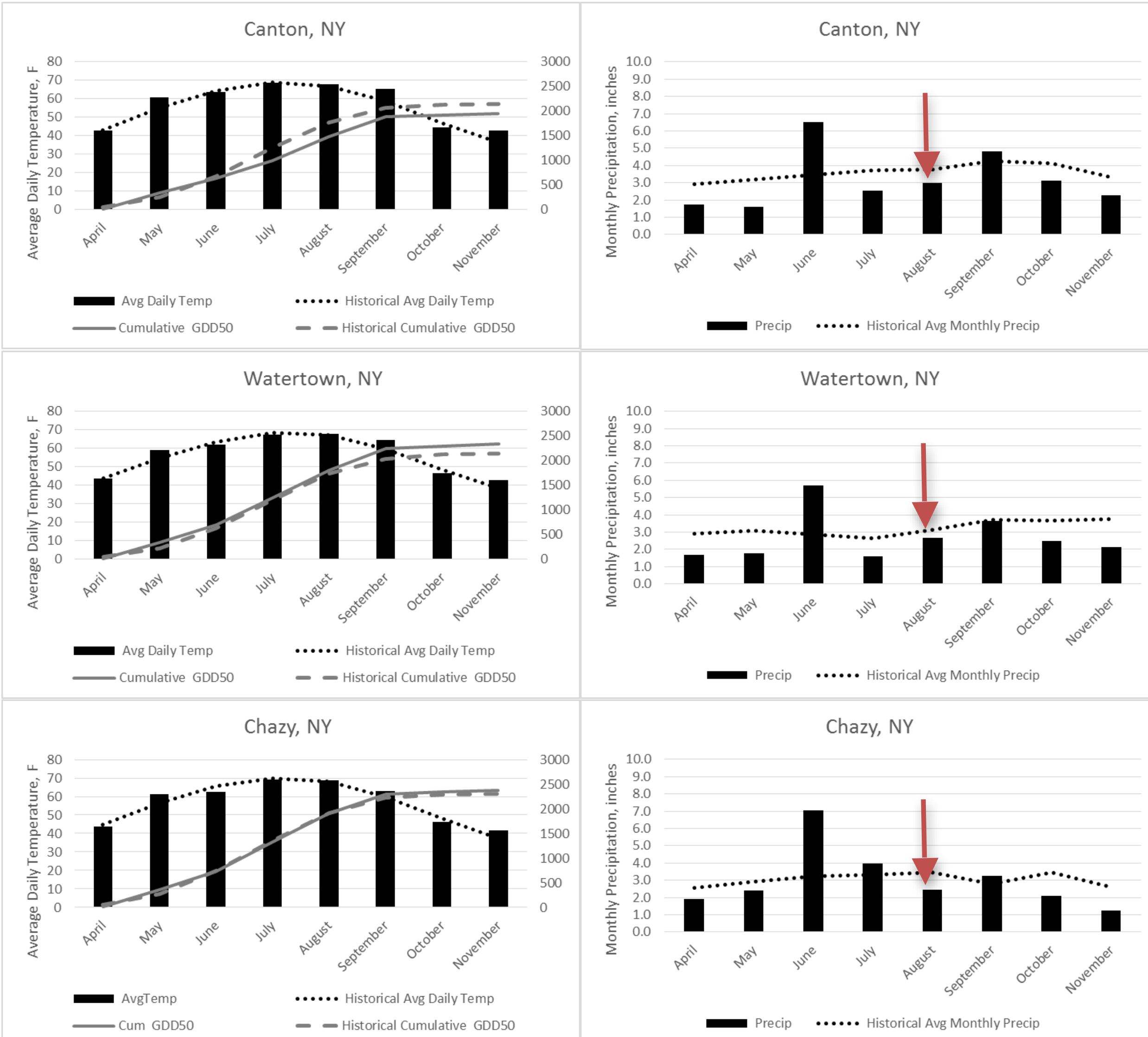

Figure 1. Graphs in the left column depict average monthly temperature in 2015 (dark bars), historical average monthly temperature (dark dotted line) and GDD accumulation for 2015 (solid gray line) and historical GDD accumulation (dashed gray line) for 3 experimental sites. Graphs in the right column depict monthly precipitation totals for 2015 (dark bars) and historical average monthly precipitation totals (dotted line) for all 3 experimental sites. Arrows indicate the approximate planting date at each site.

Forages were sampled at approximately late boot stage by manually clipping plants at 4” above the soil surface. Plant samples were weighed, dried in a 65 ºC forced air oven for 24 hours and weighed again to determine moisture content and DM yield. Dried samples were analyzed with wet chemical methods for standard nutritional components including dry matter, crude protein, acid- and neutral-detergent fiber, non-fiber carbohydrate, relative feed value, total digestible nutrients net energy, metabolizable energy and digestible energy content (DairyOne Lab, Ithaca, NY). Thirty-hour in vitro true digestibility (IVTD) and neutral-detergent fiber digestibility (NDFD) were also measured to feed value for dairy cattle and livestock.

Results:

The 2015 growing season was defined by mild to average temperatures and precipitation extremes. April and May were very dry for all three locations. Canton and Watertown received 49 to 58% of normal rainfall during April and May while Chazy fared slightly better, receiving about 75% of historically normal precipitation.

June was extremely wet. Each of the three trial sites received roughly twice normal rainfall during the month of June.

July marked a return of dry weather for Canton and Watertown where just 60-70% of typical rain was received. Chazy fared better again, receiving a bit more than normal rainfall during July. Subsequently, in Canton and Alexandria, the oat trials were planted into very dry soils, while in Chazy soils were slightly moister.

The month of August was again below normal precipitation totals with the three locations receiving 70-83% of normal rainfall. The dry soil and weather conditions in August resulted in failure of the Alexandria trial. Canton and Chazy plots germinated and were in fair condition.

September rainfall was average or above for both Canton and Chazy. Dry conditions early in the growing period caused uneven, short stands, but the plots at Canton and Chazy did not fail.

Forage yields in the Canton and Chazy locations were lower than expected for both varieties and all N treatments (Table 4). Despite the slightly above-normal precipitation totals for September in both locations, oat plants could not overcome the dry August. Plants were short in all plots.

In addition to short plants, significant crown rust infections were apparent in all plots, but appeared most severe in forage variety plots, in both Canton and Chazy locations, first noticed in early September (Photo 2).

Crown rust (*Puccinia* species) is a common and damaging fungal disease of wild and cultivated oats, grasses and buckthorn. Also called leaf rust, the disease is characterized by dusty orange-colored pustules on leaves and stems. The fungus is not harmful to livestock, but reductions in plant productivity occur as a result of leaf damage, which causes decreased photosynthetic capacity.

Moderate crown rust infection can reduce yields by 10 percent, and greater severity causes larger losses, up to and including crop failure, for susceptible cultivars grown in ideal disease conditions. Severe crown rust not only limits plant growth but can also reduce forage quality.

Crown rust develops and spreads most rapidly during mildly warm (68-77 F) and sunny days with mild nights (60-68 C) with adequate dew and moisture. Conditions were optimal for crown rust in late August and early September in Canton and Chazy. It is also possible that Corral and Foragemaker 50 are not crown rust-resistant varieties.

Forage yield was slightly higher at Chazy than Canton and was greater for the grain variety at Chazy only. Dry matter yield was not significantly affected by N fertility at Canton, but both varieties responded to N fertilization at Chazy, but 50 and 100 lbs of N were not significantly different.

Table 4. Effect of oat type and N fertility on DM yield and crude protein content of oat forage grown in 2015 in Canton and Chazy, NY.

	DM Yield, tons / acre				Crude Protein, % of DM			
	Canton		Chazy		Canton		Chazy	
Grain	0.768		1.328	a	23.2		20.1	
Forage	0.795		0.681	b	21.9		21.7	
0	0.695		0.895	b	18.6	b	20.9	
50	0.783		1.043	ab	24.6	a	21.2	
100	0.865		1.077	a	24.6	a	20.6	
Grain+0	0.826	ab	1.180		18.6		18.4	b
Grain+50	0.710	ab	1.377		24.9		21.7	ab
Grain+100	0.766	ab	1.427		26.2		20.3	ab
Forage+0	0.564	b	0.609		18.7		23.5	a
Forage+50	0.856	ab	0.709		24.2		20.8	ab
Forage+100	0.964	a	0.726		22.9		20.8	ab
ANOVA F-test, p-value								
Oat Type	0.815		**0.001**		0.321		0.114	
N Trtmt	0.081		**0.039**		**0.001**		0.749	
Type*N Trtmt	**0.010**		0.604		0.465		**0.012**	

a,b Values within a column grouping followed by the same letter are not significantly different ($P \leq 0.05$).

Table 5. Effect of oat type and N fertility on NDF content and NFC in oat forage grown in 2015 in Canton and Chazy, NY.

	NDF, % of DM			NFC, % of DM		
	Canton		Chazy	Canton		Chazy
Grain	47.0		57.1	19.0		10.9
Forage	48.6		55.2	18.7		11.2
0	48.0		56.6	22.6	a	10.6
50	46.9		55.4	17.7	b	11.5
100	48.5		56.4	16.2	b	11.1
Grain+0	48.0	ab	59.7	22.6		10.1
Grain+50	47.3	ab	55.1	17.0		11.4
Grain+100	45.7	b	56.5	17.3		11.3
Forage+0	47.9	ab	53.5	22.6		11.2
Forage+50	46.5	ab	55.7	18.5		11.6
Forage+100	51.3	a	56.4	15.1		10.9
ANOVA F-test, p-value						
Oat Type	0.152		0.275	0.782		0.788
N Trtmt	0.325		0.758	**0.001**		0.786
Type*N Trtmt	**0.018**		0.143	0.231		0.845

a,b Values within a column grouping followed by the same letter are not significantly different ($P \leq 0.05$).

Table 6. Effect of oat type and N fertility on 30-hour In Vitro True Digestibility and NDF Digestibility of oat forage grown in 2015 in Canton and Chazy, NY.

	30h IVTD, % of DM				30h NDFD, % of DM			
	Canton		Chazy		Canton		Chazy	
Grain	88.3	a	74.4		75.1	a	54.9	
Forage	84.4	b	77.6		67.8	b	59.6	
0	86.3		76.1		71.8		58.3	
50	86.5		76.6		71.4		57.5	
100	86.1		75.3		71.3		56.0	
Grain+0	87.8	ab	72.3	b	74.3		53.5	
Grain+50	87.0	ab	75.5	ab	73.0		55.3	
Grain+100	90.0	a	75.5	ab	78.0		56.0	
Forage+0	85.0	ab	80.0	a	68.3		63.0	
Forage+50	86.0	ab	77.8	ab	69.8		59.7	
Forage+100	82.3	b	75.0	ab	65.5		56.0	
ANOVA F-test, p-value								
Oat Type	**0.032**		0.059		**0.034**		0.081	
N Trtmt	0.953		0.582		0.965		0.491	
Type*N Trtmt	**0.045**		**0.024**		0.089		0.074	

a,b Values within a column grouping followed by the same letter are not significantly different ($P \leq 0.05$).

Table 7. Effect of oat type and N fertility on yields of crude protein and digestible DM for oat forage grown in 2015 in Canton and Chazy, NY.

	Crude Protein Yield, tons / acre				Digestible DM, tons / acre			
	Canton		Chazy		Canton		Chazy	
Grain	0.179		0.268	a	0.675		0.988	a
Forage	0.177		0.147	b	0.669		0.526	b
0	0.131	b	0.179	b	0.600		0.670	b
50	0.191	a	0.223	a	0.675		0.791	a
100	0.211	a	0.221	a	0.741		0.811	a
Grain+0	0.157		0.215		0.722	ab	0.853	
Grain+50	0.177		0.299		0.614	ab	1.032	
Grain+100	0.201		0.291		0.689	ab	1.078	
Forage+0	0.105		0.144		0.479	b	0.486	
Forage+50	0.205		0.148		0.735	ab	0.550	
Forage+100	0.221		0.151		0.793	a	0.543	
ANOVA F-test, p-value								
Oat Type	0.950		**0.004**		0.955		**0.001**	
N Trtmt	**0.002**		**0.051**		0.089		**0.017**	
Type*N Trtmt	0.081		0.092		**0.013**		0.198	

a,b Values within a column grouping followed by the same letter are not significantly different ($P \leq 0.05$).

Crude protein is typically expected to respond to N fertilization when N is limiting, however Canton was the only site where CP was increased with N treatment. Both varieties appeared to improve in CP with fertilization though 50 lbs and 100 lbs of N were not different.

NDF and NFC differed between the two trial sites. Overall, it appears that Canton forages were of higher nutritional quality than Chazy forages despite being at approximately the same growth stage – late boot. Canton forages contained less NDF and more NFC than Chazy-grown forages (Table 5).

Canton forages also had higher IVTD and NDFD measures compared with Chazy oats (Table 6). It is unclear whether moisture stress and crown rust infections affected oat forage quality at one or both locations. Both sites accumulated roughly 900 GDD during the growth of the oat trial, though this sum was slightly more GDD than normal for Chazy and fewer than normal for Canton for that time period. In Canton, the grain variety had higher IVTD and NDFD than the forage variety. Neither IVTD nor NDFD was affected significantly by N fertilization at either trial site.

Yield of CP or digestible DM per acre were greater for the grain variety and also for plots receiving N fertilizer at the Chazy trial, though 50 or 100 lbs of N were similar for both parameters (Table 7). CP per acre responded to N fertilizers similarly at Canton, though overall yield was much less.

Conclusions/Outcomes/Impacts:

Results of this study were complicated by droughty conditions early in the growth period and fungal pathogen effects later in the growth period. Both impacts are possible in any given year in Northern NY, which may affect the feasibility of late summer oats as an emergency forage option.

Productivity of both grain and forage oat varieties was poor in this trial, regardless of location and N fertility treatment. Forage quality was very good, despite poor yields. In Chazy, where dry conditions were slightly less severe, the grain variety yielded best and both oat varieties responded to N fertility, though 100 lbs of N was not significantly better than 50 lbs.

This experiment will be repeated in 2016 and will hopefully yield clearer results. Crown rust-resistant varieties will be sought for 2016.

Outreach:

We plan to develop a practical guide for growing and fertilizing summer-planted oats for forage production for high-quality livestock feed, however a second year of results is required for robust recommendations.

An agronomy factsheet will be written summarizing best management practices for forage oats. Research will be summarized for distribution across the 6-county region in CCE Field Crops News and local county newsletters.

The research summarized here builds on experience with summer annual forage options appropriate for Northern NY.

Next steps:

The 2015 growing season provided a good reminder of why two or more years of results are preferable for developing solid guidelines and robust recommendations for any cropping practice. NNYADP funding was awarded to repeat this trial in 2016 and will result in published practical recommendations and guidelines for Northern NY growers.

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