

# Northern NY Agricultural Development Program 2008-2009 Project Report

**Project Title:** Production/Evaluation of Grasses for Energy Conversion in NNY

**Project Leader(s):** D.R. Viands, J. Hansen, H. Mayton, Extension Associate, Department of Plant Breeding and Genetics; Cornell University;

**Collaborator(s):** Michael H. Davis, Research Associate, Department of Crop and Soil Sciences, Cornell University and Mike Hunter CCE Jefferson County.

**Cooperating Producers:** W.H. Miner Institute, Clinton County, NY; 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 most widely used bioenergy crop for ethanol production in the Midwest. Grasses and legumes, used as feedstock for biofuel, have the potential to be more economical and environmentally sustainable than corn-ethanol production. Perennial grasses reduce greenhouse gas emissions and soil erosion by sequestration of carbon from the atmosphere and 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 high biomass production. However, 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. Thus, data obtained in the Midwest trials may not reflect how the perennial grass will perform in New York. Since yield is highly influenced by environmental conditions, we feel it is important to evaluate these grasses in as many bioregions of New York as possible.

In 2007, our research group was funded by the Northern New York Agricultural Development Program (NNYADP) to evaluate perennial grasses as a feedstock for biofuel production. In addition to the funds from the NNYADP, our group also received funding for perennial grass yield trials by the New York Farm Viability Institute (NYFVI). In the spring of 2007, a cultivar evaluation trial with six replicates of 20 monoculture and 4 mixed plots of warm season grass species was planted in Jefferson County. The perennial grass trials were planted in three other regions of New York in 2007. Through funding from this project both warm and cool season perennial grass trials were planted in the eastern region (Clinton County, Miner Institute) of Northern NY in 2008, to determine which species and cultivars have potential to generate the maximum biomass production (Tables 1 and 2). The goals are to identify high yielding grass species and cultivars that can be harvested in an efficient and timely manner and used for conversion to liquid fuels, gases and combustible products. Identification of these grass

species and cultivars in NNY will benefit current and potential producers in the region by providing information on which grasses to establish for dedicated bioenergy production.

**Methods:** Replicated warm and cool season perennial grass trials were established on the 9<sup>th</sup> of May in 2008, at the Miner Institute in Clinton County, NY. Plots for both trials (3.5' X 15') each with six rows spaced six inches apart, were established in a randomized complete block design with six replications. Trials were established with a Carter (Carter Manufacturing Co., Brookston, ID) small plot seeder. For the warm season grass trial, 20 trial entries were planted in monoculture and four entries consisted of a mixture of two different grass species (Table 3). Seven trial entries of four cool season perennial grass species (Tables 4) were established in the cool season grass trial. Both fields were plowed and fertilized (300 lb/A 10-20-20) before seeding. Data on yield, % stand, canopy, height, and maturity rating for the warm season grasses were collected. Data on yield, % stand, and canopy height were collected from the cool season grasses harvested on a two-cut schedule (July 13 and September 1).

**Results:** The harvest in 2009 was the first production year for the Miner Institute warm season grass trial. Typically, for warm season grasses, the first production year yield is usually approximately 50% of the yield of a mature stand. Therefore yield data in 2010 should be approximately 50% greater than this year's yields.

For the warm season grasses trial at the Miner Institute, yields ranged from 1.7 dry tons per acre for the eastern gamma grass cultivar 'Pete' to 5.8 dry tons per acre for the switchgrass/ big bluestem 'Cave-in-rock'/ 'Bonanza' cultivar mixture (Table 5). The average yield across all entries was 3.5 dry tons per acre. Percent stand ranged from 46.2 – 97.9 for the eastern gamagrass cultivar Pete and switchgrass cultivar 'Shawnee', respectively. The average stand was 81.4 %. Canopy height ranged from 34 inches for the big bluestem cultivar 'Goldmine' and eastern gamagrass cultivar Pete to 54 inches for the switchgrass cultivar 'Cave-in-Rock' (07-302). The average canopy height was ~ 44 inches. Maturity rating based on a scale of 0-5, where 0=dead and 5 lush green tissue) ranged from 2.8 for the switchgrass cultivar 'Nebraska 28' to 5.00 for six other entries. The average maturity rating was 4.2. Yield, percent stand, canopy height, and maturity rating varied by species and cultivar. Maturity was fairly high compared to the other regional trials due to the early harvest date of 1 September 2009. Yield data from the Clinton County trial for most entries was approximately 2/3 of the yield observed in trials established in 2007 (Table 6). The lowland cultivar 'Kanlow' which is susceptible to winter injury did not yield as well in Jefferson and Clinton Counties as in other parts of the state. Cultivars 'Blackwell', Shawnee and Cave-in-rock did well in both counties.

For the cool season grass trial at the Miner Institute, total season yields ranged from 7.4 dry tons per acre for the reed canarygrass cultivar 'Bellevue' to 10.1 dry tons per acre for the tall fescue cultivar 'Enhance' (Table 7). The average total season yield was 8.4 dry tons per acre. First harvest yields ranged from 4.6 dry tons per acre for the tall fescue cultivar 'Bull' to 6.3 dry tons per acre for the wheatgrass cultivar 'Largo'. The average first harvest yield was 2.8 dry tons per acre. Second harvest yields ranged from 1.6 dry tons per acre for the wheatgrass cultivar Largo to 3.9 dry tons per acre for the tall fescue

cultivar 'Enhance'. Plant stands ranged from 85-100 % for the wheatgrass cultivar Largo and bromegrass cultivars 'Peak' and 'York'. The average % stand was 95.1. Canopy height ranged from 12.3 inches for wheatgrass cultivar 'Jose' to 27.0 inches for the reed canarygrass cultivar Bellevue. The average canopy height was 19.2 inches. Yield, percent stand, and canopy height varied by species and cultivar.

**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. A quick germination test can be done to check seed quality. The protocol for this test can be downloaded from our project web-site ([nybiofuels.info](http://nybiofuels.info)). We are also working with Dr. Alan Taylor on refining the quick germination test. Establishment of the warm season perennial grasses without the use of post-emergent herbicide applications resulted in plots with heavy weed pressure, yet good stands of the grasses were obtained in most cases. Competition with annual and perennial weeds is a common problem in establishment years for warm season perennial grass field trials, as has been reported in the literature. Results from these trials will be compared with trials established in other regions of the state. A few of the warm season grass cultivars have been reported to have problems with winter survival. As a result, stand and yield data in 2009 may have different rankings from the trials in NNY than from other locations.

The mean dry tons/acre was higher from the cool season grass trial harvested at the Miner Institute (8.4) than the trial in Ithaca (7.7) in 2009.

Data from these trials already are providing information that is useful in establishing best management practices for growers to obtain good stand establishment and higher biomass yields.

**Outreach:** 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 11, 2009. A field day was held in St. Lawrence County on the farm owned and operated by Tom Lee September 23, 2009 where a strip trial of perennial warm season grasses was established in 2007. Through personal conversations with producers attending the field day in St. Lawrence County, it was understood that the information provided was helpful for their future plans in planting these types of grasses. Six posters describing the perennial grass bioenergy project (36" x 42") were made for display in each of the six regional county extension offices. These posters were handed out at the field crop agents meeting held in Ithaca on 27 January. We will also be developing fact sheets/handouts that will be delivered to the regional offices.

Some information relating to these trials and others in NNY has been reported in newspaper articles and news stories.

**Next steps if results suggest continued work is needed in the areas of research, demonstration and/or education.** Research on seed quality, germination and dormancy in relation to successful stand establishment is necessary to make gains in production of these grasses. Analysis of biomass harvested from these trials for quality characteristics of economic significance such as quantity and type of cell wall sugars, theoretical ethanol yield, ash and mineral content, and total BTU's are currently underway. Nitrogen utilization efficiency data are needed to develop best management practices to maximize yields with the best economic return.

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**Reports and/or articles in which the results of this project have already been published.** Data from these trials have been reported in the 2009 Forage Breeding Project Annual Databook produced by the Forage Breeding project at Cornell University.

**Person(s) to contact for more information (including farmers who have participated:** Hilary Mayton [hsm1@cornell.edu](mailto:hsm1@cornell.edu); Julie Hansen [jlh17@cornell.edu](mailto:jlh17@cornell.edu); and Donald Viands [drv3@cornell.edu](mailto: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>; Mike Hunter Cornell Cooperative Extension [meh27@cornell.edu](mailto:meh27@cornell.edu); Michael H. Davis, Research Associate, Department of Crop and Soil Sciences, Cornell University; and Farm Manager, Cornell Baker Research Farm, Willsboro, NY, 518-963-7492, [mhd11@cornell.edu](mailto:mhd11@cornell.edu).

## Appendices

**Table 1.** Common and scientific names of warm season perennial grasses established in small plot trials at the Miner Institute, Clinton County, NY.

<b>Common name</b>	<b>Species</b>
big bluestem	<i>Andropogon gerardii</i>
coastal panic grass	<i>Panicum amarulum</i>
eastern gamagrass	<i>Tripsacum dactyloides</i>
Indiangrass	<i>Sorghastrum nutans</i>
Switchgrass	<i>Panicum virgatum</i>

**Table 2.** Common and scientific names of warm cool season perennial grasses established in small plot trials at the Miner Institute, Clinton County, NY.

<b>Common name</b>	<b>Species</b>
wheatgrass	<i>Thinopyrum ponticum</i>
tall fescue	<i>Festuca arundinacea</i>
Reed canarygrass	<i>Phalaris arundinacea</i>
Brome grass	<i>Bromus inersis</i>

**Table 3.** Cultivar, common name, % pure live seed (PLS), seed tag label % quick germination, and seeding rate of perennial grass entries in cultivar evaluation trials.

<b>Cultivar</b>	<b>Common name</b>	<b>Seeding Rate lbs /Acre</b>
Jose	Wheatgrass	40
Largo	Wheatgrass	40
Enhance tall fescue	tall fescue	20
Bull tall fescue	tall fescue	20
Bellevue	reed canarygrass	20
Peak	brome grass	20
York	brome grass	20

**Table 4.** Cultivar, common name, % pure live seed (PLS), seed tag label % quick germination, and seeding rate of warm season perennial grass entries in cultivar evaluation trials.

Cultivar	Common name	% PLS*		% Seed tag quick germination	Seeding Rate lb PLS/A
Bonanza	big bluestem	72		80	12
Goldmine	big bluestem	56		68	12
Niagara	big bluestem	22		74	12
Pawnee	big bluestem	63		68	12
Atlantic	coastal	87		88	8
	panic grass				
Pete	eastern	84		30	10
	gamagrass				
Rumsey	indiangrass	86		78	10
Nebraska 54	indiangrass	92		67	10
Blackwell	switchgrass	86		31	10
Carthage	switchgrass	94		51	10
Cave-in-rock	switchgrass	95		71	10
Cave-in-rock***	switchgrass	95		37	10
Forestburg	switchgrass	77		21	10
Kanlow	switchgrass	93		86	10
Pathfinder	switchgrass	74		16	10
Shawnee	switchgrass	93		93	10
Shelter	switchgrass	86		22	10
Sunburst	switchgrass	98		98	10
Trailblazer	switchgrass	93		83	10
Nebraska 28	switchgrass	92		92	10
Cave-in-rock	switchgrass	95	72	37	5
Bonanza	big bluestem			80	6
	switchgrass	98	22	98	5
Sunburst/ Niagara	big bluestem			74	6
	switchgrass	95	84	37	5
Cave-in-rock /Pete	eastern			30	5
	gamagrass				
Niagara/ Pete	big bluestem	22	84	74	6
	eastern			30	5
	gamagrass				

\* % 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 5.** Cultivar, species, yield, % stand, height of canopy, and maturity rating of perennial warm season grasses established at the Miner Institute.

<b>2008 Warm Season Chazy, Clinton County, Sown May 8, 2008</b>					
<b>Cultivar</b>	<b>Species</b>	<b>2009</b>	<b>1-Sep-09</b>		
		<b>1-Sep Yield</b>	<b>% Stand</b>	<b>Canopy Height (in.)</b>	<b>Maturity</b>
Bonanza	big bluestem	3.35	93.33	34.83	4.83
Goldmine	big bluestem	2.69	66.33	34.33	4.83
Niagara	big bluestem	2.04	82.00	36.83	5.00
Atlantic	coastal panic grass	2.48	46.17	39.67	4.83
Pete	e.gamagrass	1.72	57.83	34.33	4.83
Blackwell	switchgrass	4.80	84.33	45.83	3.50
Carthage	switchgrass	3.34	84.83	46.50	4.00
Cave-in-rock (07-302)	switchgrass	4.93	95.33	54.00	3.67
Cave-in-rock (07-338)*	switchgrass	4.27	90.83	52.67	3.50
Forestburg	switchgrass	2.41	79.33	42.33	3.33
Kanlow	switchgrass	3.21	75.83	50.50	5.00
Pathfinder	switchgrass	3.95	82.33	44.67	3.83
Shawnee	switchgrass	5.15	97.67	50.83	3.33
Shelter	switchgrass	4.24	91.00	47.83	4.00
Sunburst	switchgrass	3.48	92.83	49.50	3.17
Trailblazer	switchgrass	4.38	93.00	49.17	3.33
Nebraska 54	indiangrass	2.97	71.00	42.17	5.00
Nebraska 28	switchgrass	2.36	79.67	42.17	2.83
Rumsey	indiangrass	2.70	69.67	43.17	5.00
Pawnee	big bluestem	2.57	97.33	34.83	5.00
Mixtures 1	Cave-in-Rock/Bonanza	5.78	91.33	50.50	4.25
Mixtures 2	Sunburst/Niagara	2.94	72.50	42.33	4.42
Mixtures 3	Cave-in-Rock/Pete	5.14	82.00	47.50	4.33
Mixtures 4	Niagara/Pete	2.60	77.83	39.00	5.00
<b>Average</b>		3.48	81.43	43.98	4.20
<b>F-entries</b>		3.26**	3.81**	7.25**	14.34**
<b>LSD(.05)</b>		1.76	20.90	6.37	0.54
<b>CV(%)</b>		35.7	22.5	12.7	11.2

Notes:

Cave-in-Rock lot no. 07-338 was stratified prior to planting

Pathfinder seed lot was contaminated with (99%) foxtail seed

\*\* Significant at 0.01

Yield = dry tons/acre

% Stand based on visual rating

Height measured is canopy height at harvest

Maturity rating based on a 0-5 scale: 0 = senescent; 5 = green at harvest

Yield is based on reps 1-4

Table 6. Comparison of yield data from five counties in NY. Trial entry, common name, and yield (dry tons/acre) data from replicated small plot trials harvested in October 2009. The trials were established in Tompkins, Chemung, Jefferson, and Genesee, NY in 2007. Trial in Clinton County was established in 2008.

Entry	Common name	2009 Yield Dry Tons/Acre				
		Tompkins	Chemung	Jefferson	Genesee	Clinton
Bonanza	big bluestem	1.7	2.0	3.8	1.7	3.4
Niagara	big bluestem	3.4	3.1	3.1	4.8	2.0
Atlantic	coastal panic grass	8.6	5.7	3.7	5.0	2.5
Pete	e.gamagrass	4.9	3.6	1.4	4.0	1.7
Blackwell	switchgrass	9.5	7.4	6.2	7.5	4.8
Carthage	switchgrass	9.0	6.1	4.8	5.8	3.3
Cave-in-rock	switchgrass	10.4	7.7	5.1	6.1	4.9
Kanlow	switchgrass	10.3	3.7	2.4	5.8	2.4
Shawnee	switchgrass	9.9	8.3	5.0	7.2	5.2
Shelter	switchgrass	9.2	6.7	4.9	6.5	4.2
Sunburst	switchgrass	5.3	3.0	3.3	4.0	3.5
Trailblazer	switchgrass	6.0	5.2	4.4	4.1	4.4
Nebraska 54	indiangrass	6.5	3.3	5.5	5.1	3.0
Nebraska 28	switchgrass	4.7	4.1	3.1	3.0	2.4
Rumsey	indiangrass	6.2	3.5	5.1	5.3	2.7
Pawnee	big bluestem	2.6	2.7	3.3	1.7	2.6
Mixtures 1	Cave-in-Rock/Bonanza	10.5	7.2	5.1	6.3	5.8
Mixtures 2	Sunburst/Niagara	6.3	3.6	3.4	4.4	2.9
Mixtures 3	Cave-in-Rock/Pete	10.8	7.7	5.5	7.6	5.1
Mixtures 4	Niagara/Pete	4.1	4.5	2.7	3.8	2.6
	Overall mean	6.6	4.8	4.0	4.8	3.48
	F-entries	29.5**	14.1**	8.9**	10.2**	3.26
	LSD(.05)	1.6	1.5	1.2	1.5	1.7

\*\* Significant at 0.01

**Table 7.** Cultivar yield height of canopy (two dates), and % stand of perennial cool season grasses established at the Miner Institute in 2008, harvested in a two-cut system.



**2008 Cool Season  
Chazy, Clinton County, Sown May 8, 2008**

Entry	2009			2008	13-Jul-09		1-Sep-09	
	13-Jul Yield	1-Sep Yield	Total Season	Total Season	% Stand	Canopy Height (in.)	% Stand	Canopy Height (in.)
Jose Wheatgrass	5.96	1.64	7.60	1.57	92.17	30.83	85.83	12.33
Largo Wheatgrass	6.31	1.55	7.85	1.91	91.67	34.00	85.00	14.33
Enhance Tall Fescue	6.13	3.96	10.08	2.79	94.17	26.67	98.83	14.67
Bull Tall Fescue	4.61	3.68	8.29	2.94	92.50	25.00	97.50	15.83
Bellevue R. Canarygrass	4.64	2.73	7.37	2.24	88.33	37.17	98.83	27.00
Peak Brome	5.89	3.04	8.93	2.58	87.17	36.00	100.00	24.83
York Brome	5.47	2.97	8.44	2.62	85.83	35.67	100.00	25.50
<b>Trial Mean (T/A)</b>	5.57	2.80	8.37	2.38	90.26	32.19	95.14	19.21
<b>F-entries</b>	14.49**	60.97**	15.48**	24.58**	3.34*	14.91**	54.53**	55.65**
<b>LSD (.05)</b>	0.53	0.34	0.68	0.29	4.94	3.59	2.62	2.42
<b>CV (%)</b>	8.1	10.4	6.9	10.3	4.6	9.5	2.3	10.7

Note:

\* Significant at 0.05

\*\* Significant at 0.01

Yield = dry tons/acre

% Stand based on visual rating

Height measured is canopy height at harvest

## Photos

September 2009 warm season perennial grass trial



2) 1 September 2009 warm season perennial grass trial harvest (2)



3) September 2009 cool season perennial grass trial harvest

