Northern NY Agricultural Development Program
2004 Project Report

Brown Midrib Sorghum Sudangrass: An Economic and Environmentally-Sound Alternative to Corn in Northern New York?

Project Leader(s):

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Background:

A significant acreage of agricultural land in the Northeast USA cannot produce economic yields of corn silage. Northern NY has been hit especially hard these past several of years with wet springs and droughts. This has resulted in a growing interest in the use of brown midrib (BMR) sorghum sudangrass as a forage crop. The crop is adapted to a wide range of soil types, topography, low soil pH, high temperature and excess moisture. With multiple cut systems and high N application rates, BMR sorghum sudangrass can produce twice as much protein as corn silage. The BMR sorghum sudangrass has high digestibility and has the potential to support a high forage diet. A high forge diet reduces the amount of feed concentrates brought onto the farm and this in turn reduces P loading on farms from imported animal feed.

The BMR sorghum sudangrass may have less detrimental effect on the environment compared with corn silage. The USDA NRCS rates the soil erosion potential of sorghum sudangrass to be much lower than that of corn. The crop has rapid emergence and this may negate the need for herbicides with proper seedbed preparation. Also, there is no economic losses. Likewise, crop damage from rodents or deer seems to be minimal. A need to use insecticides and nematicides as both insects and nematodes do not cause 2- cut system is possible with BMR sorghum sudangrass. This allows for a split application of manure in summer when the risk of nitrogen losses through leaching, denitrification and phosphorus losses through runoff is reduced.

The BMR sorghum sudangrass is more tolerant of a shorter growing season than silage corn, allowing for more flexibility in planting date. Likewise, it has a larger harvest window than silage corn, allowing for better utilization of labor and farm equipment. The transition from growing silage corn to BMR sorghum sudangrass is not expected to be expensive for farmers. The crop can be grown using the conventional hay forage planting and harvesting equipment and this eliminates the need to invest in extra machinery.

The agronomic management of BMR sorghum sudangrass is not well defined because BMR sorghum sudangrass is a relatively new crop to the Northeast USA. Research conducted these past years included trials on stand height management (determination of harvest time optimum for both yield and quality), seeding rate studies, potassium needs and phosphorus removal. These trials included studies conducted by Pete Barney, Cornell Cooperative Extension of St Lawrence County. Studies on optimum N rates were done at the Valatie Research Farm in Columbia Co and the Mt Pleasant Research Farm in Tompkins Co. We needed to expand our efforts on determining optimum N rates and to address these questions for NNY, trials were conducted in St Lawrence Co, Lewis/Jefferson Co, and at the Willsboro Research Farm in Essex County in the 2004 growing season.

Methods:

Three fully replicated trials were conducted in 2004. The trials were conducted in St Lawrence County (leader: Pete Barney, Cornell Cooperative Extension of St Lawrence Co), at a farm in Lewis/Jefferson Co (Leader: Mike Hunter, Cornell Cooperative Extension of Lewis and Jefferson Counties), and at the Willsboro Research farm in Essex Co (leaders: Ketterings/Cherney/Davis). There were 6 N rates (0, 50, 100, 150, 200 and 250 lbs/acre per cut), four replicates per treatment and 2 cuttings at the sites in Essex and St Lawrence Co and one in Jefferson Co. Soil samples were taken for each plot just prior to planting (Table 1) and after each of the two harvests to evaluate soil nitrate and soluble salt levels. Yields were determined and forage analyses were done.

Table 1: Soil fertility of the 3 NNY trial sites.

	Soil Fertility at Onset of the Trials (n=24)		
	Jefferson	**St Lawrence**	**Essex**
Soil Series	**Rhinebeck silt loam**	**Hailesboro silt loam**	**Cosad loamy fine sand**
Cropping history	**Continuous corn**	**Sorghum sudangrass**	**First year following grass/alfalfa sod kill**
pH (1:1)	6.1	6.4	6.5
OM (%)	4.3	4.1	3.4
P (mg P/kg)†	7.2	5.2	14.0
K (mg K/kg)†	58	53	24
Ca (mg Ca/kg)†	1208	1327	1250
Mg (mg Mg/kg)†	203	223	91
Nitrate (mg N/kg)	5.6	10.5	7.9
Salts (mmho)	0.14	0.14	0.16

†Values are reported in mg/kg (equals ppm). To convert to lbs/acre multiply values by two.

Results:

Optimum economic yields varied from 7.2 tons/acre (65% moisture) for the site in Jefferson County (one cut only) to 13.4 tons/acre in Essex Co (Figure 1).

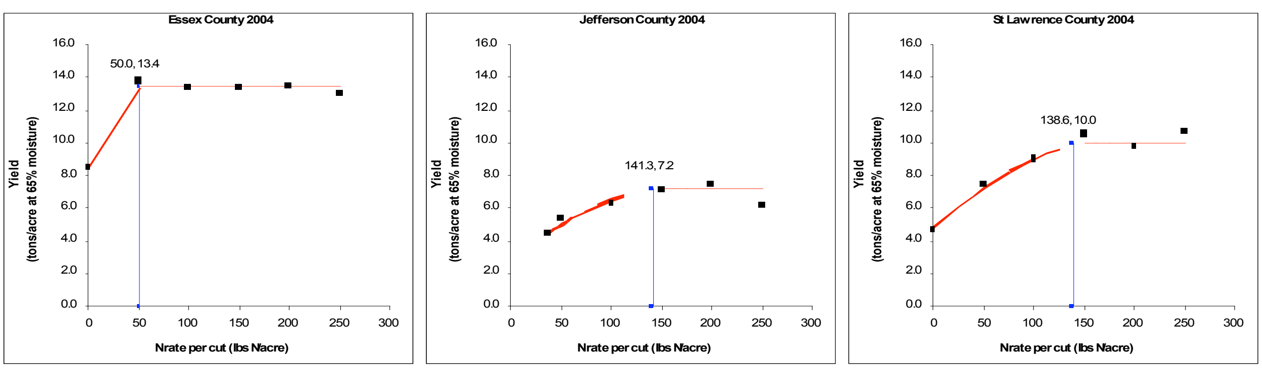

Figure 1: Optimum economic N rates for BMR sorghum sudangrass. The Essex County site followed plowdown of a legume containing sod. The Jefferson County site was one cut only (versus 2 cuts at the other two sites).

The economic optimum fertilizer N rates assuming fixed costs of $178/acre, a nitrogen fertilizer cost of $0.32 per pound and a forage value of $35 per ton (65% dry matter), were about 140 lbs/acre for the one-cut trial in Jefferson Co, and the 2-cut trial in St Lawrence Co, and <50 lbs/acre per cut in Essex Co (first year crop following grass/alfalfa plow-down). However, returns per acre at optimum economic yield were variable ($27, $82, $259 per acre for Jefferson, St Lawrence, Essex, respectively). Nitrogen released from the sod that was killed in the spring of 2004 substantially reduced the amount of N needed for optimum production and this resulted in a higher return per acre in Essex County.

Table 2: Optimum economic N rates, return per acre and yield at the optimum economic N rate as well as reported corn yield potential for 3 Northern New York sites.

	Optimum economic N rate (OENR)	Return per acre at OENR	Yield at OENR	Reported corn yield potential
	lbs N/acre per cut (N uptake efficiency)	$/acre	tons/acre (65% moisture)	tons/acre (65% moisture) Undrained/Drained
Jefferson	141 (37%)	27	7.2	17.9 / 20.4
St Lawrence	139 (39%)	82	10.0	18.7 / 21.3
Essex	<50 (60%)	259	13.4	17.9 / 20.4

Residual N levels (N left in the soil profile following the second cut) were of environmental concern with application rates greater than 150 lbs N per cut in the trials in Jefferson and St Lawrence counties (Table 3). Nitrogen uptake efficiencies at optimum economic N rates were low in all trials (although much higher for the site following sod in Essex Co than in the other two sites) and uptake efficiencies steadily declined with N application beyond the economic optimum N rate for all trials except for the Jefferson County trial where there was no clear relationship between N uptake efficiency and N rate.

Although no direct comparison was done, yields seemed lower than would have been expected for corn in such a good growing season as we had in 2004 (Table 2) but silage quality expressed as milk production per ton of silage (Table 3) was probably higher than would be expected for corn (direct comparisons are needed!).

Table 3: BMR sorghum sudangrass yield, predicted milk production, nitrogen uptake, pre- and post-harvest soil nitrate and soluble salts as affected by N rates in NNY (2004 season) †.

Total N applied	Yield (35% dm)	Estimated Milk Production		N uptake	Soil Nitrate		Soluble Salts	
					Initial	At 2nd cut	Initial	At 2nd cut
lbs/acre	tons/acre	lbs/ton	lbs/acre	lbs/acre	mg/kg (=ppm)		mmho	
Jefferson County Trial (one cut only!)								
37	4.4 b	4009 a	6152 a	27 c	6.0 a	2.3 b	0.16 a	0.14 b
50	5.4 ab	3899 a	7418 a	30 bc	4.8 a	1.5 b	0.14 a	0.16 b
100	6.3 ab	4081 a	8923 a	39 bc	3.3 a	3.0 b	0.14 a	0.21 b
150	7.1 ab	3805 a	9382 a	70 ab	7.0 a	5.0 b	0.13 a	0.22 b
200	7.5 a	4160 a	10946 a	105 a	7.0 a	29.6 ab	0.15 a	0.39 ab
250	6.2 ab	4107 a	8800 a	95 a	5.3 a	58.1 a	0.15 a	0.62 a
St Lawrence County Trial								
0	4.7 c	3747 a	6104 d	50 c	10.5 a	7.5 a	0.15 a	0.14 b
100	7.5 b	3883 a	10198 c	91 b	12.0 a	12.0 a	0.16 a	0.20 ab
200	9.0 ab	3700 a	11652 bc	117 b	9.7 a	5.6 a	0.13 a	0.23 ab
300	10.5 a	3733 a	13706 a	169 a	7.4 a	13.8 a	0.14 a	0.30 ab
400	9.8 a	3763 a	12909 ab	177 a	10.6 a	16.0 a	0.14 a	0.33 a
500	10.7 a	3670 a	13652 a	201 a	13.0 a	22.9 a	0.15 a	0.35 a
Essex County Trial (following grass sod plowdown)								
0	8.5 b	4020 a	11964 a	63 b	7.7 a	0 a	0.17 a	0.13 ab
100	13.8 a	4011 a	19014 a	125 ab	8.4 a	0 a	0.18 a	0.13 ab
200	13.4 a	4094 a	19171 a	166 a	6.1 a	0 a	0.15 a	0.11 b
300	13.3 a	3964 a	18546 a	173 a	10.5 a	0 a	0.18 a	0.13 ab
400	13.5 a	3973 a	18772 a	183 a	6.1 a	1.2 a	0.15 a	0.15 a
500	13.0 a	3965 a	18020 a	165 a	8.9 a	2.2 a	0.17 a	0.16 a

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

Nitrogen application increased crude protein levels in all trials (Table 4) with percentages ranging from 6.1% without N addition in Essex County to 17% with the addition of 250 lbs of N/acre per cut in St Lawrence County. Digestibility of NDF was high and only declined with N application for the second cuts. Estimated milk yields were directly related to dry matter yields although silage quality declined slightly when stands became too tall.

Table 4: Effect of N application on crude protein (CP), neutral detergent fiber (NDF) and digestibility of NDF (dNDF) of BMR sorghum sudangrass grown at the 3 NNY trial sites.

N applied per cut lbs N/acre	Crude Protein (% of DM)					
	First Cut			Second Cut		
	Jefferson‡	St Lawrence	Essex	Jefferson‡	St Lawrence	Essex
0	.	10.2 c	6.1 b	.	8.4 d	7.9 bc
37	5.7 bc	.	.	.	.	.
50	5.2 c	12.3 bc	8.9 ab	.	9.6 cd	7.2 c
100	5.6 bc	11.3 bc	12.6 ab	.	11.9 bc	9.2 ab
150	8.7 b	14.5 ab	12.8 ab	.	14.3 ab	9.8 a
200	12.5 a	16.9 a	14.0 a	.	15.7 a	10.0 a
250	13.9 a	17.0 a	12.0 ab	.	16.5 a	10.9 a
	NDF (% of DM)					
	First Cut			Second Cut		
	Jefferson‡	St Lawrence	Essex	Jefferson‡	St Lawrence	Essex
0	.	64.4 a	66.6 a	.	61.2 a	64.0 a
37	.	.	.	.	.	.
50	63.9 a	.	.	.	.	.
100	61.5 ab	64.0 ab	65.5 ab	.	58.1 b	61.4 ab
150	59.3 bc	64.1 ab	63.5 ab	.	56.3 bc	64.0 a
200	60.4 b	61.9 ab	61.5 ab	.	56.1 bc	60.7 ab
250	58.7 bc	61.4 b	60.7 b	.	55.6 c	59.0 b
	dNDF (% of DM – 48 hr)					
	First Cut			Second Cut		
	Jefferson‡	St Lawrence	Essex	Jefferson‡	St Lawrence	Essex
0	.	73.1 a	77.7 a	.	84.7 a	84.4 a
0+M	.	.	.	.	.	.
37	79.5 a	.	.	.	.	.
50	76.0 a	76.9 a	78.9 a	.	79.5 ab	76.6 ab
100	78.0 a	70.8 a	79.2 a	.	76.9 b	79.5 ab
150	72.5 a	70.8 a	74.2 a	.	78.0 ab	77.7 ab
200	78.9 a	72.2 a	77.4 a	.	78.0 ab	73.1 b
250	78.9 a	69.6 a	78.6 a	.	76.6 b	71.3 b

†Average values *within columns* with different letters (a,b,c) are statistically different ($\alpha = 0.05$)
‡All plots received a base N application of 37 lbs N/acre.

Conclusions:

Optimum N rates ranged from about 50 lbs N/acre per cut in the site in Essex County where BMR sorghum sudangrass followed a sod plowdown to about 140 lbs N/acre per cut for the sites in Jefferson and St Lawrence County. Estimated milk yields were directly related to dry matter yields. The results of these 3 trials need to be combined with our previous work on N rate studies and the 3 additional trials that were conducted in 2004 (one site in Cayuga County, one in Tompkins County and one in Columbia County) to draw final conclusions but these trials indicated that this crop needs to be fertilized like a grass rather than like corn. The Essex trial suggests that past sod credits need to be taken into account. Direct comparisons with corn production are needed to conclude if this crop can compete for dry matter production and estimated milk production with corn.

Outreach:

We are working on a final summary of these trials that includes the three additional sites and previous 2 years of work. Once the summary is complete (expected in April), extension articles will be written and the data and conclusions will be presented through various venues (extension newsletters, presentations, Nutrient Management Spear Program websites for NNY projects (http://nmsp.css.cornell.edu/projects/nny.asp) and for the BMR sorghum sudangrass project (http://nmsp.css.cornell.edu/projects/bmr.asp), updated fact sheet etc.) and statewide venues.

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Acknowledgements:

A full list of articles on BMR sorghum sudangrass research can be found at our project website: http://nmsp.css.cornell.edu/projects/bmr.asp.

For More Information:

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For statewide BMR sorghum sudangrass work, contact Tom Kilcer, Cornell Cooperative Extension of Rensselaer County, tfk1@cornell.edu, 518-272-4210, http://www.cce.cornell.edu/rensselaer/Agriculture/new%20bmr_sorghum.htm.

Northern New York Agricultural Development Program:

The Northern New York Agricultural Development Program provided funding for this agricultural environmental research project. The Northern New York Agricultural Development Program is a farmer-driven research and education program specific to New York state's six northernmost counties: Jefferson, Lewis, St. Lawrence, Franklin, Clinton and Essex. Thirty-three farmers serve on the Program board led by Co-Chairs Jon Greenwood of Canton (315-386-3231) and Joe Giroux of Plattsburgh (518) 563-7523. For more information, contact Jon, Joe or R. David Smith at 607-255-7286 or visit www.nnyagdev.org # # #