Yield and Feeding Value of Annual Crops Planted for Emergency Forage

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Project Summary

Forages are the basis of ruminant diets, and ruminant livestock producers need a constant supply of forages for their animals. Weather can make the production of adequate, quality forage a challenge. We set out to investigate a number of farmer questions, such as: What can I do when forage crops cannot be planted on time due to weather challenges? I need a constant supply of forage; are there alternative crops I can plant? What crop will give me reasonable forage yield and quality when planted in June or July? To answer these and other related questions, this demonstration study evaluated a series of alternative forage crop options. Team members included agronomists and animal scientists who worked together to evaluate agronomic and nutritional information about these crops. In addition, Pelican Rapids dairy producer David Sjostrom provided the on-farm site for this project and assisted with the project design, implementation, and dissemination of results, adding a practical perspective to the team.

Project Description

Perennial forage crops are the foundation of sustainable ruminant livestock operations in Minnesota. Because of the harshness of Minnesota's climate, perennial forage crops, particularly alfalfa, occasionally winterkill and leave producers faced with an immediate lack of high quality forage. In other years, excess spring moisture prohibits growers from planting perennial forages during the window of time critical for establishment success. In situations like these, producers who are faced with a forage supply shortage generally need to plant an annual forage crop to fill the gap.

Heavy spring rains that delayed planting during the 2001 growing season, and drought during the 2003 growing season provided prime examples of the climatic variability that farmers have to contend with. Sometimes, producers need to plant emergency forage in June or even July. While some information exists on yield and feeding value of various annual crop alternatives, there is no comprehensive comparative information, particularly at later planting dates. The goal of this project was to provide information that would help farmers select and manage emergency forages, which can be key to the farm's short- and long-term profitability and sustainability.

In 2002, we seeded this demonstration experiment at two locations in Minnesota: one on a dairy farm in Pelican Rapids, Otter Tail County (northern Minnesota), and the other at the University of Minnesota's UMore Park in Rosemount, Dakota County (southern

Early arrivals at the Sjostrom field day consider a trial entry.

Minnesota). In 2002, treatments included forage species (alfalfa and 16 annual crops with forage potential) and planting date (early, middle and late).

In 2003, we again seeded the experiment on the Otter Tail County dairy farm for the northern location. For the southern location, we planted the experiment at the University of Minnesota's St. Paul Campus, Ramsey County. We evaluated the same set of crops in 2003 as in 2002, with the addition of brown midrib sorghum-sudangrass in 2003.

Replicated plots were seeded at both locations. In 2002, the early, mid, and late seeding dates at Rosemount were May 15, June 10, and June 28, respectively. Corresponding planting dates at Pelican Rapids were May 21, June 17, and July 3. In 2003, the early, mid, and late seeding dates at St. Paul were May 8, June 6, and July 1, respectively. Corresponding planting dates at Pelican Rapids were May 16, June 16, and July 2.

In both locations, corn and brown midrib (BMR) forage sorghum plots were seeded 1-1.5" deep in four 30" rows with a single row planter. All other entries were seeded in ten 6" rows to a .25 to 1" depth, depending on seed size. Plots that included legumes were inoculated with the proper Rhizobium species.

In 2002, fertility was not limiting at either location. Dairy manure was incorporated prior to planting at Pelican Rapids. Soil test P and K levels were very high at both sites. All warm season grasses (corn, BMR sorghum, sudan, and millets) received 75 lb N/A within ten days after planting. Grass entries with multiple harvests received an additional 50 lb N/A after each cutting (except the final cutting). Thus, grass entries with three harvests received 175 lb N/A during the season.

In 2003, dairy manure was incorporated prior to planting at both locations so soil test P and K levels were very high. At Pelican Rapids, no synthetic fertilizer was applied during 2003. At St. Paul, nitrogen fertilizer was applied as follows: within seven days after planting, single-cut grasses (foxtail millets and forage barley) received 100 lb N/A, multiple-cut warm season grasses (sudan, sorghum-sudan, pearl millet, and Japanese millet) received 50 lb N/A with an additional 50 lb N/A for each additional harvest, and corn and forage sorghum received 150 lb N/A in one application.

In both years, corn and forage sorghum plots were harvested by cutting the center two rows of each four-row plot to a 6" stubble. The remaining entries were harvested with a ail harvester at Rosemount and St. Paul, and with a sickle harvester at Pelican Rapids. Stubble height for sudangrass, sorghum-sudan, pearl millet, and Japanese millet was 6" to encourage regrowth, with the last harvest at 3". All other entries were cut to a 3" stubble. In general, harvest timing was scheduled to optimize yield and quality. The exception was the final harvest of multi-cut warm season grasses, which were allowed to mature until temperatures were too cool for continued growth in September. Thus, midseason harvests of these entries were at vegetative stages, but the final harvest of some entries was at a reproductive (heading) stage. Based on previous research on regrowth potential after harvesting, sudangrass, sorghum-sudan, hybrid pearl millet, and Japanese millet were scheduled for multiple harvests. Foxtail millets were scheduled for just one harvest at boot stage.

Yield data were collected at each harvest. Feeding value of 2002 crops was determined by drying and grinding the samples and analyzing for several parameters in the University of Minnesota Forage Quality laboratory, including crude protein (CP), neutral detergent fiber

Table 1. Monthly temperatures (°F) and precipitation (inches) during 2002 and 2003 growing seasons.

	Southern Location Rosemount, 2002; St. Paul, 2003				Northern Location Fergus Falls (Pelican Rapids)			
	Temperature		Precipitation		Temperature		Precipitation	
Month	2002	2003	2002	2003	2002	2003	2002	2003
April	--	49.0	--	2.4	--	45.2	--	1.8
May	52.9	58.2	2.3	6.8	50.8	56.6	2.5	4.2
June	69.6	67.9	10.3	6.5	70.0	65.2	2.4	4.8
July	74.9	72.6	3.3	2.1	74.1	71.6	9.8	1.6
Aug.	68.5	74.8	8.2	0.9	68.6	74.3	4.6	0.8
Sept.	63.6	63.2	5.9	2.2	63.0	58.6	1.2	1.3
Oct.	--	52.0	--	0.9	--	49.2	--	0.7
Avg./Total	65.9	62.5	30.1	21.6	65.3	60.1	20.5	15.3

(NDF), *invitro* true dry matter digestibility (IVTD), and total digestible nutrients (TDN). The MILK2000 computer program was used to estimate potential milk production per ton and per acre, as well as net energy for lactation (NEL). Similar analyses will be performed for samples harvested in 2003.

Table 1 summarizes precipitation and temperature for both trial years and locations. After a cool, dry May, the remaining growing season in 2002 (June-September) was warm and wet with temperatures averaging 3°F above long-term averages. Rainfall was 8" above long-term averages at Rosemount and 10" above near Pelican Rapids during just July and August. By contrast, 2003 was a drier year. May and June were cool and wet, then from July through September, rainfall was 8" below long-term averages at St. Paul and 5" below long-term averages near Pelican Rapids. Average August temperatures were above normal in both locations.

Results

2002

Total season yield results are reported in Tables 2 and 3. Forage quality data for 2002 only is reported in Table 4. Yields of warm season species were unusually high at both locations, probably due to the combined effects of above average temperature and rainfall. Entries did not always produce less at later planting dates. For example, at Rosemount, yields of the 81 and 95 RM corn entries planted June 28 did not differ from yields for earlier planting dates. However, the longer-season 103 RM corn and BMR sorghum did produce greater yields when planted earlier. In contrast, at Pelican Rapids, late (July 3) planting resulted in reduced yields of all four of these entries. Nevertheless, within a location, these entries produced similar yields when planted late.

Total season yields of multi-cut warm season grasses were competitive with corn and BMR sorghum at all planting dates. The exception was the June 17 seeding at Pelican Rapids, and Japanese millet at all planting dates and both locations. Japanese millet may produce higher yields under a one-cut system. The one-cut foxtail millets (Siberian and Golden German) produced less forage than the other warm season forages, but they produced this yield in significantly fewer days. They tended to perform best at the middle seeding date in mid-June. The 3.7 ton/A produced by Golden German foxtail millet planted in mid-June was achieved within about 60 days. In addition, the foxtail millets established well at all planting dates and locations.

Barley and small grain/pea mixtures produced considerably less forage than the warm season grasses, and had difficulty with weed competition at later planting dates. Soybeans struggled with deer damage and weed competition at Rosemount, but performed surprisingly well at Pelican Rapids, where deer damage was lower and weed control more effective. The later-maturing soybean produced more forage than the earlier maturing soybean only for the early (mid-May) planting date. At Pelican Rapids, the 5.8 tons/A of forage produced by the later maturing soybean planted in mid-May was greater than total season yields of most established alfalfa stands, and based on previous work with soybean, forage quality may be similar. Thus, full-season soybean may have potential as an alfalfa forage replacement in emergency situations. Alfalfa generally produced considerably less forage than all warm season species at all planting dates, reinforcing the potential value of the warm season forage species in emergency situations. Stands of chickling vetch were generally poor, which may re ect inappropriate seeding depth. Plants that did establish appear to compensate for the thin stands, but regrowth after harvest was typically limited.

2003

Total season yield results are reported in Tables 2 and 3. At Pelican Rapids, precipitation was 2.6" above normal in May-June, but 5" below normal in July-September, resulting in significant summer drought stress and thus stunted forage yields. Total season forage yields of entries varied substantially, both within and among planting dates. Averaged across all entries at Pelican Rapids, delaying planting until June 16 or July 2 reduced total season forage

Marcia observing the research plot on the St. Paul Campus.

Table 2. Influence of planting date on total season dry matter (DM) yields of emergency forages at Pelican Rapids (Otter Tail County), MN in 2002 and 2003. Yields representing multiple harvests are followed by the number of harvests.

	2002 Planting Date			2003 Planting Date		
	Early: 21-May	Mid: 17-Jun	Late: 3-Jul	Early: 16-May	Mid: 16-Jun	Late: 2-Jul
	---------- Ton DM/A ----------			---------- Ton DM/A ----------		
Corn (81 day RM)	6.6	6.0	4.4	5.9	5.2	2.5
Corn (95 day RM)	6.6	6.0	4.3	6.8	5.4	2.5
Corn (103 day RM)	6.2	6.3	4.1	4.9	4.3	2.8
BMR Forage Sorghum	16.7	6.9	5.1	4.4	4.4	3.4
Sudangrass	7.8 (3)	4.3 (3)	4.2	4.8 (3)	3.7 (3)	3.0 (2)
Sorghum-sudan	6.5 (3)	3.7 (3)	4.9	4.3 (3)	3.2 (3)	2.9 (2)
Sorghum-sudan (BMR)				4.6 (3)	2.8 (3)	2.2 (2)
Japanese Millet	0.9 (2)	0.5	2.7	2.3 (3)	0.6 (3)	1.1 (2)
Hybrid Pearl Millet	6.5 (3)	4.4 (3)	5.4	3.5 (3)	2.8 (3)	2.6 (2)
Barley	1.4	1.2	0.8	3.1	1.3	0.9
Barley/Pea	1.8	1.2	0.9	3.4	1.7	1.3
Oat/Pea	1.6	1.6	1.3	3.1	1.1	1.3
Soybean A*	3.0	2.4	1.8	2.9	2.1	na
Soybean B**	5.8	3.6	1.8	2.9	2.3	1.2
Siberian Foxtail Millet	1.4	2.0	1.5	2.9	1.7	1.5
Golden German Millet	2.3	3.7	2.2	5.2	3.4	2.6
Alfalfa	0.9 (2)	1.1 (2)	0.4	1.0 (2)	0.4	na
Chickling Vetch	0.5	1.1 (2)	1.0 (2)	1.4	0.9	0.4
Mean	4.4	3.3	2.9	3.7	2.6	1.9
LSD (0.05)	1.5			0.89		

**Soybean A: 2002 - 0.8 RM; 2003 - 0.7 RM, **Soybean B: 2002 - 2.0 RM; 2003 - 2.5 RM*

Table 3. Influence of planting date on total season dry matter (DM) yields of emergency forages at Rosemount (Dakota County), MN in 2002 and St. Paul (Ramsey County), MN in 2003. Yields representing multiple harvests are followed by the number of harvests.

	2002 Planting Date			2003 Planting Date		
	Early: 15-May	Mid: 15-Jun	Late: 28-Jun	Early: 8-May	Mid: 6-Jun	Late: 1-Jul
	---------- Ton DM/A ----------			---------- Ton DM/A ----------		
Corn (81 day RM)	6.8	6.8	6.2	Poor stand	5.0	4.6
Corn (95 day RM)	6.9	7.7	6.9	Poor stand	5.6	4.2
Corn (103 day RM)	9.3	9.0	6.6	Poor stand	4.9	4.6
BMR Forage Sorghum	7.7	6.6	6.4	5.4	5.4	4.7
Sudangrass	8.3 (3)	7.6 (3)	5.9 (2)	3.7 (3)	3.8 (3)	3.9 (2)
Sorghum-sudan	7.6 (3)	8.2 (3)	6.4 (2)	2.5 (3)	3.4 (3)	3.6 (2)
Sorghum-sudan (BMR)	n/a	n/a	n/a	3.6 (3)	3.5 (3)	3.1 (2)
Japanese Millet	4.7 (3)	3.6 (3)	4.9 (2)	2.7 (3)	3.0 (3)	2.8 (2)
Hybrid Pearl Millet	7.4 (3)	6.6 (3)	5.9 (2)	1.2 (3)	3.6 (3)	4.0 (2)
Barley	2.0	1.2	1.5	2.4	2.0	1.2
Barley/Pea	2.2	2.1	0.5	2.9	2.2	1.5
Oat/Pea	2.4	2.3	1.2	3.4	2.5	1.6
Soybean A*	2.0	2.5	--	3.4	3.7	2.9
Soybean B**	2.8	--	--	4.1	3.7	2.9
Siberian Foxtail Millet	2.0	2.9	2.2	3.4	4.6	2.2
Golden German Millet	3.2	3.7	4.0	3.0	4.8	3.6
Alfalfa	1.6 (2)	1.7 (2)	1.2	3.4 (2)	1.3	1.6 (2)
Chickling Vetch	0.1	0.5	--	2.6	2.0	1.7
Mean	4.5	4.3	3.5	3.2 (no corn)	3.6	3.0
LSD (0.05)	0.8			0.9		

**Soybean A: 2002 - 0.8 RM; 2003 - 0.7 RM, **Soybean B: 2002 - 2.0 RM; 2003 - 2.5 RM*

Table 4. Feeding value of emergency forages sampled in 2002.
(Caution: results are preliminary and represent only one year of data)

	CP	NDF	IVTD	TDN	NEL	Milk/ton	Milk/A
Corn (81 day RM)	9.2	46.8	78.4	63.6	0.65	2,953	18,580
Corn (95 day RM)	8.8	45.6	78.0	62.9	0.65	2,883	18,878
Corn (103 day RM)	8.9	41.2	81.7	65.4	0.67	3,100	22,174
BMR Forage Sorghum	8.1	55.5	73	55.7	0.57	2,475	20,896
Sudangrass*	17.2	56.9	72.4	49.5	0.5	2,172	12,119
Sorghum-sudan*	16.8	56.1	72.1	48.4	0.48	1,941	11,298
Japanese Millet*	18.4	52.8	74.2	52.5	0.53	2,239	5,937
Hybrid Pearl Millet*	16.7	57.3	72.7	49.2	0.49	2,012	11,213
Barley	19.3	55.4	73.2	45.8	0.46	1,767	2,336
Barley/Pea	17.7	54.7	72.3	47.1	0.47	1,839	2,659
Oat/Pea	16.6	56.3	71.1	46.7	0.47	1,805	3,072
Soybean	18.4	43.7	74.8	54.8	0.56	2,328	6,650
Siberian Foxtail Millet	16.5	61.3	70.2	43.3	0.43	1,581	3,151
Golden German Millet	14.3	62.3	69.8	43.1	0.43	1,570	4,869
Alfalfa*	20.8	33.2	78.0	61.6	0.63	2,737	3,260

All results averaged across 2 locations and 3 planting dates.
**These crops also averaged across multiple harvest dates.*
Corn silage and alfalfa are included for comparison.
Definitions:
CP = crude protein, % of dry matter
NDF = neutral detergent fiber, % of dry matter
IVTD = invitro true dry matter digestibility, %
TDN = total digestible nutrients, calculated value, % of dry matter
NEL = net energy for lactation, calculated value, Mcal/lb
Milk/ton = milk production in lb/ton of forage, estimated using the MILK2000 spreadsheet
Milk/acre = milk production in lb/acre, estimated using the MILK2000 spreadsheet
(MILK2000 equations were developed for corn silage and alfalfa/grass mixtures; therefore we caution that these numbers are only estimates.)

yield by about 30 and 50%, respectively, compared to planting May 16. The mid- and early-maturity corn silage hybrids were the highest yielding entries for the May 16 and June 16 planting dates. In contrast, for the July 2 planting date, total season forage yields were greatest for forage sorghum, sudangrass, sorghum-sudan, late-maturity corn, and pearl millet. Corn populations were generally thinner than desired, so silage production potential was probably underestimated. In addition, deer damage to soybean and potato leafhopper damage to alfalfa resulted in stunted yields for those entries.

Total season yields of multi-cut warm season grasses were competitive with corn and forage BMR sorghum at the late planting date only. The exception was Japanese millet, which may produce higher yields under a one-cut system. The one-cut foxtail millets (Siberian and Golden German) were competitive with the other warm season forages. They performed best at the May seeding date at Pelican Rapids, and at the June seeding date at St. Paul. The 5.2 tons DM/A produced by Golden German foxtail millet planted in May at Pelican Rapids was achieved within about 77 days.

The high yields of June-planted foxtail millets at St. Paul approached yields of corn and forage sorghum planted on the same date. In addition, the foxtail millets established well at all planting dates and locations.

Barley and small grain/pea mixtures produced more forage at the early planting date. Soybeans struggled with deer damage at Pelican Rapids. The later-maturing soybean produced similar amounts of forage to the earlier maturing soybean. Alfalfa generally produced considerably less forage than all warm season species at all planting dates, indicating the potential emergency forage value of the warm season species.

In St. Paul, none of the early-planted corn hybrids produced a crop. Germination test results on the seed lot were acceptable, so we don't know for sure what caused the lack of growth. One hypothesis is that heavy rains soon after planting created soil crusting, which prevented emergence. Yields of mid- and late-planted corn were similar to those at Pelican Rapids. Yields of multi-cut warm season grasses were slightly higher at St. Paul than at Pelican Rapids. The

sorghum-sudan BMR had similar yields to the conventional sorghum-sudan at both locations. This is a positive finding, considering that the BMR variety is expected to have improved fiber digestibility due to a lower lignin content compared with the conventional variety. Soybeans appeared to yield better at St. Paul, and that result probably re ects absence of deer damage at St. Paul.

Conclusion

Results showed that some of the crops evaluated have potential as emergency forages. Based on yield performance, our data suggest that corn and forage sorghum may be among the best emergency forage options, even at planting dates as late as early July. Foxtail millets generally did not produce as much forage as corn or forage sorghum, but produced consistently good stands that were competitive with weeds and ready to harvest within an average of only about two months after planting.

The options we evaluated are primarily "emergency options", not "systems" per se. Our project demonstrated that it's pretty tough to beat corn as an emergency forage, even at late planting dates. The warm season annual grasses might provide a better option for those producers that are looking for an emergency grazing crop. The foxtail millets provide a nice and easy "quick" one-cut option. The soybeans really showed promise as the one emergency option that might be most similar to alfalfa in quality, and thus possibly serve as its replacement in emergency situations.

The project generated a lot of interest among producers in the area, and about 50 attended a field day at the Sjostrom farm in Pelican Rapids. Although we are not sure how many will use any of these emergency options, they now have a local database to draw from when faced with decisions about what crops to consider in emergency situations. Although the project has ended, cooperating farmer David Sjostrom is planning to plant soybeans for forage this coming year. Logical next steps to expand the knowledge gained from this project would be larger-scale plantings/research that compare feeding (as stored hay or silage) to grazing in order to evaluate animal acceptance/ performance and the more practical aspects of using some of these emergency forage options.

Cooperators

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Project Location

Otter Tail County site: Approximately 2.5 miles south of Pelican Rapids on the west side of Hwy. 59 at David Sjostrom farm.

Dakota County site: At University of Minnesota UMore Park in Rosemount. From the intersection of Hwy. 42 and Akron Ave., go south .5 mile.

Other Resources

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University of Wisconsin Forage Web site. Available at: www.uwex.edu/ces/crops/uwforage