Legume and Cool-Season Grass Mixtures: A Demonstration Planting in Perkins County, South Dakota

INTRODUCTION

A common practice in the Northern Great Plains is to plant legumes with cool-season grasses to improve quality, production, and digestibility of forage. Adding legumes to the mix may also reduce the need for added nitrogen fertilizer. Alfalfa is typically the primary legume recommended for mixtures with cool-season grasses. In permanent or semi-permanent grazing systems in this region of South Dakota, producers often select alfalfa varieties that have low (decumbent) growth, aggressive root proliferation, and superior winter hardiness. These alfalfa types have a more fibrous, laterally-spreading root system than the typical narrow taproot varieties used for hay production. They are preferred in grazing systems because of their ability to establish, persist and thrive in mixtures with cool-season grasses.

The Bismarck Plant Materials Center (PMC) seeded a demonstration planting in Perkins County, South Dakota, to observe and evaluate selected legumes and cool-season grasses, and provide an outdoor classroom for educating field office staff and landowners on the benefits of binary legume and grass mixtures for hay and grazing. The planting included two alfalfa selections that possess the proliferating root-spreading habit; 'Travois' alfalfa, a variegated flowering type, and a South Dakota State University yellow-flowered selection, later released as 'Sholty' alfalfa. Cicer milkvetch and sainfoin were other legumes planted for comparison in these plantings. Cooperators in the demonstration were the PMC, Jim Lyon (Perkins County producer), the Perkins County Conservation District, and the USDA-NRCS Perkins County field office. The planting site was located about 25 miles southeast of Bison, South Dakota. Previous cropping history was small grains in rotation. The surrounding land vegetation was introduced grass Conservation Reserve Program mix. Soil type is Reeder loam, and the site was mostly level. Average precipitation for the area is approximately 17.62 inches annually.

Fig. 1. Binary mixture of 'Newhy' RS wheatgrass and Travois alfalfa.

MATERIALS AND METHODS

The non-replicated, 11-ft x 57-ft plots were seeded on April 30, 2007 into a cultivated and harrowed seedbed. The legumes were planted alone and in binary mixtures with different cool-season grasses (Fig. 1). Plots were seeded at 1.5 times the recommended NRCS pure live seed planting rate. The percentage of grass to legume in each mixture was 70% and 30% respectively. Grasses used in binary mixtures included 'Manska' pubescent wheatgrass, 'Fleet' meadow bromegrass, 'NU-ARS AC2' crested wheatgrass, 'Mankota' Russian wildrye, 'Rush' intermediate wheatgrass, 'Newhy' RS wheatgrass, 'Lodorm' green needlegrass, 'Rodan' western wheatgrass,

'Manifest' intermediate wheatgrass, and 'Goldar' bluebunch wheatgrass. Areas between and around the perimeter of the plots were seeded to Bad River ecotype blue grama. Initial weed competition was Russian thistle and foxtail. Weed severity was relative to the percent emergence and vigor of planted species. In May 2008, a bromoxynil herbicide was applied to control a flush of Russian thistle in all the plots, with good results.

The demonstration planting was evaluated annually from 2008-2013. Stand ratings of the legume and cool-season grass cultivars were determined by visual observation at the beginning of each growing season, from 2008-2013. Yield was determined in late July-early August in 2009, 2011 and 2012 by harvesting 2-ft x 10-ft swaths that were representative of the stand of the legume and perennial grass within each plot (Fig. 2). Harvest dates were based on once-per-season cutting. This timing was less than optimum for capturing high forage quality, resulting in lower quality than what would be expected from an earlier and more typical harvest date. Forage quality data was collected from the sampled plots in 2012 only.

Fig. 2. A 2-ft x10-ft swath was harvested from each plot for dry matter yield.

RESULTS AND DISUSSION

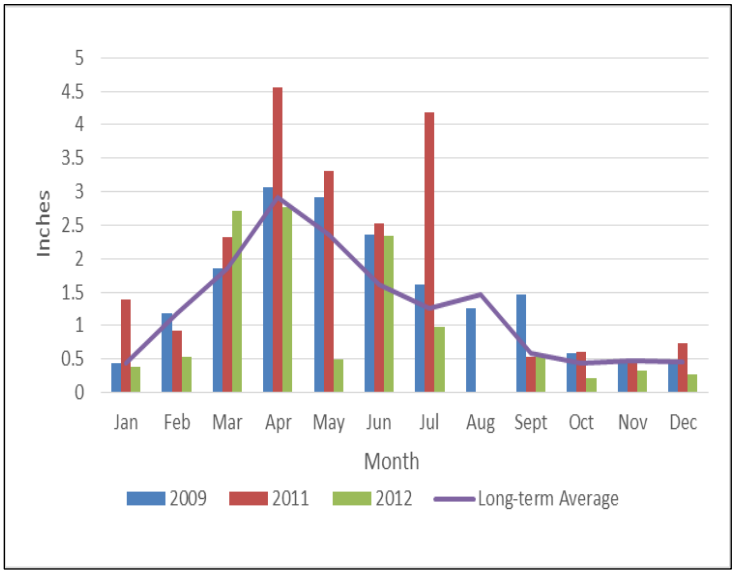


Fig. 3. Annual rainfall for 2009, 2011, 2012 and long-term average, Bison, South Dakota.

Rainfall received during the primary growing season for cool-season plantings near Bison, South Dakota, was near or above the long-term average in 2009 and 2011. Rainfall in 2012 was slightly below average during the primary growing season, but well below average for the year with only 8.5 inches of total precipitation (Fig. 3).

The plots established slowly during the 2007 seeding year, primarily due to low rainfall. Most species were well established by the fall of 2008.

Annual evaluation of stand densities of the legumes and the grasses is shown in Table 1. Both alfalfas established slowly but by year 3 they had adequate to good stands, and performed well alone and in the binary mixtures. Sainfoin, either alone or in the mixtures, established well, but failed to persist after 2011. The cicer milkvetch established slowly and improved when planted alone. It had a poor stand in most of the binary mixtures. Most of the grasses were well established by year 3 and maintained good stands except when mixed with Sholty alfalfa. Only pubescent wheatgrass and crested wheatgrass maintained a good stand in binary mixes with Sholty. Where plot stands were poor, weeds had a big impact on specie yield and performance.

Table 1. Stand and forage yields in 2008-2013 of legumes and legume-grass mixtures planted near Bison, South Dakota.

Bison, SD Grass & Forbs Demonstration Planting Stand and Production Data																
Variety/Species	*** Legume Stand Rating** *(Year)*						*** Grass Stand Rating** *(Year)*						**Forage Production Pounds/acre** *(Clipping Date)*			
	2008	*2009*	*2010*	*2011*	*2012*	*2013*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*07/21/09*	*08/09/11*	*07/18/12*	**Avg**
Lutana cicer milkvetch	8	8	5	3	1	5							1210	3637	1089	**1,979**
w/ Manska pubescent wheatgrass	8	8	7	7	7	8	6	4	2	3	2	2	3596	4339	843	**2,926**
w/ Fleet meadow bromegrass	8	8	8	8	8	8	5	3	2	2	1	2	2954	3319	503	**2,258**
w/ AC2 crested wheatgrass	8	8	8	8	7	8	4	3	1	1	1	1	3249	2220	1123	**2,197**
w/ Rodan western wheatgrass	8	8	6	6	5	6	7	7	3	2	1	1	2639	3650	*(a)*	*(a)*
w/ Lodorm green needlegrass	8	8	7	4	3	3	7	7	7	6	5	3	*(a)*	5482	*(a)*	*(a)*
Sholty yellow alfalfa	6	6	1	1	1	4							6477	13030	2947	**7,485**
w/ Manska pubescent wheatgrass	6	5	3	1	2	3	5	5	1	2	4	3	3891	12632	2745	**6,422**
w/ Fleet meadow brome	5	7	3	1	2	3	4	4	1	1	7	7	4466	7890	3048	**5,135**
w/ AC2 crested wheatgrass	5	5	3	3	3	1	4	3	1	2	4	1	5167	7867	3061	**5,365**
w/ Mankota Russian wildrye	5	6	3	1	1	2	5	4	6	4	9	8	2765	*(a)*	2465	*(a)*
w/ Rodan western wheatgrass	5	6	3	1	1	3	7	7	5	6	6	8	7456	*(a)*	3219	*(a)*
w/ Lodorm green needlegrass	6	6	3	1	1	1	7	7	7	7	9	8	5112	*(a)*	*(a)*	*(a)*
w Bonilla big bluestem	5	5	4	1	1	2	7	7	8	8	9	9	*(a)*	*(a)*	*(a)*	*(a)*
Travois alfalfa	5	4	2	2	2	1							4018	3049	1299	**2,788**
w/ Manska pubescent wheatgrass	5	5	4	1	4	2	5	3	1	1	1	2	5006	6271	2055	**4,444**
w/ Fleet meadow brome	5	5	4	1	4	2	5	3	1	1	1	2	3734	4491	1642	**3,289**
w/ AC2 crested wheatgrass	3	6	4	1	2	1	5	3	1	1	2	1	3694	5494	2155	**3,781**
w/ Mankota Russian wildrye	4	4	4	1	2	3	4	3	4	2	3	2	2798	3425	1606	**2,610**
w/ NewHy wheatgrass X	4	4	4	1	4	3	4	3	1	1	2	2	5565	4105	1883	**3,851**
w/ Rush intermediate wheatgrass	4	4	4	1	3	2	6	5	3	2	1	2	4577	6618	2456	**4,550**
w/ Rodan western wheatgrass	6	3	3	1	2	2	8	8	6	7	8	4	3775	*(a)*	*(a)*	**3,775**
w/ Lodorm green needlegrass	6	3	3	1	4	3	6	8	5	8	7	6	3289	*(a)*	*(a)*	**3,289**
w/ Goldar bluebunch wheatgrass	6	3	2	1	2	4	6	8	8	8	9	9	*(a)*	*(a)*	*(a)*	*(a)*
w/ Manifest intermediate wheatgrass[(b)]	-	-	-	-	3	3	-	-	-	-	2	2	*(a)*	4777	2124	*(a)*
Eski sainfoin	4	4	7	7	8	9							581	*(a)*	*(a)*	*(a)*
w/ Manska pubescent wheatgrass	4	4	4	5	9	9	5	5	6	2	2	1	3324	3317	1852	**2,831**
w/ Fleet meadow brome	4	5	5	5	9	9	4	3	3	1	2	2	2153	1519	939	**1,537**
w/ Rodan western wheatgrass	4	6	4	4	9	8	5	6	6	1	1	1	1731	2295	1264	**1,763**
w/ AC2 crested wheatgrass	4	6	5	4	8	8	5	5	3	1	1	1	3626	2778	*(a)*	*(a)*
w/ Lodorm green needlegrass	4	4	5	5	9	9	8	8	7	5	8	8	*(a)*	*(a)*	*(a)*	*(a)*

** Stand Rating- (1 = Best; 9 = Poorest)*

(a) Incomplete data as samples were not collected due to poor stand and/or heavy weed pressure.

(b) This plot was replanted 5/14/2009 with species listed.

Forage yields of the legume and legume-grass mixtures varied depending on year and yield contribution of each component in the mixture (Table 1). Plots with alfalfa had the best and most consistent yields. Sholty alfalfa yields were exceptional, and it was the most competitive legume when mixed with a grass (Fig. 4). The plots with Travois alfalfa also produced good yields, and appeared to perform even better when mixed with a cool-season grass. Most of the grasses maintained a good stand in the Travois-grass mixed plots (*Travois alfalfa was impacted in some years from grasshopper predation which negatively affected both yields and quality*). Cicer milkvetch did not perform as well as the alfalfas at this site. It did not compete well with most of the grasses, but maintained a fair stand where it was seeded alone. The sainfoin performed poorly and did not persist in any of the plots. By the 6th year, yields for sainfoin plots were provided by the grass component only. Intermediate wheatgrass, meadow brome, and crested wheatgrass were the most productive and consistent performers of the cool-season grasses, and competed best with the legumes, including the Sholty alfalfa. Meadow brome, western wheatgrass, green needlegrass, and Russian wildrye also yielded well in most of the legume combinations.

Fig. 4. Sholty yellow alfalfa plot between the mixed plots of green needlegrass and pubescent wheatgrass.

The forage samples from 2012 were also measured for forage quality. The results are shown in Table 2. Legumes planted alone or in a mix with Russian wildrye had the highest crude protein. Cicer milkvetch alone contained the highest crude protein. Correlating the percentage of each quality factor with production, provides an indication of nutrition provided per acre (Fig. 5).

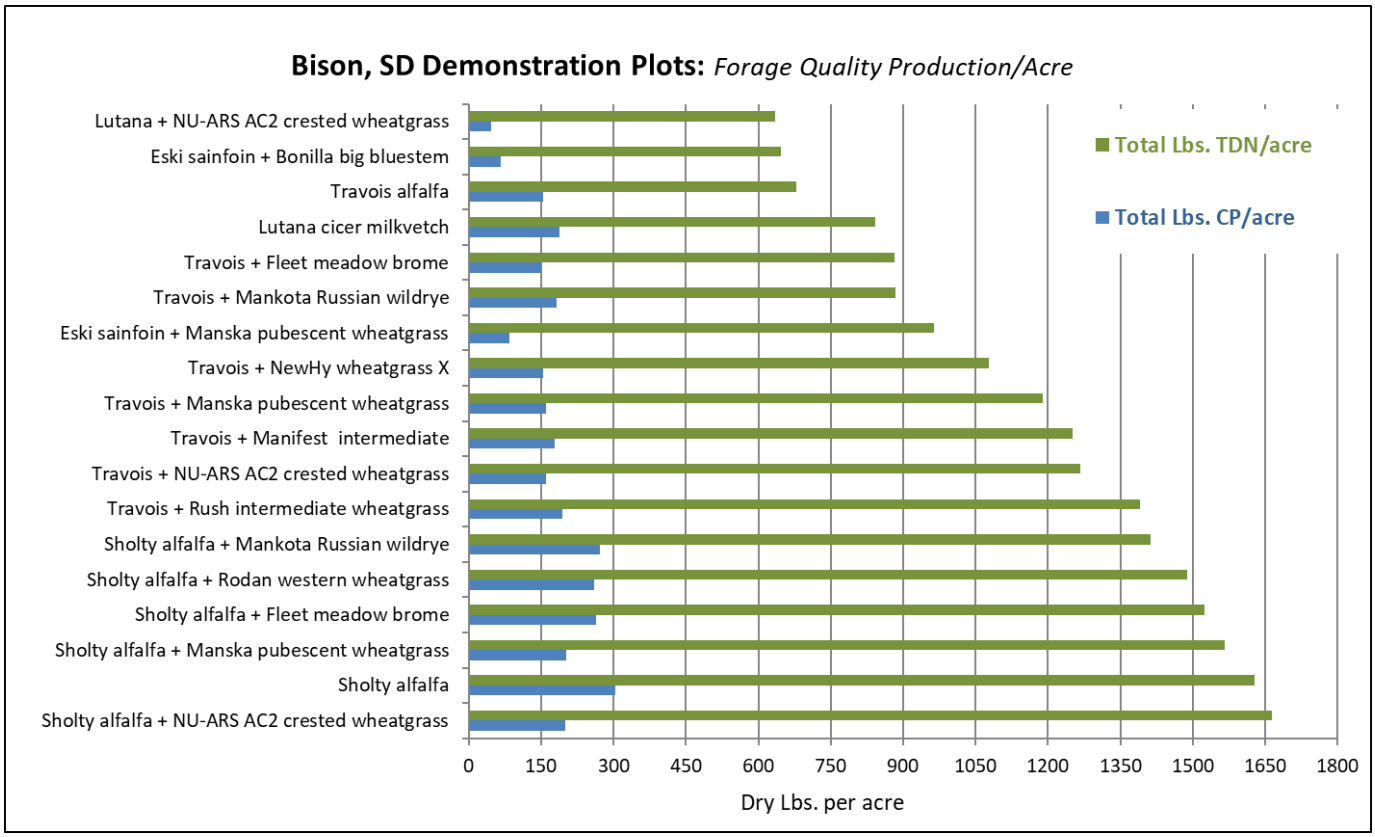
Table 2. Forage quality of grass/legume mixtures collected 7/18/2012 near Bison, South Dakota.

Legume Species	+ Grass Species	1/CP	2/ADF	3/NDF	4/CF	5/TDN	6/RFV
sainfoin *(Eski)*	+ meadow brome (*Fleet)*	6.1	47.0	68.2	37.6	49.0	71.4
sainfoin *(Eski)*	+ pubescent wheatgrass (Manska)	4.6	44.3	70.3	35.4	52.1	72.0
cicer milkvetch (*Lutana*)	+ crested wheatgrass (*NU-ARS AC2*)	4.1	40.4	69.5	32.3	56.5	76.8
cicer milkvetch (*Lutana*)	+ meadow brome *(Fleet)*	6.9	44.6	65.6	35.6	51.8	76.8
cicer milkvetch (*Lutana*)	+ pubescent wheatgrass *(Manska)*	6.0	39.4	67.8	31.5	57.6	79.9
cicer milkvetch (*Lutana*)		14.9	32.0	36.3	25.6	66.1	163.8
alfalfa *(Travois)*	+ crested wheatgrass *(NU-ARS AC2)*	7.4	38.4	64.3	30.7	58.8	85.3
alfalfa *(Travois)*	+ meadow brome *(Fleet)*	9.1	42.8	63.5	34.2	53.8	81.4
alfalfa *(Travois)*	+ Russian wildrye *(Mankota)*	11.3	41.6	67.7	33.3	55.1	77.6
alfalfa *(Travois)*	+ pubescent wheatgrass *(Manska)*	7.8	39.2	65.5	31.3	57.9	82.9
alfalfa *(Travois)*	+ wheatgrass X (*Newhy*)	8.2	39.8	65.2	31.8	57.2	82.6
alfalfa *(Travois)*	+ intermediate wheatgrass *(Rush)*	7.9	40.3	66.7	32.3	56.6	80.2
alfalfa *(Travois)*		11.9	44.1	53.7	35.3	52.3	94.4
*alfalfa *(Sholty)*	+ crested wheatgrass *(NU-ARS AC2)*	6.5	42.3	64.5	33.8	54.3	80.7
*alfalfa *(Sholty)*	+ meadow brome *(Fleet)*	8.7	46.1	64.4	36.9	50.0	76.6
*alfalfa *(Sholty)*	+ Russian wildrye *(Mankota)*	11.1	39.7	49.4	31.8	57.3	109.2
*alfalfa *(Sholty)*	+ pubescent wheatgrass *(Manska)*	7.4	39.9	65.9	31.9	57.1	81.7
*alfalfa *(Sholty)*	+ western wheatgrass *(Rodan)*	8.1	42.6	56.1	34.1	46.2	81.2
*alfalfa *(Sholty)*		10.3	41.5	51.7	33.2	55.2	101.8

* yellow flowered ( ) cultivar name

1/ CP=crude protein; 2/ ADF=acid detergent fiber; 3/ NDF=neutral detergent fiber; 4/ CF=crude fiber; 5/TDN=total digesitble nutrients; 6/ RFV=relative feed value. All analysis results reported on dry matter basis.

Figure 5. Total pounds (Lbs). of crude protein and total digestible nutrients based on yield of the harvested samples collected on 7/18/2012.



CONCLUSIONS

This demonstration supports other studies that confirm the validity of adding a legume with a cool-season grass to enhance diversity and improve quality and production. It also confirmed alfalfa as the better legume to use with cool-season grasses in this soil and climatic environment. The Sholty alfalfa was extremely aggressive and only a few of the cool-season grasses persisted with it in the mix. It was the highest biomass producer alone and in the binary mixtures during the years of this demonstration. The Travois alfalfa mixed plots also performed well, despite considerable grasshopper pressure on the alfalfa. Mixed plots with sainfoin evolved to mostly a grass component, confirming the difficulties of maintaining sainfoin stands for more than a few years. The cicer milkvetch plots were slower to establish and produced less forage, but were higher in forage quality.

Since only binary mixtures of a cool-season grass and a legume were seeded in these plots, one can only make assumptions for how these legumes will perform with several species of grasses and/or other legumes in a mixed planting. However, the results from this planting would indicate there is value in having a legume in the mix.