COMPARISON OF COMPANION VERSUS SINGLE SPECIES GRAZING ON RANGELANDS INFESTED WITH LEAFY SPURGE

(A Four-Year Summary)

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Introduction

In the past twenty years grazing animals as a biological control for leafy spurge has become an acceptable management practice. Research has showed grazing goats with cattle increased grass and grass-like disappearance by cattle, reduced leafy spurge stem densities, and reduced overall leafy spurge production after two grazing seasons (Prosser et al. 1995). Recent research has also has shown that sheep will reduce leafy spurge stem densities and also increase grass and grass-like disappearance, and there is significant benefit using multi-species grazing to better manage leafy spurge infested rangelands (Prosser 1995).

The objective of this study were to test the effects of companion and single species grazing treatments using cattle and sheep on: 1) differences in leafy spurge control, plant species richness and density, plant species diversity, 2) evaluate differences in utilization levels by plant type and herbage production, and 3) evaluate differences in livestock weight gain.

Study Area

This study was conducted on Section 32, T139N, R81W of Morton County owned by the North Dakota State Correction Center in south central North Dakota, approximately two miles southwest of Mandan, and on the north half of Section 9 T138N, R81W of Morton county on native rangeland operated by the Northern Great Plains Research Laboratory, approximately three miles south of Mandan. The study area was located in the Missouri Slope Prairie region. Vegetation in this region is typical of northern mixed grass prairie (Barker and Whitman 1988) and classified as a wheatgrass-grama-needle grass (*Agropyron, Bouteloua, Stipa*) plant community (Shiflet 1994).

Grazing treatments were multi-species and single species grazing on three replicated 20 acre blocks. Replicate one and two were within the North Dakota State Correction Center land and replicate three on the Northern Great Plains Research Laboratory. Each of the replicates were subdivided into 5 acre plots and treated with either a cattle only treatment (CO), sheep only treatment (SO), cattle and sheep treatment (CS) and a non use control (NU). Treatments were randomly selected within each block. The experimental design was a randomized complete block design (RCBD).

Sheep were placed on treatments approximately 15 May when leafy spurge as ready for grazing and cattle 1 June when native cool season grass species reach grazing readiness (3-4 leaf stage). Livestock species were removed from treatments when 50 to 60 percent degree of grass and grass-like species use or before 15 September.

Each replicated research block had one plot grazed by yearling steers (CO), one grazed by mature ewes (SO), and one grazed by yearling steers and mature ewes (CS). Stocking rates include two yearling steers for the CO from 1996 to 1999; twelve mature ewes in 1996, ten mature ewes 1997 and 1998, and seven mature ewes in 1999 for the SO; one yearling steer and six mature ewes in 1996 and one yearling steer and five matures for the CS from 1997 to 1999. Stocking rates were about 1.5 AUMs/acre for the CO, SO, and CS treatments. Stocking rates for this trial were designed for 3.5 months of grazing for the steers and 4 months of grazing for the ewes. The flexible stocking rates on the SO and CS in sheep were due the adjustment in leafy spurge control and range condition.

Methods

Leafy spurge density counts were obtained by using a permanent 109 yard line transect and counts collected approximately every 5 ½ yards using a 12 inch^2 quadrat. One transect was systematically

placed in each of the four treatments (CO, SO, CS, and NU) for each replicate. Transects were selected based on leafy spurge location within the treatments to assure full length of transect comprised leafy spurge. Leafy spurge density were monitored over the two years to determine effectiveness of sheep grazing to control. Leafy spurge densities were collected annually around the end of May.

Forb and shrub species frequency, density, richness, and diversity were determined using a 24 inch^2 quadrat. Nested within the 24 inch^2 quadrat was a 12 inch^2 quadrat which was used to determine graminoid species frequencies, richness, and diversity. Data was collected from 109 yard transects with readings conducted approximately every 5 ½ yards. Data was collected on all treatments and replicate from the leafy spurge transect developed to monitor leafy spurge stem density counts. One native (no leafy spurge) 109 yard transect was located within each replicated treatment to monitor species diversity and richness changes that may naturally occur due to treatment. Readings were collected from the native transects annually, with the exception of 1997. The leafy spurge transects were monitored annually and will continued to be monitored annually throughout the ten year trial.

The ten-pin point frame was used to determine basal cover (Levy and Madden 1933) as modified by Smith (1959) and described by Mueller-Dombois and Ellenberg (1974). Basal cover was determined in 1996 and will be monitored biennially throughout the duration of the trial. The ten-pin point frame measurements were collected from the same 109 yard transects used for species diversity and richness on both native and leafy spurge sites, and collected every yard.

Leafy spurge, graminoid, shrub, and forb herbage production was determined by clipping in late July on the NU treatment when vegetative species reached peak production (Whitman et al. 1952). The NU was stratified into 7 ½ by 7 ½ yard plot. A 7 ½ yard buffer strip was implemented to prevent edge effect. Twenty-five plots were randomly selected and clipped within each NU using a 24 inch^2 quadrat.

Degree of use of leafy spurge, graminoids, forbs, and shrubs were determined for each treatment at the end of the grazing season by stratifying each treatment into 7 ½ by 7 ½ yard quadrats. Twenty-five quadrats were randomly selected and clipped using 24 inch^2 quadrat on each grazed and nonuse treatment to determine the degree of disappearance.

Livestock performance and production were collected for both cattle and sheep by determining average daily gain and gain per hectare, respectively. Both classes of livestock were weighed prior to pasture turn out and monthly to follow performance throughout the grazing season. Final livestock weights were collected at end of grazing season.

Treatment and year effects for leafy spurge stem density, species richness, forb and shrub density, herbage production, degree of use, and livestock performance were analyzed using a general linear model (GLM) (SPSS 1999). A mean separation was performed using Tukey's Honesty Significant Difference when significant ($P \leq 0.05$) differences were found. The Shannon Wiener Index was used to calculate species diversity indices for both leafy spurge infested and non leafy spurge infested range sites. Treatment and year effects of species diversity was analyzed using a non-parametric test (Krushal-

Wallis Test) (SPSS 1999).

Results and Discussion

A significant ($P \leq 0.05$) reduction in leafy spurge stems occurred after one grazing season on the SO treatment and in three grazing seasons on the CS treatment. Leafy spurge was reduced from 10.4 stems/12 inch^2 in 1996 to 0.8 stems in 1999, a reduction of 36% after one grazing season and 92% after three on the SO. Leafy spurge stem densities were not affected after two grazing seasons on the CS treatment, but were lower in 1999 compared to 1996, 1997, and 1998. Leafy spurge stems were reduced ($P \leq 0.05$) from 11.6 stems/12 inch^2 in 1996 to 6.5 in 1999, a reduction of 44% after three grazing seasons. There was no significant ($P > 0.05$) change in leafy spurge stem density on the CO and NU treatments after three years of grazing (Table 1).

Graminoid species richness significantly changed ($P \leq 0.05$) over the grazing seasons within treatments on non-infested and leafy spurge infested range sites. After three grazing seasons graminoid richness increased ($P \leq 0.05$) from 9.7 $\pm$ 1.2 (SE) to 10.7 $\pm$ 1.7 (SE) graminoid species on leafy spurge infested sites in the CS treatment. The NU treatment decreased ($P < 0.05$) in graminoid richness on non-infested range sites from 9.3 $\pm$ 1.3 (SE) to 9.0 $\pm$ 1.2 (SE) graminoid species from 1996 to 1999, and on the NU leafy spurge infested range sites graminoid species decreased ($P \leq 0.05$) from 8.0 $\pm$ 0.7 (SE) treatment from 1996 to 1999. The SO treatment had a decrease ($P \leq 0.05$) in graminoid richness from 10.3 $\pm$ 1.9 (SE) to 8.7 $\pm$ 0.9 (SE) on leafy spurge infested range sites from 1996 to 1999.

Table 1. Leafy spurge stem densities per 12 inch^2 quadrat (standard errors in parentheses) on the cattle only (CO), sheep only (SO), cattle and sheep (CS), and control (NU) treatments for 1996, 1997, and 1998.

	CO[2]	**SO[2]**	**CS[2]**	**NU[2]**
	# of Stems/12 inch^2 quadrat			
1996[1]	9.8 (1.2)^{ax}	10.4 (0.9)^{ax}	11.6 (1.0)^{ax}	9.8 (1.1)^{ax}
1997[1]	12.0 (1.2)^{ax}	6.7 (0.7)^{by}	12.3 (1.0)^{ax}	11.4 (1.3)^{ax}
% Change 1996 to 1997	**+22**	**-36**	**+6**	**+16**
1998[1]	10.8 (1.0)^{ax}	2.5 (0.6)^{cy}	11.6 (1.0)^{ax}	11.1 (1.2)^{ax}
% Change 1996 to 1998	**+10**	**-75**	**0**	**+13**
1999[1]	11.1 (0.8)^{ax}	0.8 (0.2)^{cy}	6.5 (0.8)^{bz}	10.5 (1.0)^{ax}

% Change 1996 to 1999	**+13**	**-92**	**-44**	**+7**

[1]Years with the same letter within each treatment are not significantly different (P>0.05) (a,b and c).

[2] Treatments with the same letter are not significantly different (P>0.05) (x, y, and z).

Graminoid species richness was significantly ($P \leq 0.05$) different between non-infested and leafy spurge infested range sites within treatments. Cattle only and NU treatments non-infested range sites was higher ($P \leq 0.05$) in graminoid richness than leafy spurge infested range sites, 9.3 ± 0.7 (SE) to 8.3 ± 0.7 (SE) on the CO, 10.3 ± 1.9 (SE) to 8.7 ± 2.7 (SE) on the NU, in 1998. The SO leafy spurge infested range sites (10.7 ± 1.8 (SE)) was higher ($P \leq 0.05$) than non-infested range sites (9.3 ± 1.2 (SE)) in 1998. Results also showed that there was no difference (P>0.05) between non-infested and leafy spurge infested range sites in graminoid richness within treatments in years 1996 and 1999.

Treatment effects were present between non-infested and leafy spurge infested range sites in graminoid richness 1997, 1998, and 1999. Graminoid richness on the SO leafy spurge infested range sites were higher (P<0.05) than NU leafy spurge infested in 1997. Cattle only treatment non-infested range sites were lower (P<0.05) in graminoid richness than CS treatment non-infested range sites in 1998. The NU non-infested range sites were greater (P<0.05) in graminoid richness than CO and SO non-infested range sites in 1998. The SO non-infested range sites were lower (P<0.05) than CS non-infested range sites in 1998. Non-use control leafy spurge infested range sites were higher (P<0.05) in graminoid species richness than the CS leafy spurge infested range sites in 1998, however, the NU leafy spurge infested range sites was lower (P<0.05) than SO leafy spurge infested range sites in graminoid richness in 1998. The NU non-infested range sites were lower (P<0.05) in graminoid richness than the CO, SO, and CS non-infested range sites in 1999. Leafy spurge infested range sites on the NU treatment were also lower (P<0.05) than SO and CS leafy spurge infested range sites in graminoid richness in 1999. The SO treatment leafy spurge infested range sites were also greater (P<0.05) than the CO treatment leafy spurge infested range sites in graminoid richness in 1999.

Forb and shrub species richness was significantly (P<0.05) different between non-infested and leafy spurge infested range sites within treatments. Treatments CO and NU non-infested range sites were higher (P<0.05) than leafy spurge infested range sites in years 1996, 1998, and 1999. Treatments SO and CS treatments non-infested range sites were higher (P<0.05) than leafy spurge infested range sites in years 1996 and 1999.

Forb and shrub species richness were also different (P<0.05) between treatments in 1998 and 1999. The NU treatment non-infested range sites were significantly higher (P<0.05) in forb and shrub richness than non-infested range sites on the CO, CS, and SO treatments in 1998. Forb and shrub richness on the non-infested range sites CS treatment was lower (P<0.05) than the NU non-infested range sites in 1999. There was no significant (P>0.05) difference between treatments on leafy spurge infested range sites in

1996, 1997, 1998, and 1999.

Forb and shrub density were significantly ($P<0.05$) different between non-infested and leafy spurge infested range sites within treatments. Results showed non-infested range sites were greater ($P<0.05$) in forb and shrub density, in all treatments, than leafy spurge infested sites in 1996 and 1999. The only treatment that showed a significant difference in non-infested and leafy spurge infested in 1998 was the NU treatment, which leafy spurge infested range sites were lower ($P<0.05$) than non-infested range sites (Table 2). Results showed that there were significant year effects on the CO and SO treatments on the non-infested range sites. The SO treatment increased ($P<0.05$) in forb and shrub density from 1996 to 1999 and there was a increase in forb density on the CO non-leafy spurge range sites from 1998 to 1999. Results also showed that there were differences ($P<0.05$) among treatments on non-infested leafy spurge (Table 2). The densities on non-infested range sites on the CS treatment were lower ($P<0.05$) than the NU treatment in 1996 and 1998. Sheep only treatment non-infested range sites densities were greater ($P<0.05$) than NU non-infested sites in 1998. Both the CO and SO treatments non-infested range sites were greater ($P<0.05$) than the CS treatment non-infested range sites in 1999 (Table 2).

Species diversity results showed that there were significant ($P<0.05$) differences between leafy spurge and non-infested range sites in all treatments. In all of the treatments non-infested range sites were higher ($P\leq0.05$) in species diversity than leafy spurge infested sites. Results also showed that species diversity did not change ($P>0.05$) after three grazing seasons and there was no treatment or year effect present after the three years of grazing.

Herbage production was different ($P<0.05$) between growing seasons in graminoid lb/acre and forb lb/acre. Results showed that graminoid lb/acre was lower ($P<0.05$) in 1998 than 1996 and 1999, however, was similar ($P>0.05$) between 1997 and 1998. Forb production results showed that forb lb/acre was higher ($P<0.05$) in 1999 than 1997 and 1998. Results would also indicate that leafy spurge has not effected shrub lb/acre after four growing seasons. Leafy spurge production did not change ($P<0.05$) after for growing seasons (Table 3).

Table 2. Forb and shrub species density/24 inch^2 quadrat on the cattle only non-infested (CON), cattle only leafy spurge infested (COS), sheep only non-infested (SON), sheep only leafy spurge infested (SOS), cattle and sheep non-infested (CSN), cattle and sheep leafy spurge infested (CSS), control non-infested (NUN), and control leafy spurge infested (NUS) treatments for 1996, 1997, and 1998. (Standard errors in parentheses.)

	1996[1]	**1997[1]**	**1998[1]**	**1999[1]**
	Density/24 inch^2 quadrat			

CON[2]	6.7 (1.0)^{abxz}	----	4.1 (0.1)^{ax}	7.8 (1.1)^{bxz}
COS[2]	1.8 (0.4)^{ay}	1.5 (0.4)^{ax}	1.3 (0.3)^{ax}	1.0 (0.3)^{ay}
SON[2]	5.8 (1.1)^{axz}	----	2.1 (0.5)^{bx}	7.0 (1.5)^{ax}
SOS[2]	1.1 (0.3)^{ay}	0.5 (0.2)^{ax}	0.8 (0.2)^{ax}	2.2 (0.5)^{ay}
CSN[2]	4.5 (0.4)^{ax}	----	2.3 (0.4)^{ax}	3.0 (0.4)^{ay}
CSS[2]	0.9 (0.2)^{ay}	0.3 (0.1)^{ax}	0.8 (0.3)^{ax}	1.4 (0.4)^{ay}
NUN[2]	7.8 (0.9)^{az}	----	6.9 (0.8)^{az}	5.8 (0.7)^{az}
NUS[2]	1.1 (0.4)^{ay}	0.9 (0.3)^{ax}	1.0 (0.3)^{ax}	1.9 (0.5)^{ay}

[1] Years with the same letter within each treatment are not significantly different (P>0.05) (a, and b).

[2] Treatments with the same letter are not significantly different (P>0.05) (x, y, and z).

Table 3. Herbage production (lb/acre) on the non-use control treatment in 1996, 1997, 1998, and 1999. (Standard errors in parentheses.)

	1996[1]	**1997[1]**	**1998[1]**	**1999[1]**
		lb/acre		
Grass & Grass-Like	1543 (128)^{a}	1325 (157)^{ab}	1041 (77)^{b}	1803 (281)^{a}
Forb	119 (42)^{ab}	84 (25)^{a}	46 (13)^{a}	190 (0.3)^{b}
Shrub	79 (61)^{a}	13 (10)^{a}	15 (8)^{a}	15 (9)^{a}
Leafy Spurge	339 (66)^{a}	396 (64)^{a}	350 (47)^{a}	464 (173)^{a}

[1] Years with the same letter within each treatment are not significantly different (P>0.05) (a, b, and c).

Leafy spurge degree of disappearance increased on all sheep treatments form 1996 to 1999. The SO treatment went from 76% to 99% leafy spurge disappearance from 1996 to 1999, and the CS treatment went from 62% to 97% from 1996 to 1999. There was an increase ($P \leq 0.05$) in leafy spurge disappearance in the CO treatment with 23% disappearance in 1996 compared to 50% in 1997 and

1998; however, reduced again to 23% in 1999. These results in leafy purge disappearance on the CO treatment would indicate that steers were consuming leafy spurge; however, due to the design and location of watering facilities, the leafy spurge disappearance was more likely due to a trampling affect. As graminoid disappearance increased on CO treatment, so did leafy spurge disappearance, indicating with more use of the graminoids, more grazing and trampling occurs. Graminoid degree of disappearance was similar (P>0.05) throughout the grazing seasons within and between grazing treatments for all years except 1999, were graminoid disappearance was reduced on the sheep treatments.

Steer average daily gain (ADG) was not different (P>0.05) between treatments (CO and CS) after four grazing seasons of the study (Table 4). There was no change (P>0.05) in steer ADG between years on the CO and CS treatment. Ewe ADG was not different (P>0.05) between treatments (SO and CS) for either years of the study. There was a decrease (P<0.05) in ewe ADG between years 1996 and 1998 on both SO and CS treatments, however, ADG were significantly higher (P,0.05) in 1999 than the 1998 grazing season (Table 4). These results would indicate multi-species grazing had no negative or positive impact on sheep or cattle performance compared to single species grazing.

Table 4. Livestock average daily gains (standard errors in parentheses) for individual livestock classes on the (CO) cattle only, (SO) sheep only, and (CS) cattle and sheep treatments for 1996, 1997, 1998, and 1999.

Treatment & Livestock Class[1]	1996[2]	1997[2]	**1998[2]**	**1999[2]**
		lb/day		
CO Steer	1.76 (0.07)[a]	1.61 (0.13)[a]	1.23 (0.06)[a]	1.80 (0.25)[a]
CS Steer	1.53 (0.32)[a]	1.12 (0.16)[a]	0.96 (0.13)[a]	1.44 (0.22)[a]
SO Ewe	0.16 (0.02)[y]	0.07 (0.02)[yz]	0.04 (0.02)[z]	0.09 (0.02)[y]
CS Ewe	0.16 (0.02)[y]	0.09 (0.03)[yz]	0.07 (0.02)[z]	0.18 (0.02)[y]

1 Years with the same letter within each treatment are not significantly different (P>0.05).

2 Treatments with the same letter within each livestock class are not significantly different (P>0.05).

CONCLUSIONS

Sheep grazing, either as a sole enterprise or mixed with cattle, will provide and effective tool in controlling leafy spurge by reducing stem densities. When replacing cattle AUM's with sheep AUM's, leafy spurge stem density counts were reduced by 92% after three years of grazing. When grazing sheep and cattle together, leafy spurge was reduced by 44% after three years. There were no negative or positive effects on species diversity grazing sheep or cattle alone or together after three grazing seasons. Graminoid disappearance was similar among all grazing treatments, indicating replacing cattle with sheep would not effect graminoid disappearance while reducing leafy spurge. There was no difference in livestock performance when grazing cattle and sheep separately or in combination, indicating multi-species grazing had no negative or positive effects on livestock performance as it relates to weight gain in this study.

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