MULTI-SPECIES GRAZING AND SINGLE SPECIES GRAZING ON LEAFY SPURGE INFESTED RANGELAND (Seven-Year Summary)

J.D. Dahl[1], K.K. Sedivec[2], T.C. Faller[1],
J.F. Karn[3], P.E. Nyren[4], and J. Olson[2]

[1]NDSU Hettinger Research and Extension Center, Hettinger
[2]Animal and Range Sciences Department, North Dakota State University, Fargo
[3]Northern Great Plains Agricultural Research Center, Mandan
[4]Central Grasslands Research and Extension Center, Streeter

Acknowledgments: We would like to give special and well-deserved thanks to the Hettinger Research Extension Center staff. Also we would like to thank Dennis Whitted and Connie O'Brien for their help in collecting vegetative data.

Introduction

The use of sheep as a biocontrol agent in the control of leafy spurge is not a new concept. In the late 30's and early 40's Christensen et al. (1938), Helgeson and Thompson (1939) and Helgeson and Longwell (1942) indicated that sheep consumed leafy spurge and should be integrated into management strategies in controlling leafy spurge, however, there was limited promotion. Herbicides continue to be the primary method for control of leafy spurge (Lym et al. 1995). Many areas infested with leafy spurge, however, are in environmentally sensitive areas and most herbicides for controlling leafy spurge are not labeled for application in these sensitive areas. Which have lead many land managers to choose an alternative control agent such as Angora goats or sheep. Research conducted in the 1980's and 1990's has shown that sheep or goats will reduce leafy spurge stem densities and increase grass and grass-like disappearance, and there are significant benefits in using multi-species grazing to manage leafy spurge infested rangelands (Prosser 1995).

Weedy forbs and brush cause more losses on the United States 252 million hectares of rangeland than all other pests combined (Quimby et al. 1991). Based on this report it amplifies the use of sheep or goats in the control of other troublesome forbs and brush as well as leafy spurge found on many rangelands that have been traditionally grazed by cattle only.

Multi-species grazing is an important idea in rangeland management because rangelands usually consist of one or more classes of vegetation (Merrill et al. 1966). By using more than one livestock species on a given rangeland containing various vegetative communities provides the potential of increasing red meat production, species diversity, vegetative production, and revenue for a given ranching operation, with proper management plans. Although multi-species grazing provides the above benefits, the introduction of leafy spurge and its consistency of infesting grasslands in the mid-west exploit the importance of using a multi-species grazing approach.

The objectives of this study were to test the effects of multi-species 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 USDA/ARS 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 1989) and classified as a wheatgrass-grama-needlegrass (*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 USDA/ARS 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) or a 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 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 2001; twelve mature ewes in 1996, ten-mature ewes 1997 and 1998, and seven mature ewes from 1999 to 2001 for the SO; one yearling steer and six mature ewes in 1996 and one yearling steer and five mature ewes for the CS from 1997 to 2001. Stocking rates were approximately 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 was due the adjustment in leafy spurge control and range condition.

Methods

Leafy spurge stem density counts were obtained by using a permanent 109.4 yard line transect and counts collected approximately every 5 ½ yards using a 1.08 ft^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 densities were monitored over the seven years to detect effectiveness of sheep grazing in single and multi-species environment in the control of leafy spurge. Leafy spurge densities were collected the end of May.

Forb and shrub species diversity and densities were determined using a 2.7 ft^2 quadrat. Nested within the 2.7 ft^2 quadrat was a 1.08 ft^2 quadrat used to determine grass and grass-like species

diversity. Data was collected from 109.4 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 (non-infested) 109.4 yard transect was located within each replicated treatment to monitor species diversity and density changes that may naturally occur due to treatment. Readings were collected from the native transects annually, except in 1997. The leafy spurge transects were monitored annually and will continue to be monitored annually throughout the ten-year trial.

Leafy spurge, grass and grass-like, shrub, and forb herbage production were 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 7.67 x 7.67 yard plot. A 7.67 yard buffer strip was implemented to prevent edge effect. Twenty-five plots were randomly selected and clipped within each NU using a 2.7 ft^2 quadrat.

Degree of disappearance of leafy spurge, grass and grass-like, forbs, and shrubs were determined for each treatment at the end of the grazing season by stratifying each treatment into 7.67 by 7.67 yard quadrats in 1996, 1997, 1998, and 1999. Twenty-five quadrats were randomly selected and clipped using a 2.7 ft^2 quadrat for each grazed and non-use treatment to determine the degree of disappearance. The method of determining degree of disappearance was change in 2000 due to the change in herbage production on the grazing treatments. Degree of disappearance was monitored using the pair-plot technique, in 2000 and will continue throughout the duration of the trial, two frames within the cage and two out were clipped after the removal of livestock species. Five cages were systematically placed within each grazing treatment (CO, SO, and CS) in leafy spurge infested sites. This method allowed use to monitor the herbage production on the grazing treatments and the degree of disappearance of grass and grass-like, forbs, shrubs, and leafy spurge.

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

Treatment and year effects for leafy spurge stem density, forb and shrub density, herbage production, degree of disappearance, and livestock performances were analyzed using a general linear model (GLM) (SPSS 2000). 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-infested range sites. Treatment and year effects of species diversity were analyzed using a non-parametric test (Krushal-Wallis Test) (SPSS 2000).

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/1.08 ft^2 in 1996 to 0.4/1.08 ft^2 stems in 2002, a reduction of 36% after one grazing season and 96% after six on the SO. Leafy spurge stem densities were not affected after two grazing seasons on the CS treatment, however, by the third year the CS treatment had a significant ($P \leq 0.05$) reduction and results showed that a significant ($P \leq 0.05$) change between

year three and four. Leafy spurge stems were reduced ($P \leq 0.05$) from 11.6 stems/1.08 ft^2 in 1996 to 0.2 stems/1.08 ft^2 in 2002, a reduction of 98% after six grazing seasons (Table 1).

Leafy spurge and non-infested range sites were significantly ($P \leq 0.05$) different in forb and shrub densities at the on set of the study in 1996. The main focus of the study was to evaluate the change of forb and shrub density on leafy spurge infested range sites over the course of the study. Non-infested range sites, however, were also evaluated separately from the leafy spurge infested sites throughout the duration of the study (Table 2 and 3). Results after six grazing seasons show that no year or treatment effects were present on leafy spurge or non-infested range sites in the number of forb and shrub stems per 2.4 ft^2 (Table 2 and 3).

Plant species diversity results showed that there were significant ($P \leq 0.05$) differences between leafy spurge and non-infested range sites in all treatments in 1996. Again or focus was on evaluating the leafy spurge infested sites in each treatment to detect changes in plant species diversity. Results showed that plant species diversity has not change ($P > 0.05$) after six grazing seasons which shows that there was no treatment or year effect present (Tables 4 and 5).

Peak herbage production results show differences between growing seasons for graminoid, forb, and leafy spurge production, on the NU (Table 6). These changes would be directly related to annual precipitation and temperatures. At the start of the study or hypotheses was that leafy spurge would have a negative effect on graminoid, forb, and shrub herbage production, however, results found over seven grazing season would not indicate this.

Leafy spurge degree of disappearance increased on all sheep treatments from 1996 to 2001. The SO treatment went from 76% to 99% leafy spurge disappearance from 1996 to 2001, and the CS treatment went from 62% to 97% from 1996 to 2000. There was an increase ($P \leq 0.05$) in leafy spurge disappearance in the CO treatment with 23% disappearance in 1996 compared with 50% in 1997 and 1998; however, reduced again to 23% in 1999. These results in leafy purge disappearance on the CO treatment would suggest 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 effect. As graminoid disappearance increased on CO treatment, so did leafy spurge disappearance, suggesting 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, where 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 six grazing seasons of the study (Table 7). 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 ($P \leq 0.05$) in ewe ADG between years 1996 and 1998 on both SO and CS treatments, however, ADG was significantly higher ($P \leq 0.05$) in 1999 than the 1998 grazing season (Table 7). These results would suggest multi-species grazing had no negative or positive impact on sheep or cattle performance compared with single species grazing.

Table 1. Leafy spurge stem densities on the cattle only, sheep only, cattle and sheep, and control treatments from1996 through 2002. (SE in parentheses.)

Year[1]	Cattle Only[2]	Sheep Only[2]	Cattle and Sheep[2]	Control[2]
	# of Stems/1.08 ft^2 quadrat			
1996	9.8 (1.2)^{abx}	10.4 (0.9)^{ax}	11.6 (1.0)^{ax}	9.8 (1.2)^{ax}
1997	12.0 (1.2)^{ax}	6.7 (0.7)^{by}	12.3 (1.0)^{ax}	11.4 (1.3)^{ax}
1998	10.8 (1.0)^{abx}	2.5 (0.6)^{cy}	11.6 (1.0)^{ax}	11.1 (1.2)^{ax}
1999	11.1 (0.8)^{abx}	0.8 (0.2)^{cy}	6.5 (0.8)^{bz}	10.5 (1.0)^{ax}
2000	7.6 (0.8)^{bc}	0.6 (0.3)^{cy}	2.1 (0.2)^{cy}	11.8 (0.8)^{ax}
2001*	7.0 (0.7)^{bx}	0.5 (0.2)^{cy}	1.2 (1.2)^{cy}	7.3 (0.8)^{ax}
2002*	3.3 (0.4)^{cx}	0.4 (0.2)^{cx}	0.2 (0.1)^{cx}	3.3 (0.5)^{bx}
% Change	**66%**	**96%**	**98%**	**66%**

[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).
***Biocontrol insects present (2001 biocontrol insects were found in all treatments and rep's).**

Table 2. Forb and shrub species densities on native sites on the cattle only, sheep only, cattle and sheep, and control treatments for 1996 through 2002. (SE in parentheses.)

Year	Cattle Only	Sheep Only	Cattle and Sheep	Control
	Density/2.7 ft^2 Quadrat on Native Sites			
1996	6.7 (1.0)	5.8 (1.1)	4.5 (0.4)	7.8 (0.9)
1997	NA	NA	NA	NA
1998	4.1 (0.1)	2.1 (0.5)	2.3 (0.4)	6.9 (0.8)
1999	7.8 (1.1)	7.0 (1.5)	3.0 (0.4)	5.8 (0.7)
2000	9.5 (1.5)	6.0 (0.9)	3.5 (0.5)	6.1 (0.7)
2001	5.9 (0.7)	3.0 (0.4)	2.6 (0.3)	6.9 (0.8)
2002	4.4 (0.6)	2.3 (0.4)	2.0 (0.3)	5.8 (0.8)

Table 3. Forb and shrub species densities on leafy spurge infested sites on the cattle only, sheep only, cattle and sheep, and control treatments for 1996 through 2002. (SE in parentheses.)

Year	Cattle Only	Sheep Only	Cattle and Sheep	Control
	Density/2.7 ft^2 Quadrat on Leafy Spurge Infested Sites			
1996	1.8 (0.4)	1.1 (0.3)	0.9 (0.2)	1.1 (0.4)
1997	1.5 (0.4)	0.5 (0.2)	0.3 (0.1)	0.9 (0.3)
1998	1.3 (0.3)	0.8 (0.2)	0.8 (0.3)	1.0 (0.3)
1999	1.0 (0.3)	2.2 (0.5)	1.4 (0.4)	1.9 (0.5)
2000	1.1 (0.3)	1.7 (0.2)	0.9 (0.4)	1.6 (0.4)
2001	2.3 (0.5)	1.3 (0.2)	0.8 (0.2)	2.4 (0.7)
2002	0.9 (0.2)	1.2 (0.2)	0.7 (0.2)	1.1 (0.3)

Table 4. Shannon Weiner diversity index for native sites on the cattle only, sheep only, cattle and sheep, and control treatments for 1996 through 2002. (SE in parentheses.)

Year	Cattle Only	Sheep Only	Cattle and Sheep	Control
	Species Diversity Index on Native Sites			
1996	2.73 (0.17)	2.62 (0.04)	2.66 (0.17)	2.57 (0.11)
1997	NA	NA	NA	NA
1998	2.60 (0.10)	2.42 (0.25)	2.46 (0.06)	2.76 (0.12)
1999	2.60 (0.05)	2.58 (0.25)	2.46 (0.08)	2.67 (0.15)
2000	2.65 (0.14)	2.69 (0.19)	2.63 (0.12)	2.76 (0.17)
2001	2.71 (0.11)	2.55 (0.21)	2.51 (0.09)	2.40 (0.35)
2002	2.58 (0.09)	2.45 (0.14)	2.42 (0.25)	2.11 (0.41)

Table 5. Shannon Weiner diversity index on leafy spurge infested sites on the cattle only, sheep only, cattle and sheep, and control treatments for 1996 through 2002. (SE in parentheses.)

Year	Cattle Only	Sheep Only	Cattle and Sheep	Control
	Species Diversity Index on Leafy Spurge Infested Sites			
1996	2.30 (0.07)	2.31 (0.13)	2.15 (0.12)	2.08 (0.04)
1997	2.23 (0.26)	2.17 (0.21)	1.91 (0.07)	1.92 (0.27)
1998	2.12 (0.13)	2.24 (0.15)	1.92 (0.21)	2.02 (0.29)
1999	2.11 (0.19)	2.23 (0.18)	2.19 (0.07)	1.90 (0.47)
2000	2.26 (0.13)	2.37 (0.10)	2.17 (0.04)	2.21 (0.28)
2001	2.21 (0.08)	2.28 (0.11)	2.23 (0.11)	2.24 (0.26)
2002	2.03 (0.23)	2.34 (0.09)	2.20 (0.04)	2.03 (0.23)

Table 6. Peak herbage production (lb/acre) for graminoid, forbs, shrubs, and leafy spurge on the control treatment for 1996 through 2002. (SE in parentheses.)

Year	Graminoids	Forbs	Shrubs	Leafy Spurge
	lb/acre			
1996	1527 (146)^{ab}	118 (46)^{ab}	82 (76)^{a}	407 (139)^{ab}
1997	1317 (168)^{ad}	87 (29)^{ab}	14 (13)^{a}	446 (77)^{ab}
1998	1060 (139)^{d}	46 (23)^{a}	14 (14)^{a}	350 (81)^{a}
1999	1609 (202)^{ab}	171 (59)^{b}	14 (12)^{a}	410 (92)^{ab}
2000	1652 (143)^{ab}	93 (53)^{ab}	10 (8)^{a}	624 (173)^{b}
2001	2244 (93)^{c}	92 (20)^{ab}	29 (14)^{a}	287 (45)^{a}
2002	1791 (82)^{b}	48 (14)^{a}	7 (6)^{a}	251 (29)^{a}

Table 7. 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 through 2002.

Year[1]	CO Steer[2]	CS Steer[2]	SO Ewe[2]	CS Ewe[2]
	lb/day			
1996	1.76 (0.07)^{ax}	1.53 (0.32)^{ax}	0.16 (0.02)^{acx}	0.16 (0.02)^{abx}
1997	1.61 (0.13)^{ax}	1.12 (0.16)^{ax}	0.07 (0.02)^{bx}	0.06 (0.03)^{abx}
1998	1.23 (0.06)^{ax}	0.96 (0.13)^{ax}	0.04 (0.02)^{bx}	0.07 (0.02)^{bx}
1999	1.80 (0.25)^{ax}	1.44 (0.22)^{ax}	0.09 (0.02)^{abx}	0.18 (0.02)^{abx}
2000	1.96 (0.24)^{ax}	2.02 (0.10)^{ax}	0.20 (0.02)^{acx}	0.22 (0.03)^{ax}
2001	1.86 (0.17)^{ax}	1.63 (0.33)^{ax}	0.23 (0.02)^{cx}	0.20 (0.03)^{ax}
2002	1.33 (0.14)^{ax}	1.55 (0.30)^{ax}	0.13 (0.02)^{acx}	0.21 (0.01)^{ax}

[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).

CONCLUSIONS

Sheep grazing, either as a sole enterprise or mixed with cattle is an effective tool in controlling leafy spurge. When replacing cattle AUM's with sheep AUM's, leafy spurge stem density counts were reduced by 96% in six years of grazing. When grazing sheep and cattle together, leafy spurge was reduced by 98% in six years. There were no negative or positive effects on species diversity grazing sheep or cattle alone or together after five grazing seasons. Grass and grass-like disappearance was similar among all grazing treatments, showing replacing cattle with sheep would not affect grass and grass-like disappearance while reducing leafy spurge. There was no difference in livestock performance when grazing cattle and sheep separately or in combination, suggesting multi-species grazing had no negative or positive effects on livestock performance as it relates to weight gain in this study.

Literature Cited

Barker, W.T. and W.C. Whitman. 1989. Vegetation of the northern Great Plains. Rangelands. 10:266-272.

Merrill, L.B., P.O. Reardon, and C.L. Leinweber. 1966. Cattle, sheep, goats... mix'em up for higher gains. Texas Agr. Prog. 12:13-14.

Prosser, C.W. 1995. Multi-species grazing of leafy spurge infested rangeland in North Dakota. M.S. Thesis. N.D. State Univ., Fargo. 80 pp.

Shiflets, T.N. 1994. Rangeland cover types of the United States. Soc. for Range Manage. Denver, CO. 152 pp.

SPSS. 2000. Statistical producers for Social Science. Marketing Dept. SPSS. Inc. Chicago, Ill.

Quimby, P.C. Jr., W.L. Bruckart, C.J. Deloach, L. Knutson, and M.H. Ralphs. 1991. Biological control of rangeland weeds. P 83-102 Chapter 9. In: Noxious Range Weeds. Westview Press, Boulder, San Francisco, & Oxford.

Whitman, Warren, C., D.W. Bolin, E.W. Klostermann, K.D. Ford, L. Moomaw, D.G. Hoag, and M.L.Buchanan. 1951. Caroten, protein, phosphorus in grasses of western North Dakota. Agr. Exp. Sta., N.D. Agr. College. N. D. Agr. Exp. Sta. Bull. No. 370.