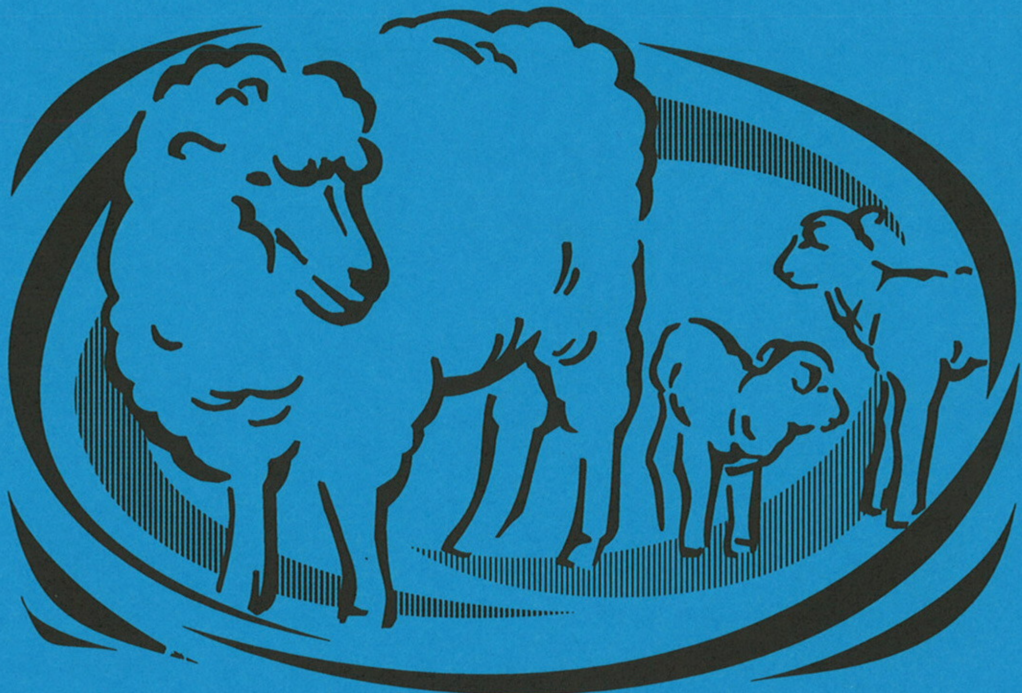
REPORT NO. 40



WESTERN DAKOTA SHEEP DAY

February 10, 1999

HETTINGER ARMORY

Hettinger Research Extension Center
and
Department of Animal and Range Sciences
North Dakota State University

February 10, 1999

Dear Sheep Producer:

On behalf of the Hettinger Research Extension Center and the Department of Animal and Range Sciences, let us welcome you to "Sheep Day". This report collectively represents North Dakota State University's efforts at both locations to provide information for the support of the sheep industry. We welcome your comments as grassroots users of the efforts of both Extension and Experiment Station resources. Your constructive comments assist us to participate meaningfully in the future of your industry.

A collective, positive and participatory attitude by producers and caretakers of their land grant resources will go far to solve problems confronting the sheep industry.

Best wishes for a day of sharing and learning.

Timothy C. Faller
Director
Hettinger Res. Ext. Ctr.
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This publication will be made available in alternative formats upon request. Five hundred copies of this publication were printed at a cost of approximately $1.75 each. Contact Hettinger Research Extension Center, 701-567-4323.

PROGRAM

9:00-10:00 AM (MST)		Open House at barns to tour projects and view the rams on the "RAM TEST"
9:30 AM	Doors Open - and coffee at Hettinger Armory	
10:10 AM	Early Bird Door Prize Drawing	
10:15 AM	HETTINGER & FARGO STATION REPORTS Dr. Paul Berg Dr. Marc Bauer Mr. Dan Nudell Mr. Jack Dahl Dr. Jeff Held Mr. Tim Faller	
12:00 NOON	LUNCH: AMERICAN LAMB DINNER	
1:00 PM	OPENING COMMENTS: Peter Orwick, Executive Director American Sheep Industry Association	
1:10 PM	"COOL SEASON GRASSES AND THEIR NUTRITIVE VALUES" Dr. Kevin Sedivec, Range Specialist NDSU Dept. of Animal & Range Sciences Fargo, North Dakota	
1:40 PM	"NEW WOOL PACKAGING REQUIREMENTS, WHAT WILL BE THE IMPACT?" Larry Prager, Manager Center of the Nation Wool Warehouse Belle Fourche, South Dakota	
2:10 PM	"DISEASE IMPACTS ON THE COMMERCIAL SHEEP OPERATOR" Dr. Charles Stoltenow, Extension Veterinarian North Dakota State University Fargo, North Dakota	
2:55 PM	"CLOSING REMARKS" James Marshall Jr., President North Dakota Lamb & Wool Producers Assoc. Oriska, North Dakota	

*There will be a spouse program in the afternoon beginning at 1:15 PM. Presentations at this program will focus on "UPDATES ON LAMB COOKERY & WOOL FIBERS", "A NEW LOOK WITHOUT A NEW LOAN" and "IS IT TIME FOR A HOME COMPUTER?"

SHEEP DAY DIGEST

by
Timothy C. Faller, Director
Hettinger Research Extension Center
North Dakota State University

Lean Lamb Production

N.M. Maddux, P.T. Berg, T.C. Faller, W.R. Limesand, B.L. Moore

Introduction

NDSU has been collecting data for four years on factors that will aid sheep producers in producing lean lambs with high growth rates. The first objective of this project was to develop accurate prediction formulas which determine lean mass in the live animal and its carcass. The second objective was to utilize the formulas in establishing an effective expected progeny difference value that would prove valuable and economical to any sheep producer. The prediction formulas have been statistically analyzed and an Within Flock EPD has been developed based on the following conclusions.

A portion of this project evaluated an electronic instrument called a Bioelectrical Impedance Analyzer (BEI). The BEI machine measures the amount of low energy current which is absorbed and dispersed through the body. Lean tissue conducts an electrical current differently than does fat, so the measurements taken from the BEI were used to develop mathematical formulas which predict fat free mass. This machine was used on the live animal and its carcass during the project.

Procedure

Prediction equations were established for the live lambs and their carcasses based on Bioelectrical Impedance Analyzer (BEI) measurements. The complete data set (CDS) (n=441) had pooled data that contained standard carcass measurements and carcass BEI. Within this set are subgroups: DS (n=217) contained lambs that had standard carcass measurements and BEI measures, DS2 (n=182) were lambs with recorded live and carcass measures and DS3 (n=42) consisted of Columbia lambs with known sires. The established formulas developed from DS and DS2 were used to develop within flock expected progeny difference (WFEPD) values on individuals with identified sires found in DS3..

Results

DS1 had cutout data of lambs slaughtered at the NDSU Meats Laboratory and processed to trimmed retail product. The weight of the fabricated wholesale cuts, denuded of subcutaneous fat, were used as the dependent variable that developed the total retail product (TRP) equation when compared to measurements taken from the pooled data set. CDS contained cold carcass weight (CCW), fat depth (FAT), bodywall thickness (BW) and ribeye (RE) that were used to develop a multiple regression formula for total retail product (TRP): An# = 4.80 + (0.5710*CCW) - (7.36*FAT) - (5.87*BW) + (1.39*RE). This formula produced an R-squared of .94 when compared to the actual trimmed retail weights obtained from DS1. Based on the Impedance and cold carcass measures within this set, a BEI cold carcass formula was developed which had an R-squared = .91:

BEI_c = 6.72 + (.4818*cold carc wt) - (.0314*Rs_c) - (.0481*Xc_c) + (.254*Ln_c) + (.0223*temp)

Rs_c = Resistance from BEI instrument

Xc_c = Reactance from the BEI Instrument

Ln_c = Length between electrodes

DS2 contained lambs which were evaluated by BEI prior to slaughter and were used to develop a BEI prediction formula for the live animal. The prediction formula developed was:

BEI_L = .0973 + (0.3118*livewt) + (0.17*Rs_L) + (0.1739*Xc_L) -(0.0102*Ln_L).

The live animal (BEI_L) had an R-squared of .79. Table 1 shows the summary of all lambs in data set 2.

DS3 verified the formulas found from DS and DS2 . The formulas were found to be quite accurate with an entirely different set of animals. Table 2 gives the average carcass characteristics DS3.

An# = .82

BEI_c = .84

BEI_L= ..64

Sire groups taken from the entire complete data set (CDS) were used to develop EPD's on sires who had more than 10 offspring tested. Table 3 shows the summary of the complete data set analyzed. The values were based on the breed average within the flock which was called Within Flock Expected Progeny Difference (WFEPD). WFEPD values for sire groups were based on retail value per day of age:

RP$ = (trim shoulder wt* $2.89) + (trim rack wt.* $4.75) + (trim loin wt * $7.98) + (trim leg wt.* .90 * $4.98) + (breast, flank, etc. wt.* .50 * $.85) / age in days.

Prices were based on March 5th averages from retail stores in the Fargo-Moorhead area. The numbers .90 and .50 were multipliers developed from DS1 to get the boneless weight. The RP$ were used to calculate WFEPD by the expected progeny difference formula:

EPD = N*h2/2* [1 + (N-1) * h2 * r] * [Ps - P] (Spike et al., 1991).

h2 = heritability of pounds of TRP (.40)

N = number of records

r = repeatability

Ps = average performance of selected individual

P = population average

The WFEPD values for the Columbia identified sire group ranged from -.131 to 0.209. Table 4 shows the WFEPD values for the sires who had more than 10 offspring who were evaluated. There is variation in the sire WFEPD values for the Columbia identified flock.

Conclusion

The data accumulated from all three data sets was analyzed and shows that pounds of lean mass or total retail product can be predicted by using BEI both on the live animal and its carcass. The accuracy of the live animal prediction formula can be used in the establishment of a Within Flock EPD value based on actual pounds of retail product. This value is an accurate, economical and unbiased tool which can aid producers in identifying breeding stock that have the genetic potential to produce fast growing, lean lambs.

Prospective

A feedlot trial using lambs with identified sires and dams from this project will begin in the next year. The objective of this project is to further the accuracy of the WFEPD value when it is used on a large group of lambs in a consistent environment who are on the same nutritional plain.

TABLE 1. ANATOMICALLY PREDICTED TRP GROUP 2 LAMB SUMMARY

TRAIT	AVERAGE	
LIVE WT (kg)	57.93	
COLD CARC WT	30.80	
LIVE Rs	31.00	
LIVE Xc	3.10	
LIVE Ln (cm)	117.86	
COLD CARC Rs	201.70	
COLD CARC Xc	62.70	
COLD CARC Ln	110.49	
RIBEYE AREA (square cm)	14.45	
12TH RIB FAT (cm)	0.48	
BODY WALL THICKNESS (cm)	2.06	
ANATOM PRED LEAN (kg)	18.86	61.23% OF CCWT
BEI PRED LEAN CARC (kg)	19.22	61.70% OF CCWT
BEI PRED LEAN LIVE (kg)	18.86	61.23% OF CCWT

N = 182

TABLE 2. AVERAGE CARCASS CHARACTERISTICS AND PREDICTED KILOGRAMS OF TRP FROM GROUP 3

TRAIT	AVERAGE
AGE IN DAYS	187.71
LIVE WT (kg)	55.91
COLD CARC WT (kg)	27.25
RIB EYE AREA (cm squared)	13.68
12TH RIB FAT (cm)	0.33
BODYWALL THICK (cm)	1.78
SHANK WT (kg)	0.544
KIDNEY FAT (kg)	0.15
MARBLING	3.59
STREAKING	3.38
LEG SCORE	10.35
CONFORMATION SCORE	9.95
DRESSING %	51.5
An# (kg)	17.19 63.10% OF CCWT
CARC BEI (kg)	17.03 62.50% OF CCWT
LIVE BEI (kg)	17.01 62.42% OF CCWT

N = 42

TABLE 3. GROUP 1-3 SLAUGHTER CHARACTERISTICS AND PREDICTED TRP

TRAIT	AVERAGE	
LIVE WT (kg)	58.63	
COLD CARC WT (kg)	31.35	
RIBEYE AREA (square cm)	15.29	
12TH RIB FAT (kg)	0.43	
BODY WALL THICKNESS (cm)	1.93	
KIDNEY FAT	0.86	
USDA YIELD GRADE	2.28	
MARBLING	*3.95	
STREAKING	*3.9	
LEG SCORE	10.94	
CONFORMATION SCORE	10.79	
LEAN COLOR SCORE	3.20	
TRIM RETAIL PRODUCT (kg)	18.55	61.55% CCWT
BIA PRED LEAN (BEIc) (kg)	18.93	61.92% CCWT
ANATOM. PRED LEAN (An#) (kg)	18.80	61.78% CCWT
SUM AS % OF LIVE WT	31.95	

N = 441
*MARBLING/STREAKING SCORE
TRACES = 2.00
SLIGHT = 3.00
SMALL = 4.00

TABLE 4. COLUMBIA SIRE EVALUATION FOR WFEPD $/DAY

ID	PRG NO.	AVG WT (kg)	DAYS /AGE	LVPD TRP (kg)	CALC $TRP	$TRP /DAYS	WFEPD $/DAY
1	13	55.73	142.31	18.14	189.52	1.35	0.162
2	13	55.48	132.69	18.01	188.22	1.43	0.209
3	12	44.98	170.67	17.56	183.43	1.17	0.053
4	10	41.69	143.75	13.60	142.14	1.01	-0.035
5	9	47.53	187.56	15.46	161.61	1.05	-0.013
6	9	47.73	156.68	15.62	163.18	1.04	-0.018
7	8	50.46	160.46	16.70	172.31	1.08	0.002
8	7	48.73	138.29	15.85	165.63	1.22	0.063
9	7	39.60	149.63	12.94	135.23	0.91	-0.073
10	7	41.54	150.65	13.58	141.93	0.96	-0.051
11	7	60.00	194.57	19.52	204.02	1.05	-0.012
12	6	57.76	206.67	18.86	197.06	1.00	-0.031
13	5	49.81	292.40	19.69	205.65	0.71	-0.131
14	5	56.70	194.20	18.56	193.92	1.02	-0.020
15	5	57.88	184.00	18.88	197.25	1.19	0.041
16	4	57.38	207.50	18.65	194.89	1.00	-0.023

N = 136

Nutrient Composition of Selected Cool-season Grasses near Hettinger, North Dakota

Kevin Sedivec[1], Irwin Russell[2], Kimberly Vader[1], Dwight Tober[2], Russell Haas[2], and Timothy Faller[3]

[1]Extension Rangeland Specialist and Graduate Student, Animal and Range Sciences Dept., NDSU, Fargo; [2]District Conservationist, Plant Material Center Supervisor, and Environmental Resource Coordinator, Natural Resource Conservation Service; [3]Director, Hettinger Research Experiment Center, Hettinger, ND.

Cooperators: North Dakota State University, Animal and Range Sciences, Fargo, ND; USDA, Adams County Soil Conservation District, Hettinger, ND; USDA, Plant Materials Center, Bismarck, ND; Dakota West Rural Community and Development (RC&D), Dickinson, ND; North Dakota State University, Hettinger Research Experiment Center, Hettinger, ND; Mr. Joseph Clement, Landowner, Hettinger, ND.

Introduction

Cool-season grasses are commonly planted in North Dakota for spring, early summer, and fall pastures, hayland, wildlife habitat, roadside right-a-ways, and set aside acres. Meeting the nutritional requirements of domestic livestock is the key to optimizing performance on and off pasture. Crude protein (CP) content, acid detergent fiber (ADF), and total digestible nutrient (TDN) content comprise the majority of values needed to develop feed requirements for domestic livestock (Nutrient Requirements of Beef Cattle 1996). Knowledge of the nutritional concentrations of these cool-season grasses can be used by livestock producers to obtain optimum performance through the addition of proper management and timely supplementation during the grazing season when nutritional requirements are deficient.

Many ranchers in North Dakota and surrounding states and Canadian provinces have indicated a need for improved cool-season grasses for additional pasture land and hayland that best complements native rangeland. To best suit this need, nutritional content of the grasses, production potential, and best use base on plant phenology and production are needed to address these concerns. With the advent of such knowledge and the potential to improve cattle performance on a regional basis, a need has developed to determine the nutrient content and forage production potential of selected cool-season grasses in the northern Great Plains region.

Objectives and Hypothesis

Objective 1: Determine and compare the nutrient content by date and phenological growth stage of 25 cool-season grasses.

Objective 2: Determine and compare forage production levels of 25 cool-season grasses.

Objective 3: Develop management recommendations on proper use of cool-season grasses.

Null Hypothesis 1: No differences in nutrient content will occur between 25 different cool-season grasses.

Null Hypothesis 2: No differences in forage production will occur between 25 different cool-season grasses.

Study Area

This research and demonstration project is conducted on private land (T129,R96,Sec 24, SE1/4) south of Hettinger, ND. All grass species and cultivars were planted on a Vebar-Flasher soil series. Vaber-Flasher soils are classified as a fine sandy loam, slopes 3 to 9 percent, shallow, somewhat excessively drained, and prone to erosion (Ulmer and Conta 1987).

One hundred and one different varieties or experimental lines were seeded in 6 ft by 25 ft plots on April 6, 1992. Seeding rate varied with species but followed recommended seeding rates as specified in the North Dakota NRCS Technical Guide. Species with no specified seeding rates were planted at 20-25 seeds/ft^2.

Climate

North Dakota is located at the geographic center of North America. This results in a continental climate characterized by continuous air movement and large annual, daily, and day-to-day temperature changes. Relative humidity is low and precipitation tends to be irregular in time and cover (Jensen 1972).

Seventy-seven percent of the annual precipitation falls during the summer months, with 50 percent falling during May, June, and July (Bavendick 1952). Both 1995 and 1996, based on yearly averages, were above normal for annual precipitation totals, while 1997 was well below normal (Table 1). Both years 1995 and 1996 had well above average precipitation in May, ranging from 2.54 inches above normal in 1996 to 3.50 inches above normal in 1995. However, May of 1997 was 2.72 inches below normal. Only the month of June in 1997 achieved normal precipitation while the months of July, August, and September having drought condition levels. The summer of 1995 had above normal precipitation in July and August while these months in 1996 were considered droughty.

A drought is defined as a prolonged period of time receiving less than 75 percent of the average precipitation when plants suffer from lack of water (Vallentine 1990). In 1995, only September would have classified as a drought month. In 1996, April, June, July, August, and October were classified as drought months. The months of May, July, August, and September were classified as drought months in 1997.

Table 1. Monthly precipitation at Hettinger Experiment Station, Hettinger, ND for 1995, 1996, and 1997.

Month	1995	+ or - Normal	1996	+ or - Normal	1997	+ or - Normal	42 yr Avg
January	0.20	(- 0.16)	0.56	(+ 0.20)	0.05	(- 0.31)	0.36
February	0.42	(+ 0.07)	0.31	(- 0.04)	0.18	(- 0.17)	0.35
March	0.75	(+ 0.18)	0.95	(+ 0.38)	0.32	(- 0.25)	0.57
April	1.18	(- 0.47)	1.02	(- 0.63)	3.68	(+ 2.03)	1.65
May	6.07	(+ 3.35)	5.20	(+ 2.48)	1.16	(- 1.56)	2.72
June	2.88	(- 0.55)	2.45	(- 0.98)	3.79	(+ 0.36)	3.43
July	2.21	(+ 0.18)	0.86	(- 1.17)	1.16	(- 0.87)	2.03
August	3.71	(+ 2.01)	0.53	(- 1.17)	0.73	(- 0.97)	1.70
September	0.44	(- 1.01)	4.09	(+ 2.64)	0.25	(- 1.20)	1.45
October	1.27	(+ 0.28)	0.55	(- 0.44)	0.89	(- 0.10)	0.99
November	0.49	(+ 0.01)	1.59	(+ 1.09)	0.39	(- 0.11)	0.50
December	0.15	(+ 0.16)	0.72	(+ 0.40)	0.05	(- 0.27)	0.32
Totals	19.77	(+ 3.70)	18.83	(+ 2.76)	12.65	(- 3.42)	16.07

Grasses Studied

Of the 101 grasses varieties/cultivars, 25 grasses were selected in 1994 to be analyzed for nutrient and forage production. A total 18 grass species will be tested encompassing 25 cultivars (Table 2). Four cool-season species studies were selected native grasses cultivars. Fourteen grass species that made-up 21 cultivars were introduced plants from counties not found in North America.

Methods and Procedures

Nutritional quality and forage production will be determined from ungrazed, non-mowed cool-season grass clippings at 10 time periods throughout the growing season beginning late April and ending early November. An array of 25 cool-season grass cultivars were seeded in 6 ft by 25 ft plots on April 6, 1992. Three replicated arrays were developed and each grass cultivar randomly seeded in each array to create a complete randomized block design.

This nutritional quality and forage production trial began in 1995. Each plot was subdivided into 10 quadrants of equal size to correlate to a clipping period (date). The 10 clipping periods were randomly selected for each of the 75 plots. Each of the grass cultivars were tested for CP, ADF, neutral detergent fiber (NDF), phosphorus, calcium, copper, zinc, magnesium, molybdenum, iron, potassium, and manganese. Forage production was determined for each of the grass cultivars for each clipping period to determine peak herbage production and time period. Total digestible nutrient (TDN) were determined for each grass species using the net energy lactation (NEL) formula involving ADF in the model [4.898 + (89.796 x NEL), where, NEL = 1.085 - (0.0124 x % ADF)]. Crude protein, TDN, copper, and zinc content will be summarized in this report.

Table 2. List of grass species and cultivar of each cool-season grass tested near Hettinger, ND, 1995-1997.

Grass Species	Common Name	Cultivar
Elymus trachycaulus ssp. trachycaulus	Slender wheatgrass	Revenue
Pascopyrum smithii	Western wheatgrass	Rodan
Pseudoroegneria spicata ssp. spicata	Bluebunch wheatgrass	Goldar
Pseudoroegneria spicata ssp. spicata/ Elytrigia repens ssp. Repens	Bluebunch wheatgrass/ quackgrass hybrid	RS-1 hybrid R
Elymus lanceolatus	Thickspike wheatgrass	Critana
Elytrigia elongatum	Tall wheatgrass	Alkar
Elytrigia intermedium ssp. trichophorum	Pubescent wheatgrass	Manska
Elytrigia intermedium ssp. trichophorum	Pubescent wheatgrass	MND-759
Elytrigia intermedium ssp. intermedium	Intermediate wheatgrass	Oahe
Elytrigia intermedium ssp. intermedium	Intermediate wheatgrass	Reliant
Agropryon cristatum	Crested wheatgrass	Ephraim
Agropryon desertorum	Crested wheatgrass	Nordon
Agropryon cristatum/desertorum	Crested wheatgrass	Hycrest
Leymus triticoides	Beardless wildrye	Shoshone
Elymus dahuricus	Dahurian wildrye	Arthur
Leymus racemosus	Mammoth wildrye	Volga
Leymus cinereus	Basin wildrye	Magnar
Leymus angustus	Altai wildrye	Prairieland
Psathyrostachys junceus	Russian wildrye	Mankota
Psathyrostachys junceus	Russian wildrye	Bozoisky select
Bromus inermis	Smooth bromegrass	Rebound
Bromus inermis	Smooth bromegrass	Cottonwood
Bromus biebersteinii	Meadow bromegrass	Regar
Stipa viridula	Green needlegrass	Lodorm
Leymus arenarius	European dunegrass	ND-2100

The first clipping period was conducted April 26, May 14, and April 29, 1995, 1996, and 1997, respectively. Nine clipping periods occurred in 1995 and 1996, and 11 periods in 1997 at two to four week intervals. Samples were collected from each plot using a 0.25 m2 frame placed in its designated quadrant as randomly selected for each clipping period. Grasses were clipped to a 0.5 inch stubble with tissue placed into a paper bag for future preparation. Clipping date and physiological growth stage was recorded for all grass cultivars at each clipping period.

All samples were oven dried at 60 degrees Celsius, ground through a 1 mm screen in a Wiley mill, and analyzed for dry matter, ash, CP, ADF, and NDF at the North Dakota State University, Animal and Range Sciences nutritional laboratory. Dry matter, ash, and ADF were determined following standardized procedures (AOAC 1990), NDF using procedures described by Robertson and Van Soest (1982), and CP using the Kjeldahl Auto System II (AOAC 1990).

Data will be analyzed to determine differences at the 0.10 percentile ($P<0.1$) between time periods and grass species cultivars. Analysis comparing differences in nutrient quality and forage production between time periods will be conducted using 2-way analysis of variances as performed using Statistical Procedures for Social Sciences (1994). Analysis comparing differences in nutrient quality and herbage production between grass cultivars for each time period will be conducted using least square deviations as performed using Statistical Procedures for Social Sciences (1994).

Results and Discussions

The cool-season grass species differed in amount of forage production, timing of peak production, and levels of nutrient content. Yearly forage production also differed for each grass cultivar. The results will be discussed in two sections, forage production and nutritional quality.

Forage Production

Although 25 cool-season grasses were selected for this trial, 21 were tested for herbage production potential due to a loss in viable stands of European dunegrass (ND-2100), Dahurain wildrye (Arthur), mammoth wildrye (Volga), and thickspike wheatgrass (Critana). Herbage production was calculated by grass species and ranked among each other for each year (Table 3). When yearly rankings are composited into a three-year total index (ex. pubescent wheatgrass Manska: 2+2+2=6 versus basin wildrye Magnar: 4+3+1=8), pubescent wheatgrass (Manska) ranked number one among the 21 cultivars for total herbage production (Table 3). In terms of herbage production, and not accounting for timing of peak production, both cultivars of pubescent wheatgrass (Manska, MND-759), basin wildrye (Magnar), tall wheatgrass (Alkar), and intermediate wheatgrass (Oahe) achieved the highest production potentials among the 21 grass species/cultivars.

Herbage production alone should not be used to determine which grass species is a better chose for planting. Date of peak production (Table 3) and amount of time it remains at peak production (data not shown) must be looked at to best analyze a specific use of a grass species. For example, crested wheatgrass (Nordon) ranked seventh overall in production and reached peak production in early to late-July when forage quality is moderate. Tall wheatgrass (Alkar) ranked third overall in production but reached peak production in mid-August to mid-September when forage quality is very low. Although tall wheatgrass producers a high tonnage of herbage, it doesn't achieve that level until late and forage quality is poor.

Table 3. Peak herbage production (lb/ac) and ranking among 21 select cool-season grasses near Hettinger, ND, 1995-1997.

Grass Species (cultivar)	Peak Herbage Production (lb/ac) 1995	1996	1997	Mean	Yearly Ranking 1995	1996	1997	Rank	Date of Peak Production
Pubescent wheatgrass (Manska)	4603	2664	2045	3104	2	2	2	1	mid August
Basin wildrye (Magnar)	4296	2581	2760	3212	4	3	1	2	early-late July
Tall wheatgrass (Alkar)	4778	2117	1804	2899	1	8	6	3	mid August-mid Sept.
Intermediate wheatgrass (Oahe)	4475	2380	1635	2830	3	6	7	4	late July-mid August
Pubescent wheatgrass (MDN-759)	3732	2785	1520	2679	6	1	9	4	late July
Altai wildrye (Prairieland)	3428	2222	2005	2552	8	7	3	6	late July-mid August
Crested wheatgrass (Nordon)	3273	2497	1868	2546	11	4	4	7	early-late July
Intermediate wheatgrass (Reliant)	3872	2381	1382	2545	5	5	11	8	mid September
Western wheatgrass (Rodan)	3217	1723	1831	2257	12	13	5	9	mid August-mid Sept.
Slender wheatgrass (Revenue)	3703	1525	1569	2266	7	16	8	10	late July-mid August
Crested wheatgrass (Hycrest)	3338	1753	1458	2183	10	12	10	11	late July-mid August
Bluebunch wheatgrass (Goldar)	3003	1920	1258	2060	13	9	13	12	late July-mid September
Meadow bromegrass (Regar)	3420	1835	1096	2117	9	11	18	13	early-late July
Smooth bromegrass (Cottonwood)	2861	1629	1351	1947	15	14	12	14	late July-mid August
Bluebunch/Quackgrass (RS-1)	2790	1617	1186	1864	17	15	16	15	late July-mid August
Green needlegrass (Lodorm)	2619	1474	1203	1765	18	17	15	16	mid August-mid Sept.
Crested wheatgrass (Ephraim)	2266	1879	906	1684	21	10	19	16	early -late July
Smooth bromegrass (Rebound)	2846	1326	1098	1757	16	20	17	18	late July
Russian wildrye (Bozoisky)	2210	1210	1209	1543	22	21	14	19	mid August-mid Sept.
Beardless wildrye (Shoshone)	1971	1364	641	1325	23	19	21	20	late July-mid September
Russian wildrye (Mankota)	1713	1038	826	1192	24	22	20	21	late July-early October

Nutritional Quality

Twenty cool-season grasses were analyzed for nutritional quality in 1995, 1996, and 1997. To optimize livestock performance, ranchers would like the nutrient content of the grass to remain high throughout the grazing season or harvest grass stands for hay at optimum time for quality and production. These goals can be achieved if knowledge of nutrient content is determined and correlated with the production perimeters.

All grass cultivars showed a steady decline in CP content from spring throughout the summer months (Table 4). Since most cool-season grasses show a second growth period in late summer, nutritional quality should improve with new secondary growth. Of the 20 grass cultivars, only Basin wildrye and Russian wildrye (Mankota) exhibited an increase in CP content in September and/or October compared to the August value in this trial. The remaining species showed no secondary increase in quality in the late summer, early fall months. All grass species met the minimum nutrient requirements of a 1200 lb lactating cow (average calving mid March with 20 lb peak milk) through early June. Only altai wildrye and Russian wildrye maintained quality until July and only Russian wildrye (Mankota) maintained crude protein quality throughout the grazing season.

When reviewing the nutritional quality results of these cool-season grasses, quality can only be assessed for hay quality and not actual grazing quality for pasture. Livestock can selectively graze for higher quality than shown in this data; however, hay quality will be accurate as shown since clipping was conducted similar to a haying operation. Comparison among grass species can be conducted and selection for grazing or haying use since all grass species were collect and analyzed the same.

Table 4. Crude protein (%) content by date for 20 select cool-season grasses near Hettinger, ND, 1995-1997.

Plant Species	Date										
	4/26	5/15	6/1	6/15	7/1	7/24	8/24	9/14	10/3	11/2	12/2
Pubescent wheatgrass (Manska)	**20.0**	**18.3**	**12.6**	9.3	7.2	4.4	3.2	2.9	2.3	N/A	N/A
Basin wildrye (Magnar)	**23.1**	**20.4**	**14.8**	**10.9**	8.7	6.8	5.1	4.8	4.2	5.0	3.1
Tall wheatgrass (Alkar)	**19.0**	**16.7**	**12.1**	9.4	7.7	5.5	3.8	3.6	2.6	N/A	N/A
Intermediate wheatgrass (Oahe)	**20.2**	**17.8**	**12.9**	8.8	6.9	4.2	3.1	2.8	2.4	N/A	N/A
Pubescent wheatgrass (MDN-759)	**21.2**	**18.0**	**13.1**	9.4	7.3	4.6	3.5	2.9	2.4	N/A	N/A
Altai wildrye (Prairieland)	**17.9**	**17.8**	**14.6**	**10.7**	**9.1**	7.5	5.8	5.7	4.8	3.2	3.3
Crested wheatgrass (Nordon)	**20.7**	**16.9**	**13.5**	9.4	6.4	4.4	3.6	3.3	2.5	N/A	N/A
Intermediate wheatgrass (Reliant)	**21.5**	**19.7**	**12.7**	9.3	7.7	4.8	3.3	2.8	2.4	N/A	N/A
Western wheatgrass (Rodan)	**18.9**	**15.7**	**12.8**	**9.9**	7.7	5.6	4.8	4.3	2.7	N/A	N/A
Slender wheatgrass (Revenue)	**24.2**	**20.0**	**15.7**	**11.5**	8.6	5.6	4.1	3.7	2.9	N/A	N/A
Crested wheatgrass (Hycrest)	**19.1**	**16.3**	**11.9**	8.6	6.4	4.5	3.7	3.6	2.7	N/A	N/A
Bluebunch wheatgrass (Goldar)	**17.6**	**19.6**	**15.3**	**11.0**	8.6	6.1	4.7	4.6	4.0	N/A	N/A
Meadow bromegrass (Regar)	**17.5**	**16.1**	**11.0**	8.6	6.7	5.0	3.9	3.9	3.5	3.0	3.0
Smooth bromegrass (Cottonwood)	**19.9**	**15.8**	**11.4**	9.1	7.4	5.7	4.6	4.2	3.7	N/A	N/A
Bluebunch/Quackgrass (RS-1)	**21.7**	**18.9**	**14.2**	**10.4**	7.7	5.6	4.3	4.2	3.3	N/A	N/A
Green needlegrass (Lodorm)	**18.8**	**17.4**	**13.6**	9.7	7.6	6.1	4.6	4.2	3.2	N/A	N/A
Crested wheatgrass (Ephraim)	**19.8**	**17.8**	**13.4**	9.6	8.1	5.7	4.5	4.2	3.2	N/A	N/A
Smooth bromegrass (Rebound)	**18.6**	**16.0**	**12.4**	**9.8**	7.6	6.1	4.7	4.5	3.7	3.7	N/A
Russian wildrye (Bozoisky)	**21.5**	**18.9**	**15.2**	**11.5**	**10.6**	9.0	7.4	**7.1**	6.5	5.7	4.9
Russian wildrye (Mankota)	**23.0**	**20.5**	**16.1**	**11.5**	**11.1**	**9.4**	7.1	**7.9**	**7.0**	**6.8**	N/A
Average for all cool-season grasses	20.2	17.9	13.5	9.9	8.0	5.8	4.5	4.3	3.5	N/A	N/A
Min. Require. 1200 lb lact. cow (calving mid March)	10.1	10.7	10 .3	9.9	9.6	9.3	8.5	7.9	6.9	6.0	6.3

Total digestible nutrient content was determined for all grasses with comparison conducted throughout the growing season (Table 5). All grass species met minimum requirements of a 1200 lb lactating cow (average calving mid March with 20 lb peak milk) until mid June. Intermediate wheatgrass (Oahe, Reliant), pubescent wheatgrass (MDN-759), western wheatgrass, crested wheatgrass (Hycrest), bluebunch/quackgrass, and smooth bromegrass (Rebound) met the minimum requirement throughout the grazing season.

Table 5. Total Digestible Nutrients (%) content by date for 20 select cool-season grasses near Hettinger, ND, 1995-1997.

Plant Species	Date 4/26	5/15	6/1	6/15	7/1	7/24	8/24	9/14	10/3	11/2	12/2
Pubescent wheatgrass (Manska)	**69.7**	**67.0**	**61.2**	56.2	55.5	**56.8**	**55.4**	**53.2**	**49.8**	N/A	N/A
Basin wildrye (Magnar)	**75.1**	**67.3**	**61.7**	56.4	55.5	55.6	51.4	50.0	45.1	**45.9**	43.7
Tall wheatgrass (Alkar)	**72.8**	**63.3**	**59.3**	56.7	55.6	55.0	52.9	**54.3**	**49.8**	N/A	N/A
Intermediate wheatgrass (Oahe)	**70.6**	**68.0**	**63.5**	**59.7**	**59.2**	**59.1**	**57.9**	**55.0**	**50.5**	N/A	N/A
Pubescent wheatgrass (MDN-759)	**75.2**	**66.8**	**60.8**	**57.7**	56.6	**57.8**	**55.6**	**54.6**	**51.3**	N/A	N/A
Altai wildrye (Prairieland)	**68.7**	**64.2**	**59.9**	56.6	55.9	54.9	53.8	52.5	**50.5**	**49.7**	**47.9**
Crested wheatgrass (Nordon)	**70.5**	**61.5**	**62.6**	55.3	**58.6**	**58.0**	**56.0**	**54.4**	47.1	N/A	N/A
Intermediate wheatgrass (Reliant)	**71.1**	**69.6**	**62.6**	**58.0**	56.4	**57.3**	**55.4**	**55.0**	**52.1**	N/A	N/A
Western wheatgrass (Rodan)	**70.0**	**67.2**	**64.0**	**59.9**	**59.4**	**58.2**	**56.6**	**55.2**	**49.8**	N/A	N/A
Slender wheatgrass (Revenue)	**68.8**	**68.8**	**65.0**	**61.2**	**59.1**	54.3	52.5	50.4	46.1	N/A	N/A
Crested wheatgrass (Hycrest)	**71.3**	**67.2**	**61.0**	**57.8**	**59.1**	**58.8**	**56.3**	**55.4**	**49.7**	N/A	N/A
Bluebunch wheatgrass (Goldar)	**64.3**	**66.1**	**61.6**	57.5	56.2	**56.3**	53.6	52.6	**50.0**	N/A	N/A
Meadow bromegrass (Regar)	**69.6**	**67.8**	**62.6**	**59.6**	**56.9**	55.9	50.8	48.5	46.5	**47.1**	**46.7**
Smooth bromegrass (Cottonwood)	**72.7**	**67.9**	**62.5**	57.2	55.2	**57.2**	**55.9**	**53.6**	**50.5**	N/A	N/A
Bluebunch/Quackgrass (RS-1)	**71.8**	**68.5**	**64.5**	**59.9**	**58.9**	**60.2**	**57.2**	**55.5**	**51.9**	N/A	N/A
Green needlegrass (Lodorm)	**69.2**	**66.3**	**63.6**	**58.4**	**56.9**	54.0	51.7	51.3	48.7	N/A	N/A
Crested wheatgrass (Ephraim)	**68.3**	**64.7**	**59.2**	56.4	55.8	55.9	53.0	51.4	47.9	N/A	N/A
Smooth bromegrass (Rebound)	**75.4**	**70.9**	**65.0**	**60.8**	**59.9**	**60.8**	**56.5**	**53.5**	**49.1**	**53.5**	N/A
Russian wildrye (Bozoisky)	**70.9**	**67.7**	**63.7**	**58.1**	**58.2**	55.5	51.5	52.3	**50.3**	**48.0**	**47.6**
Russian wildrye (Mankota)	**73.5**	**67.4**	**61.8**	**57.8**	**57.3**	56.0	52.9	51.9	**50.2**	**51.3**	N/A
Average for all cool-season grasses	71.0	66.9	62.3	58.1	57.3	56.9	54.3	53.0	49.3	N/A	N/A
Min. Require. 1200 lb lact. cow (Calving mid March)	58.7	59.9	58.8	57.6	56.9	56.2	54.7	53.4	49.1	44.9	45.8

Copper and Zinc Content

Copper and zinc content was determined for all time periods for 20 cool-season grasses in 1995. Copper dropped below the minimum requirement of both dry and lactating ewes and lactating cows by mid June for all grass species (Figure 1). Copper is an essential micro mineral that, when limited, may have a negative impact on the immune system and reduced reproductive performance.

As with copper, zinc was also deficient among all grass species for lactating ewes and cows by mid to late June (Figure 2). Zinc was only adequate in bluebunch wheatgrass throughout the grazing season in dry ewes. Zinc is an essential mineral for hoof development and, when limiting, can create hoof problems.

Summary

It appears that forage production and nutrient content will differ between some of these cool-season grasses and even between cultivars of the same species. Drought dramatically affected forage production of many grass species, however, only moderately affecting others. Many of the grass species that were high herbage producing cultivars also were very low in CP quality by mid and late summer. Some of the highest quality grasses for late summer and fall use were the lowest producing grasses in terms of production.

Copper and zinc were deficient by mid to late June for lactating cows and ewes in all grass species, indicating these minerals are potentially low in the soils of this area. We did collect soil cores from the study area in 1996 and will analyze the soils for the final report to be published in 1999. A full report will be published at a later date showing results of all minerals and statistical analysis for crude protein, ADF, and NDF among all grass species and cultivars.

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Figure 1. Copper content (ppm) of selected cool-season grasses near Hettinger, ND and comparison to minimum requirement of a dry and lactating ewe

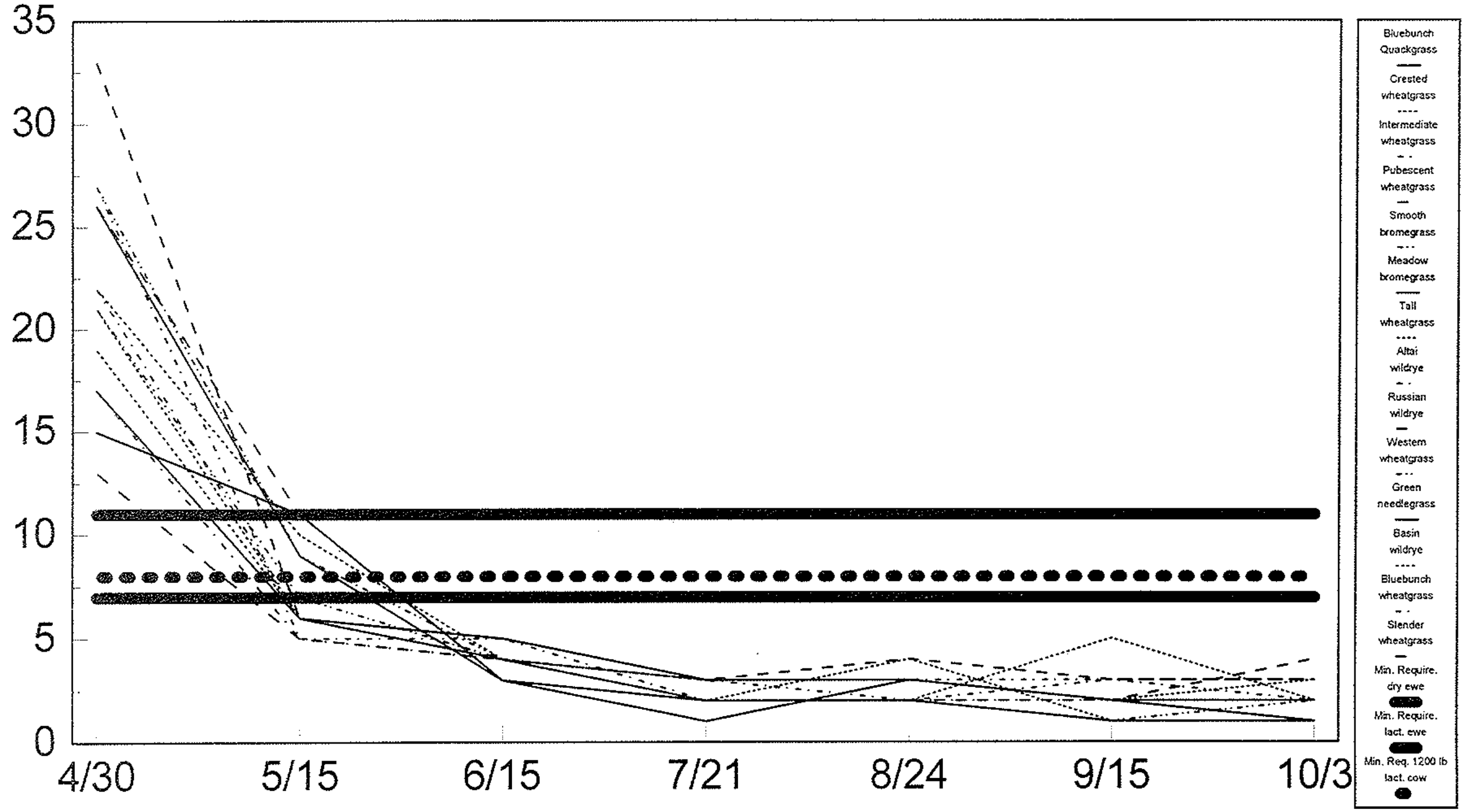
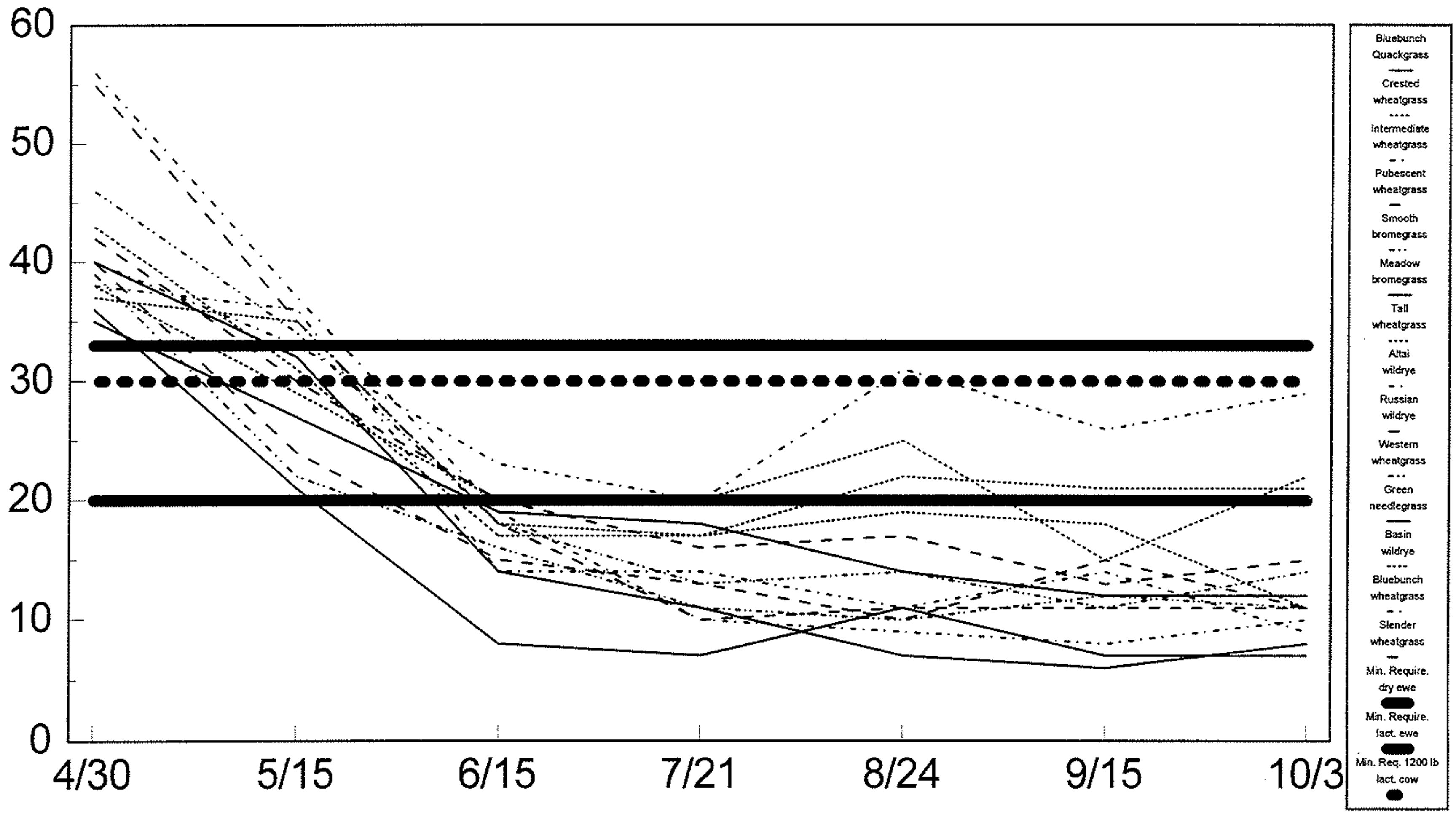


Figure 2. Zinc content (ppm) of selected cool-season grasses near Hettinger, ND and comparison to minimum requirements of a dry and lactating ewe



MANAGEMENT STRATEGIES TO EFFECTIVELY CONTROL LEAFY SPURGE IN RANGELAND BY GRAZING SHEEP
(Progress report)

Timothy C. Faller, Paul Berg, Dan Nudell

Introduction and Justification

North Dakota has in excess of one million acres of rangeland that is impacted by the presence of leafy spurge. Most of the land is controlled (owned or rented) by producers of beef cattle. Severity of infestation is impacted by waterways, overhead electrical transmission lines, railways and roadways. Presence of trees, high water tables, waterways and environmentally protected plant and animal species are constraints to the use of many herbicides as useful control methods. Increasing leafy spurge populations has negatively impacted economic well-being of many livestock producers in North Dakota.

Feed costs is the largest single component of total cost of production faced by sheep producers. Unit cost of production is one of the critical factors impacting gross income and net profit for the sheep producer. Unit cost of production is also one of the critical control points for profitable beef production (Hughes, 1998)

The opportunity to reduce variable costs and increase cash flow while adequately controlling leafy spurge in an environmentally friendly manner is attractive for many North Dakota livestock producers. Cattle are a poor utilizer of leafy spurge plants as components of the range composition while many species of wildlife and small grazing ruminants are a very good utilizer of leafy spurge as a component of the range setting. Many livestock producers truly do not want to get heavily involved in the production of alternative species of livestock (primarily sheep and goats). Management strategies that will allow them to integrate with existing sheep producers, or potentially establish profitable associated enterprises that will reduce the presence of leafy spurge are attractive to many North Dakota livestock producers, it offers the potential to reduce UCOP for both enterprises. An acceptable alternative may be to develop a cooperative structure that would establish sheep production units owned by cattle producers in areas where there are high concentrations of leafy spurge. These units might serve as a form of economic development for communities in the spurge impacted area. To do so they need a smorgasbord of alternatives and hard numbers to represent the income and expense of such proposed arrangements.

The North Dakota sheep industry provides in excess of $10,000,000 new wealth annually (1993 ND Ag Statistics). Loss to the North Dakota Ag Economy is estimated to be in excess of 70 million annually from the impact and costs associated with controlling leafy spurge (Leistritz, 1991).The potential exists to reduce costs for sheep producers by providing no-cost or low cost summer grazing and in turn improving range production for the sake of enhancing impacted beef producer's incomes.

The Sheepbud software enterprise analysis was developed to assist sheep producers evaluate the economics of their operation (Nudell, 1994). Sheepbud is S.P.A. tested and available to be used as a method of cross referencing the different strategies developed to control leafy spurge in the rangeland.

Experimental Procedure

Actual production associated with a variety of research trials at Hettinger Research Center will be evaluated economically to provide numerous strategies to be presented to industry for application. The strategies will address three different primary approaches to incorporating small ruminant animals in grazing plans focused on controlling leafy spurge. The strategies will be categorized on the basis of intensity of sheep production. Primary focuses will be: High Intensity (HI), Traditional Approaches (TA) and Low Intensity (LI). Data will be collected on; longevity, lamb survivability and routine production measures. An initial flock of 400 ewes will be established composed of 200 each of Rambouillet and Montadale x Rambouillet ewes. Half of each group will be born in 1993 and the other half in 1994. Similar breed type yearling replacement ewes mayl be added annually to keep numbers relatively constant. Similar numbers from each year and breed type will be initially assigned to each of five management strategies. The five management strategies will be compared to yearling replacement ewes of an existent accelerated lambing flock. (HI).

High Intensity Approach (HI)

Rambouillet ewes and rams will be utilized to increase the incidence of out of season mating. The attempt will be to select all replacements from fall born lambs of a closed flock of 500 ewes. Ewes will be mated and allowed to lamb in January and September as often as possible. Presently this flock of ewes is lambing at 1.3 lambings annually and presenting 1.4 lambs per lambing. This provides nearly two lambs born per ewe annually. A 56 day weaning strategy will allow ewes to graze leafy spurge infested rangeland without the presence of lambs to reduce losses to predators under both lambing times. Both sets (January lambing and September lambing ewes) will summer graze leafy spurge at the Missouri River Correctional Center (MRCC), Bismarck, North Dakota. The High intensity group will be limited to fall born ewes which are similar age to the ewes in the other groups.

Traditional Approach (TA)

Rambouillet and Montadale x Rambouillet cross ewes that lamb in January and are exposed to lamb once annually with resulting production to be weaned at 60 days of age and put in the feedlot will be compared to genetically similar ewes that will lamb in April-May, weaning weights will be taken at 60 days. Both groups will be shed lambed with half to be reared in confinement and half in outside lots.

Low Intensity Approach (LI)

Rambouillet and Montadale x Rambouillet cross ewes of similar genetic background to the TA group will be mated to begin lambing mid-may. The intent is to begin lambing on the range at the onset of the time ewes begin grazing leafy spurge. The intent of this group is to measure if the sheep operation can support itself with the primary interest being to improve the range resource for the benefit of the beef cow. Also of interest will be observing the bonding mechanism as described at the Jornada Experiment Range site in New Mexico. Bonding of sheep to cattle would be of advantage to sustaining the sheep component of this strategy.

Economic Procedure

The approach will be to measure actual production figures and imply sound economics using the Sheepbud financial analysis program to cross reference comparisons.

Duration

The data accumulated from four lambing years for each of the strategies will be utilized to evaluate economic viability of the treatments. Data from the multi-species trial will be utilized to measure effectiveness of leafy spurge control and the impact on species composition at the site. (Economic impact should be known in five years, however, it may take longer to acquire full knowledge of impact on the range site.)

1998 Results and Discussion

The results presented are preliminary and provided for discussion only. A detailed systems evaluation of the data will be conducted at the conclusion of the project. Tables 1-6 represent performance data for the ewes of the five management systems for the years 1995 through 1998. Tables 1 and 3 give production information for the various ewe types and management systems lambing in the project. Tables 2 and 4 indicate performance of the lambs born in the project to a 60 day weaning time. Lambs born and reared on grass were weighed at a similar date and left on the ewe. Table 5 indicates reproductive performance of a similar age group of Rambouillet ewes HI on an accelerated lambing project as a control and table 6 the performance of those HI generated lambs.

Tables 7-11 merge data to look at some other questions that have been popular producer questions. Again this assembly of data is for discussion purposes only as it will require at least one productive lifetime to get a feeling for differences in the systems of production.

*It should be specifically noted that there is no selection for performance during the course of this project which will account for lower production because of deficiencies in maternal traits. The only criteria for removal from the trial is failure to perform reproductivly or total lack of milk production.

Table 7 merges data for the years 1995 through 1998 for the purpose of comparing breed, lambing time and system. Table 8 merges lambing times to compare breed and system. Table 9 merges breed types and lambing time to make a comparison of systems. Table 10 merges breed type and system to compare lambing times for the MA systems and further compares that to the LI system. Table 11 merges systems and lambing time to compare breeds. The HI control group data is not incorporated in any of the merged data sets.

Table 1. Reproductive performance of Rambouillet ewes under five different rearing strategies.

	JANUARY LAMBING				MAY LAMBING					
	1995-1997		1998		1995-1997			1998		
BREED TYPE	RXR	RXR	RXR	RXR	RXR	RXR	RXR	RXR	RXR	RXR
REARING TYPE	IN	OUT	IN	OUT	IN	OUT	PAST	IN	OUT	PAST
EWE AGE @ LAMBING IN MONTHS	35	35	50	50	39	39	39	54	54	54
EWES EXPOSED	98	98	29	30	86	92	88	29	32	31
EWES LAMBING	87	93	25	30	77	81	79	27	31	28
LAMBS BORN	151	156	42	62	117	119	*	44	43	*
LAMBS WEANED	125	122	34	38	82	87	79	35	33	28
LAMBS WEANED PER EWE EXPOSED	1.28	1.24	1.17	1.27	.95	.95	.90	1.21	1.03	.90

R = RAMBOUILLET
M = MONTADALE
PAST = PASTURE
IN = CONFINEMENT REARING
OUT = BARN AND LOT REARING
8 = NO RECORD

Table 2. Performance of lambs born of Rambouillet ewes reared on five different strategies.

	JANUARY LAMBING				MAY LAMBING					
	1995-1997		1998		1995-1997			1998		
BREED TYPE	RXR	RXR	RXR	RXR	RXR	RXR	RXR	RXR	RXR	RXR
REARING TYPE	IN	OUT	IN	OUT	IN	OUT	PAST	IN	OUT	PAST
WEAN WT (lbs)	45.77	48.26	50.70	47.91	30.88	33.31	40.06	21.97	23.79	26.21
WEAN AGE DAYS	68.90	67.85	71.32	71.50	48.62	49.12	**48.23**	21.60	24.48	**23.04**
WEAN WEIGHT CORRECTED TO 60 DAYS (lbs)	39.8	42.5	42.6	40.2	38.0	40.6	49.7	43.0*	44.8*	53.9*
POUNDS LAMB WEANED PER EWE EXPOSED @ 60 DA	50.9	52.7	49.8	51.1	36.1	38.6	44.7	55.1	46.2	48.5

R = RAMBOUILLET
M = MONTADALE
WEAN AGE IN BOLD PRINT CALCULATED FROM AVERAGE OF OTHER SIMILAR GROUPS.
* 50 PERCENT OF AVE BIRTH WT. SUBTRACTED TO CORRECT TO SIXTY DAYS DUE TO EARLY WEAN WT.

Table 3. Reproductive performance of Montadale-Rambouillet cross ewes under five different rearing strategies.

	JANUARY LAMBING				MAY LAMBING					
	1995-1997		1998		1995-1997			1998		
BREED TYPE	MXR	MXR	MXR	MXR	MXR	MXR	MXR	MXR	MXR	MXR
REARING TYPE	IN	OUT	IN	OUT	IN	OUT	PAST	IN	OUT	PAST
EWE AGE @ LAMBING IN MONTHS	35	35	50	50	39	39	39	54	54	54
EWES EXPOSED	105	94	40	33	89	86	90	33	29	30
EWES LAMBING	90	84	34	31	84	82	85	32	29	29
LAMBS BORN	133	125	60	57	104	115		42	51	
LAMBS WEANED	111	98	55	42	81	91	88	31	39	47
LAMBS WEANED PER EWE EXPOSED	1.06	1.04	1.38	1.27	.91	1.06	.98	.97	1.45	1.57

R = RAMBOUILLET
M = MONTADALE
PAST = PASTURE
IN = CONFINEMENT REARING
OUT = BARN AND LOT REARING
* NO RECORD
* ULTRASOUND UTILIZED TO DIAGNOSE DRY EWES ('96)

Table 4. Performance of lambs born of Montadale-Rambouillet cross ewes reared on five different strategies.

	JANUARY LAMBING				MAY LAMBING					
	1995-1997		1998		1995-1997			1998		
BREED TYPE	MXR	MXR	MXR	MXR	MXR	MXR	MXR	MXR	MXR	MXR
REARING TYPE	IN	OUT	IN	OUT	IN	OUT	PAST	IN	OUT	PAST
WEAN WT (lbs)	47.32	50.44	46.86	46.21	32.29	35.93	39.37	18.9	16.6	23.3
WEAN AGE DAYS	66.28	70.53	67.16	71.05	43.47	51.27	47.97	22.5	21.2	21.9
WEAN WEIGHT CORRECTED TO 60 DAYS (lbs)	41.2	42.9	41.7	38.9	44.6	42.0	49.2	50.4	46.9	64.1
POUNDS LAMB WEANED PER EWE EXPOSED @ 60 DA	43.7	44.6	57.6	49.3	40.6	44.6	48.2	48.9	68.0	100.6

R = RAMBOUILLET
M = MONTADALE
WEAN AGE IN BOLD PRINT CALCULATED FROM AVERAGE OF OTHER SIMILAR GROUPS.

Table 5. Reproductive performance of Rambouillet ewes HI on an accelerated lambing strategy.

BREED TYPE	RXR			
	1995	1996	1997	1998
LAMBING TIME	JAN/SEPT	JAN/SEPT	JAN/SEPT	JAN/SEPT
REARING TYPE	IN/OUT	IN/OUT	IN/OUT	IN/OUT
EWE AGE IN MONTHS	16/24	16/24	16/24	16/24
TOTAL EWES	98	121	93	116
EWES LAMBING	63/59	89/67	78/61	84/82
DRY EWES (TOTAL)	14	8	6	1
LAMBS BORN	81/88	114/90	113/69	121/99
LAMBS WEANED	64/76	90/86	79/55	71/70

R = RAMBOUILLET
IN = CONFINEMENT REARING

Table 6. Performance of lambs born of Rambouillet ewes HI on an Accelerated lambing strategy.

BREED TYPE	RXR			
	1995	1996	1997	1998
LAMBING TIME	JAN/SEPT	JAN/SEPT	JAN/SEPT	JAN/SEPT
WEAN WEIGHT (LBS)	39.3/42.9	44.7/32.6	41.6/41.6	41.6/36.2
WEAN AGE (DAYS)	64.3/65.2	62.9/56.1	66.7/63.6	59.3/57.6
WEAN WT (LBS) Corr.To 60 DAYS)	36.6/39.6	42.6/34.9	37.4/39.2	42.0/37.6
TOTAL LBS OF LAMB PRODUCED PER EWE @ 60 DAYS (LBS)	56.6	56.5	55.00	49.7

R - RAMBOUILLET
* -EXTREMELY WET CONDITIONS IN LOTS

Table 7. Merged data for the years 1995 - 1998 for the purpose of comparing breed, lambing time and system.

	JANUARY LAMBING				MAY LAMBING					
BREED TYPE	MXR	MXR	RXR	RXR	MXR	MXR	MXR	RXR	RXR	RXR
REARING TYPE	IN	OUT	IN	OUT	IN	OUT	PAST	IN	OUT	PAST
EWES EXPOSED	145	123	127	128	122	115	120	115	124	119
EWES LAMBING	124	113	112	123	116	111	114	104	112	107
LAMBS BORN	193	176	193	218	146	166		161	162	
LAMBS BORN/ EWES EXPOSED	1.33	1.43	1.52	1.70	1.20	1.44		1.40	1.31	
LAMBS WEANED	166	140	159	160	113	133	135	117	120	107
LAMBS WEANED / EWES EXPOSED	1.14	1.14	1.25	1.25	.93	1.16	1.13	1.02	.97	.90

Table 8. Merged lambing times to compare breed and system.

	BREED TYPE AND SYSTEMS					
BREED TYPE	MXR	MXR	MXR	RXR	RXR	RXR
REARING TYPE	IN	OUT	PAST	IN	OUT	PAST
EWES EXPOSED	267	238	120	242	247	119
EWES LAMBING	240	224	114	216	235	107
LAMBS BORN*	339	342	114	216	235	
LAMBS WEANED	279	273	135	276	280	107
LAMBS WEANED/ EWE EXPOSED	1.04	1.20	1.13	1.14	1.13	.90

* DOES NOT INCLUDE PASTURE BORN LAMBS

Table 9. Merged breed types and lambing time to make a comparison of systems.

	LAMBING SYSTEMS		
	IN	OUT	PAST
EWES EXPOSED	509	485	239
EWES LAMBING	456	459	221
LAMBS BORN*	692	722	
LAMBS WEANED	555	553	242
LAMBS WEANED / EWE EXPOSED	1.09	1.14	1.01

* DOES NOT INCLUDE PASTURE BORN LAMBS

Table 10. Merged breed type and system to compare lambing times for the MI systems and further compares that to the LI system.

	LAMBING TIME AND SYSTEM		
	MI		LI
	JAN (IN & OUT)	MAY (IN & OUT)	MAY (PAST)
EWES EXPOSED	523	476	239
EWES LAMBING	472	445	221
LAMBS BORN*	780	635	
LAMBS WEANED	625	483	242
LAMBS WEANED / EWE EXPOSED	1.20	1.14	1.01

* DOES NOT INCLUDE PASTURE BORN LAMBS

Table 11. Merged systems and lambing time to compare breeds. The HI control group data is not incorporated in any of the merged data sets.

	BREEDS	
	MXR	RXR
EWES EXPOSED	625	608
EWE LAMBING	578	558
LAMBS BORN*	681	733
LAMBS WEANED	687	663
LAMBS WEANED/ EWE EXPOSED	1.10	1.09
CORRECTED # Lamb @ 60 days	49.75	46.49

*DATA DOES NOT INCLUDE PASTURE BORN LAMBS summary

Environmentally the need is to control leafy spurge with reduced reliance on herbicide exists. This research is needed to preserve the role of the sheep industry in North Dakota agriculture and to improve the economic viability of impacted beef producers. As this project has moved forward through a productive lifetime of the ewes involved the LI group has been extremely interesting to observe. Productivity of the Montadale x Rambouillet crossbred ewes has steadily improved and straight Rambouillet ewes has decreased. Two factors appear to be influencing the data; 1) more large teats are developing on the Rambouillet ewes as they age as compared to the crossbred ewes. 2) prolificacy is greater for the Rambouillet ewes than the crossbred ewes. Both factors may have negative effects on attempting to pasture lamb unattended.

The increasing success of the crossbred ewes for unattended pasture lambing opens up the necessity of further research to see if the system can be perfected and if there are breeds with greater potential than those tested. While this research was initiated to support a systems approach to leafy spurge control the outcome also indicates potential for low input farm flock enterprises not based solely on invasive weed control.

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A Preliminary Look At Economic Returns In The Lambing Systems Study

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The lambing systems study has concluded its first phase. This report looks at some preliminary economic results of that study. A final report will be presented at Western Dakota Sheep Day in February 2000.

To analyze the economic return for the various systems a model was developed to use actual production data from the trial along with actual and estimated costs and returns for each lambing system tested. Several assumptions are made in this model. One is that the lamb production is assumed to be sold at weaning at age 60 days. This is not a typical management practice, however we used this sale date to avoid confounding the results with the feedlot phase of production. All actual lamb weights were corrected to 60 days using the formula published by the American Sheep Industry Association. Fleeces were not individually weighed. All ewes were assumed to have sheared 10 pounds of wool. The Rambouillet wool was priced at $.90 per pound and the crossbred wool was priced at $.60 per pound.

Major cost categories included feed, variable costs, and fixed costs. Feed cost included grain and hay, commercial feed purchases and pasture for one production year. Feed costs included any feeds fed the lambs prior to age 60 days. Variable costs included fuel and utilities, shearing, veterinary expense and bedding. Fixed costs included a charge for investment capital and depreciation of buildings and equipment used in each system. Depreciation was calculated using a zero salvage value. Buildings were depreciated over 20 years and equipment over seven years. Investment charge was calculated as 8 percent of average investment.

No charge was made for livestock depreciation or investment. Also no charge was made for operating capital. There were no charges made for replacement expense, death loss of ewes or breeding fees. These costs were assumed to be equal across all treatments. The residual claimants to returns are then operator's labor and management and the uncharged portion of his equity contribution.

No measurement of actual labor hours expended in each treatment is available. Observation indicates that labor is dramatically reduced in the pasture lambing system. This lower labor requirement along with the higher returns seen in the pasture system means that the returns per hour labor expended strongly support the pasture lambing system. In addition the lower capital investment required lowers the entry barrier for new producers in a pasture lambing system.

Returns for the Rambouillet ewes in the study presented by year and system are shown in Table1. Table 2 presents the same information for the crossbred ewes in the study. These ewes are Montadale and Rambouillet cross ewes. Table 3 shows the results of Rambouillet and crossbred ewes combined and is reported by system and year of production.

Table 1 Cost and Return Budget, Rambouillet, All Systems and Years*										
Income Budget										
Month	Jan	Jan	Jan	Jan	May	May	May	May	May	May
System	In	Out	In	Out	In	Out	Past	In	Out	Past
Year	95-97	95-97	98	98	95-97	95-97	95-97	98	98	98
Exposed	98	98	29	30	86	92	88	29	32	31
Lambs Wean	125	122	34	38	82	87	79	35	33	28
Llbs Wean/Exp	50.9	52.7	49.8	51.1	36.1	38.6	44.7	55.1	46.2	48.5
Wool @$.90	$7.20	$7.20	$7.20	$7.20	$7.20	$7.20	$7.20	$7.20	$7.20	$7.20
Lamb @$1	$50.90	$52.70	$49.80	$51.10	$36.10	$38.60	$44.70	$55.10	$46.20	$48.50
Total Income	$58.10	$59.90	$57.00	$58.30	$43.30	$45.80	$51.90	$62.30	$53.40	$55.70
Cost Budget										
Feed	$46.95	$45.85	$46.95	$45.85	$46.18	$46.18	$36.06	$46.18	$46.18	$36.06
Other variable	$8.42	$8.02	$8.42	$8.02	$7.94	$7.88	$4.56	$7.94	$7.88	$4.56
Fixed costs	$28.73	$19.62	$28.73	$19.62	$31.52	$21.29	$8.16	$31.52	$21.29	$8.16
Returns*	($26.00)	($13.59)	($27.10)	($15.19)	($42.34)	($29.55)	$3.12	($23.34)	($21.95)	$6.92

* Returns are calculated as returns to labor, management and equity in livestock. Building and equipment equity is charged at 8 percent with 20 year depreciation on buildings and 7 years on equipment. No charge is made for operating capital

Table 2 Cost and Return Budget, Crossbred, All Systems and Years*										
Income Budget										
Month	Jan	Jan	Jan	Jan	May	May	May	May	May	May
System	In	Out	In	Out	In	Out	Past	In	Out	Past
Year	95-97	95-97	98	98	95-97	95-97	95-97	98	98	98
Exposed	105	94	40	33	89	86	90	33	29	30
Lambs Wean	111	98	55	42	81	91	88	31	39	47
Llbs Wean/Exp	43.7	44.6	57.6	49.3	40.6	44.6	48.2	48.9	68	100.6
Wool @$.90	$6.00	$6.00	$6.00	$6.00	$6.00	$6.00	$6.00	$6.00	$6.00	$6.00
Lamb @$1	$43.70	$44.60	$57.60	$49.30	$40.60	$44.60	$48.20	$48.90	$68.00	$100.60
Total Income	$49.70	$50.60	$63.60	$55.30	$46.60	$50.60	$54.20	$54.90	$74.00	$106.60
Cost Budget										
Feed	$46.95	$45.85	$46.95	$45.85	$46.18	$46.18	$36.06	$46.18	$46.18	$36.06
Other variable	$8.42	$8.02	$8.42	$8.02	$7.94	$7.88	$4.56	$7.94	$7.88	$4.56
Fixed costs	$28.73	$19.62	$28.73	$19.62	$31.52	$21.29	$8.16	$31.52	$21.29	$8.16
Returns*	($34.40)	($22.89)	($20.50)	($18.19)	($39.04)	($24.75)	$5.42	($30.74)	($1.35)	$57.82

* Returns are calculated as returns to labor, management and equity in livestock. Building and equipment equity is charged at 8 percent with 20 year depreciation on buildings and 7 years on equipment. No charge is made for operating capital

Table 3 Average Returns, All Breeds By System and Year*										
Month	Jan	Jan	Jan	Jan	May	May	May	May	May	May
System	In	Out	In	Out	In	Out	Past	In	Out	Past
Year	95-97	95-97	98	98	95-97	95-97	95-97	98	98	98
Average All	($30.20)	($18.24)	($23.80)	($16.69)	($40.69)	($27.15)	$4.27	($27.04)	($11.65)	$32.37

* Returns are calculated as returns to labor, management and equity in livestock. Building and equipment equity is charged at 8 percent with 20 year depreciation on buildings and 7 years on equipment. No charge is made for operating capital

In Table 4 we present combined results of the trial over all years and all breeds. Returns are reported by system of lambing only.

Table 4 Average Returns By System and Breed*			
	Inside	Outside	Pasture
Rambouillet	-29.7	-20.02	5.02
Crossbred	-31.17	-18.43	18.32
All Breeds	-30.43	-19.23	11.67

* Returns are calculated as returns to labor, management and equity in livestock. Building and equipment equity is charged at 8 percent with 20 year depreciation on buildings and 7 years on equipment. No charge is made for operating capital

The important information in these four tables is not the actual cash returns to each lambing system but rather the relationship among the expected economic results. Actual economic results will vary in each operation. However, the trial has demonstrated consistency in results across several years of work. The study time frame included one of the worst winters in memory as well as an exceptionally mild and open winter. Across the years and in both breeds studied, the results strongly suggest that the very low input pasture lambing system has an economic advantage. The pasture lambing system has dramatically reduced labor requirements. Thus the potential returns per hour of operators labor are much higher in the pasture system.

This initial look at the economics points out the need for further study into the costs and returns of various sheep management systems in the northern great plains. It also suggests a need for further research into methods of predator control in pasture lambing systems and into other breeds and breed combinations in a low input pasture lambing system.

Sheep on Shares

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Introduction

The sheep industry is undergoing major fundamental structural changes. The American Sheep Industry Association predicts that expanded sheep production will move into the farm belt of the upper great plains. As this happens, the potential exists for new producers to enter the business. One of the entry methods may be to use leased or rented ewes. Investors are expressing interest in owning sheep, and working farmers and ranchers are looking for alternative ways to finance sheep flock expansion. A sheep lease arrangement may provide a vehicle for a retiring sheep producers to help the next generation get started and also provide a method for deferring capital gains on the flock.

One way for an investor to capture some of the economic profits from sheep production is to own the sheep and lease them to a working farmer or rancher. In turn, the working farmer or rancher, provides the labor, feed and all other inputs needed to operate the sheep flock but does not need to provide investment capital for sheep ownership.

A leasing or sharing arrangement allows these two business people to share the production costs and, in turn, share the sheep income. A question that quickly surfaces, however, is that of what would be an equitable sheep leasing agreement?

This fact sheet will show one way to determine an equitable sheep leasing agreement.

Determining What Is An Equitable Leasing Agreement

The theoretical procedure for determining an equitable sheep share agreement is really quite simple. An equitable sheep share agreement is one in which the two parties share the business income in the same proportion that they share the production costs. If the ewe owner provides 25 percent of the production costs, then the ewe owner should receive 25 percent of the total income and the participating rancher should receive 75 percent of all income.

Expenses can be shared in many different ways. In some cases the ewe owner provides the ewes, the rams, and sometimes even the summer pasture. Typically, however, the owner of the ewes provides only the ewes and the replacement females, and the participating rancher provides the rest of the resources. Each equitably shared arrangement should be tailored to the two participants' unique resource contributions.

Include All Income From Sheep Flock In The Agreement

Although in a typical lease the equity question relates mainly to the sharing of the lamb crop, it is important to note that "all" the income from the flock should be accounted for. A sheep enterprise can generate income from four sources: lamb sales, cull ewe sales, cull ram sales, and wool. An equitable sharing agreement has to ensure that all potential income sources are taken into account. Each party needs to clearly understand the total income potential of the flock.

Projecting The Full Costs of Production

Table 1. Sample projected cost budget for a 100-ewe flock. (lambs fed to 130 lbs.)

	Units		Price	Total Costs
FEED COSTS:				
Hay	52.00	TONS	$45.00	$2,340.00
Pastur	89.00	AUMs	$12	$1,068.00
Grain	977.00	BU	$1.90	$1,856.30
Protein Suppl.	0.00	LBS	$0.00	$0.00
Stubbl	37.00	AUMs	$0.00	$0.00
Commercial Feed	Total Flock Cost			$64.00
Total Feed Cost For Enterprise				**$5,328.30**
Annual Feed Cost Per Ewe		$53.28		
LIVESTOCK COSTS:				
Bedding		per TON	$15.00	$30.00
Marketing charges for flock		per EWE	$5.44	$544.00
Vet & Medicine		per EWE	$4.50	$450.00
Power & Fuel		per EWE	$0.95	$95.00
Utilities & Gen. Farm Exp.		per EWE	$3.00	$300.00
Supplies		per EWE	$1.00	$100.00
Shearing		per EWE	$1.75	$175.00
Annual Livestock Costs per Flock				**$1,694.00**
Annual Livestock Costs per Ewe		$16.94		
Operating Capital Interest:*				$280.89
Total Variable Costs				**$7,303.19**
Total Variable Costs per Ewe		$73.03		
FIXED COSTS (depreciation, repairs, & insurance):				
Buildings (depreciation, repairs and insurance)			7%	$350.00
Equipment (depreciation, repairs and insurance)			13%	$260.00
Ewes (depreciation and insurance)				$1,100.00
Rams (depreciation and insurance)				$207.50
Total Fixed Costs				**$1,917.50**
Total Fixed Costs per Ewe		$19.18		
TOTAL COSTS (Excluding labor, management, & equity capital)				**$9,220.69**
Total Direct Costs per Ewe		$92.21		

* Operating capital interest was computed by multiplying one-half of the variable costs (feed and live by the economic or long-term interest rate. This sample projection used a rate of 8%.

An equitable sheep share agreement should be based around the projected full costs of production. Full costs should include all resources employed in the sheep enterprise, including the direct costs, the opportunity costs for the working rancher's labor and management, and the equity capital of both parties. Ewe depreciation should be included in place of replacement ewe costs (more on this later).

An example of a cost budget for a sheep flock is presented in Table 1. The projected cost of feeding this North Dakota sheep flock from weaning the previous year until weaning the current lamb crop is $5,328.30 total feed cost, or $53.28 per ewe. Add vet and medicine at $4.50 per ewe, utilities at $3.00 per ewe, power and fuel at $0.95 per ewe, marketing at $5.44 per ewe, bedding at $.30 per ewe, shearing at $1.75 per ewe, and miscellaneous supplies at $1.00 per ewe to get a projected non-feed direct cost of $16.94 per ewe, or $1694 for the total flock. An operating capital interest cost of $280.89 is assigned to the flock to cover the cost of capital for operating expenses. This example enterprise assumed that variable costs are used throughout the year and therefore on average the use is one-half of the total. The opportunity cost of this capital was assumed to be 8 percent. After accounting for asset depreciation, equipment and building repairs, and insurance, the total projected direct cost of operating this flock comes to $9220.69, or $92.21 per ewe.

The second step in setting up an equitable sheep share agreement is to calculate the opportunity costs of selected resources provided by both parties (see Table 2). In this example flock, the three hours of labor required per ewe on an annual basis was priced at $8 per hour, management charge was calculated at five percent of gross income, and the charge for equity capital was valued at eight percent of fair market value of assets. When the labor cost of $2400, management charge of $655.13, and equity capital charge of $1420 are added in, the full-cost budget comes to $13695.82, or $136.96 per ewe.

Table 2. Opportunity costs for selected resources.							
Labor Charge:			3.00	hours	@	$8.00	**$2,400.00**
Management Charge:			5%	of gross			**$655.13**
Capital Investment:			8%	of investment		Value	
	Ewes					$10,000.00	$800.00
	Ram(s)					$750.00	$60.00
	Buildings					$5,000.00	$400.00
	Equipment					$2,000.00	$160.00
	Total equity capital interest cost						**$1,420.00**
	Management charge						**$655.13**
	Labor charge						**$2,400.00**
	Total direct cost						**$9,220.69**
Full Cost of Production							**$13,695.82**
Full Cost of Production Per Ewe					$136.96		
Unit Full Costs of Production			1.74	CWTS/Ewe		$0.79	per lb.

Table 3 presents a detailed description of the example herd. This flock had 100 females (80 mature ewes plus 20 replacement females) exposed to rams the fall before. These ewes had a conception rate of 95%, so 95 were assumed pregnant. Since no pregnancy checking was done, all 100 ewes were wintered. The 100 wintered ewes produced 143 live lambs. Eighteen lambs died and five were sold as bums before weaning so that 120 live lambs were weaned. This calculates to a 120 percent lamb crop (120/100) based on live lambs weaned per females exposed. This 120 percent lamb crop was calculated according to the National Sheep-SPA Guidelines.

Table 3. Description of example sheep flock.				
100 Head Spring Lambing Ewe Flock				
Expected Replacement	20	Head	Ewe Death Rate	5%
Lamb Weaning Age	90	Days	Ewe Culling Rate	15%
Feed Included for	100	Ewes	Ewe Conception Rat	95%
			Percent Lamb Crop	132%
Lambs Fed to 130 lbs.	120	Head	Lamb Death Rate	12.5%
			Rplcmt Females	Purchased
Number of Rams	3	Head		

Table 4 presents the projected total income for the example sheep flock. The 120 lambs were split evenly between wethers and ewe lambs. Fifteen ewes and one of the three rams were culled this year. These lambs were sold at 130 pounds for $0.75 per pound, producing income of $11,700. In addition 5 bum lambs were sold for $10 each bringing lamb income to $11,750. The cull ewes brought $787.50 and the cull ram $50. Wool income was $515. The total income for this flock was $13102.50, or $131.03 per ewe.

Table 4. Gross revenue for 100-ewe flock.							
							Economic
Cash Flow*		**Receipts**					**Output**
$11,700.00	120	Lambs	15600	lbs.	$0.75	/lb =	$11,700.00
$787.50	15	Cull ewes	2250	lbs.	$0.35	/lb =	$787.50
$50.00	1	Rams			$50.00	/hd =	$50.00
$50.00	5	Bum lambs			$10.00	/hd =	$50.00
$515.00		Shorn wool	1030	lbs.	$0.50	/lb =	$515.00
$13,102.50		**Gross Income Per Flock**					**$13,102.50**
$131.03		Gross Income Per Ewe					$131.03

*Cash flow income does not need to equal economic income. It will be different if there is an inventory change and/or capital gains income is received from the sale of cull breeding animals.

The third step in setting up an equitable sheep share agreement is to allocate each resource cost to the party that will pay that particular production cost. Each member of the agreement can contribute any combination of resources as long as each party agrees on who is responsible for each and every production cost.

An Example Equitable Share Agreement

Let's evaluate a typical sheep lease situation where the investor furnishes the ewes, the rams and the replacement females. The participating rancher provides the feed, labor and management. Table 1 suggests that the cost (excluding labor, management and equity) of running this study flock is $9220.69, or $92.21 per ewe. Table 2 shows the projected full cost of operating this sheep flock, which totals $13,695.82, or $136.96 per ewe.

Once the total costs are determined, the next step is to allocate each and every cost to be shared between the two participants. This cost allocation is best done by adding in two more columns on the cost budget — one for the ewe owner and one for the working rancher (see Table 5). Each resource cost is then allocated to the party that is going to pay that cost. When labor, management, and capital costs are added, and all cost items are allocated item by item to the ewe owner and participating rancher, each participants' full cost can be figured. Each participants' cost contribution percentages are equal to their own total costs divided by the overall total cost column (see Table 5).

The owner of the sheep flock represented in Table 5 is projected to contribute 15 percent of the full cost and the participating rancher is projected to contribute 85 percent of the full cost. This suggests that an equitable share agreement would be one where the ewe owner receives 15 percent of the lamb and wool income, plus all the cull ewe income and all the cull ram income. The participating rancher should receive 85 percent of the lamb and wool income.

Table 5. Sample projected full-cost budget for a 100-ewe flock (lambs fed to 130 lbs.).

	Units		Price	Total Costs	% To Owner	Owner of Ewes	Working Rancher
FEED COSTS:							
Hay	52.00	TONS	$45.00	$2,340.00	0%	$0.00	$2,340.00
Pasture	89.00	AUMs	$12	$1,068.00	0%	$0.00	$1,068.00
Grain	977.00	BU	$1.90	$1,856.30	0%	$0.00	$1,856.30
Protein Suppl.	0.00	LBS	$0.00	$0.00	0%	$0.00	$0.00
Stubble	37.00	AUMs	$0.00	$0.00	0%	$0.00	$0.00
Commercial Feed	Flock Total Use		$0.00	$64.00	0%	$0.00	$64.00
Total Feed Cost For Enterprise				$5,328.30		$0.00	$5,328.30
Annual Feed Cost Per Ewe		$53.28					
LIVESTOCK COSTS:							
Bedding		per TON	$15.00	$30.00	0%	$0.00	$30.00
Marketing		per EWE	$5.44	$544.00	0%	$0.00	$544.00
Vet & Medicine			$4.50	$450.00	0%	$0.00	$450.00
Power & Fuel			$0.95	$95.00	0%	$0.00	$95.00
Utilities & Gen. Farm Exp.			$3.00	$300.00	0%	$0.00	$300.00
Supplie			$1.00	$100.00	0%	$0.00	$100.00
Shearin			$1.75	$175.00	0%	$0.00	$175.00
Annual Livestock Costs per Flock				$1,694.00		$0.00	$1,694.00
Annual Livestock Costs per Ewe		$16.94					
Operating Capital Interest:*				$280.89	0%	$0.00	$280.89
Total Variable Costs				$7,303.19		$0.00	$7,303.19
Total Variable Costs per Ewe		$73.03					
FIXED COSTS (depreciation, repairs, & insurance):							
Buildings (depreciation, repairs and insurance				$350.00	0%	$0.00	$350.00
Equipment (depreciation, repairs and insuran				$260.00	0%	$0.00	$260.00
Ewes (depreciation and insurance)**				$1,100.00	100%	$1,100.00	$0.00
Rams (depreciation and insurance)**				$252.50	100%	$252.50	$0.00
Total Fixed Costs				$1,917.50		$1,352.50	$610.00
Total Fixed Costs per Ewe		$19.18					
TOTAL COSTS (Excluding labor, management, & equity capital)				$9,220.69		$1,352.50	$7,913.19
Total Costs per Ewe		$92.21					
* Operating capital interest was computed by multiplying one-half of the variable costs (feed and livest							
by the economic or long-term interest rate. This sample projection used a rate of							
**Insurance estimated at 1% of total value and depreciation at $10/ewe/year							
***Insurance estimated at 1% of total value and depreciation at $67/ram/year							
Labor Charge:	3.00	hours @	$8.00	$2,400.00	0%	$0.00	$2,400.00
Management Charge:	5%	of gross		$655.13	0%	$0.00	$655.13
Capital Investment:	8%						
Ewes			$10,000.00	$800.00	100%	$800.00	$0.00
Ram(s)			$750.00	$60.00	100%	$60.00	$0.00
Buildings			$5,000.00	$400.00	0%	$0.00	$400.00
Equipme			$2,000.00	$160.00	0%	$0.00	$160.00
Total equity capital interest cost				$1,420.00		$860.00	$560.00
Full Cost of Production				$13,695.82		$2,212.50	$11,528.32
Full Cost of Production Per Ewe		$136.96					
Unit Full Costs of Production	1.74	CWTS/Ewe		$0.79	per lb.	$0.13	$0.66
Percent Contribution						16%	84%

Table 6 indicates that sharing all lamb and wool income in this herd in this 16-84 proportion, the owner of the ewes is projected to receive $28.19 per ewe — $18.90 from the sale of lambs and wool plus $8.37 cull sales income. The working rancher is projected to receive $102.84 per ewe from lamb and wool sales.

In terms of total income, the ewe owner gets 22 percent of all income and the working rancher gets 78 percent, even though the lamb and wool crop is to be shared 16-84. The example equitable share calculations shown in Table 1 through 6 indicate an equitable share that is different than the common share arrangements that range from 25-75 to 50-50. Cull ewe, cull open replacement ewes and cull ram income goes to the party that provides the investment capital.

Table 6. 16-84 equitable share agreement.									
						Total	% To	Owner	Working
Economic Income/Ewe from 100 ewes:						Flock	Owner	of Ewes	Rancher
1.20	head lambs	130	lbs.	$0.75	/lb	$117.00	16%	$18.90	$98.10
0.15	cull ewes	150	lbs.	$0.35	/lb	$7.87	100%	$7.87	$0.00
0.01	cull ram	1	head	$50.00	/hd	$0.50	100%	$0.50	$0.00
0.05	bum lambs	5	head	$10.00	/hd	$0.50	16%	$0.08	$0.42
0.01	shorn wool	1030	lbs.	$0.50	/lb	$5.15	16%	$0.83	$4.32
						$131.03		$28.19	$102.84
Gross Economic Income for Flock						$13,102.50		$2,818.86	$10,283.64
Share								22%	78%
Replacement Ewes Purchased To Maintain Flock								$2,000.00	
Owners Return on Investment								$818.86	
Owners Percent Return on Original Investment								7.62%	

Cull Ewe Income Versus Cost Of Replacement Females

Lamb crop sales may account for only 70-80 percent of the total income per ewe in a ewe flock. The remaining 20 to 30 percent of the ewe flock's income typically comes from cull animals and wool. Cull ewes account for the biggest share of the cull animal income. Managers who buy replacements will have more lambs to sell, therefore cull ewe sales will be a smaller part of gross sales. Regardless of the size of cull ewe income, it should be shared in the same proportion as the costs of replacement females are shared.

In this lease arrangement the ewe owner provides replacement females. The ranch operator should not receive any cull ewe income if he/she does not own the ewes nor has contributed any of the costs of raising or placing the ewe into the breeding herd. The ewe owner should receive all the cull ewe income. Theoretically it is the undepreciated portion of the original capital investment. The depreciation costs are included in the ewe owner's contribution of the full cost production expenses.

Yearly depreciation can be calculated as follows:

$$\text{DEPRECIATION} = \frac{\text{(PURCHASE COST - PROJECTED SALVAGE VALUE)}}{\text{PROJECTED YEARS EWE IS IN THE FLOCK}}$$

where salvage value is the projected value of cull ewes at the time that they are culled from the leased herd. Cull animal income goes to the ewe owner. The total price risk associated with the value of the ewe when culled is absorbed by the ewe owner.

Depreciation calculated with a zero salvage value would be appropriate if both parties share cull income. This can be done by calculating depreciation with a zero salvage value and letting depreciation account for the total original investment cost of the ewe. This way a larger portion of the original ewe investment is repaid to the ewe owner each year the ewe is in the flock. In this type of an arrangement, cull ewe price risk is shared by both parties. Depreciation, in this case, should be calculated as:

$$\text{DEPRECIATION} = \frac{(\text{PURCHASE COST} - \text{ZERO SALVAGE VALUE})}{\text{PROJECTED YEARS EWE IS IN THE HERD}}$$

When depreciation is calculated this way, all cull animal income is shared in proportion to expense contributions. Very few leasing arrangements, however, utilize this second approach.

A third leasing arrangement is where the replacement females are raised inside the leased ewe flock, resulting in the cost of the replacement ewes being shared by both parties. Depreciation should go back to the previous method that includes a salvage value. The cull animal income, in this case, should be shared by the parties in proportion to their total flock expense contributions. Our experience to date has been that this leasing arrangement is messy at best, and frequently leads to inequitable leasing arrangements because ownership of the flock is changing each year.

We think a better alternative, if replacements are to come from the flock, would be to have the ewe owner purchase the replacements at market lamb value at the time of sale. This provides the rancher some level of control on the replacements in the leased flock and saves him the marketing expense for the sold replacements. The ewe owner also gains more control of the replacements he buys and he may save any premiums that replacement females bring in the market.

In summary, we recommend that the replacement females be handled outside of the leased enterprise. We recommend the ewe owner provide all replacement ewes. This is the most common arrangement and seems to be the easiest to ensure equitability.

AN ALTERNATIVE LEASING AGREEMENT

An alternative to the lease where both parties share the income is one where the ewes are leased for a set cash payment each year. In this arrangement the rancher would pay the ewe owner a fixed amount each year for the use of the ewe. From the owners perspective, this payment would need to cover the depreciation of the ewes, the loss of animals, and a return to the ewe for the investment. The party leasing the ewes will not want to pay more rent than the income from the ewe's lamb and wool production less all costs of production including a value for his labor and management. A cash lease has advantages and disadvantages. The working rancher absorbs all the price and production risk associated with the year's production. If prices are lower or if environmental factors affect the total production of the leased ewes, the rancher is still obligated to make the same payment to the resource owner. On the other hand, because of the extra risk assumed, any extra income that occurs due to market prices or the working ranchers efforts and skills accrues to the rancher.

A cash lease agreement may also serve to attract investor income to the sheep industry since potential investors may be more comfortable with a non-volatile return to their investment. They may be willing to provide funds at a lower cost due to the reduction in the risk they face as investors.

Final Comments

Two final cautions to people entering into a sheep share agreement: first, agreements should be in writing and the written contract should clearly identify all the specifics agreed upon. Participants are advised to account for all production costs, death losses and exactly how the business agreement will be terminated. It is *much* easier to work out the share agreement details before the agreement is signed than to work out an agreement after an emergency or a business disagreement occurs.

It should also be pointed out that two people can enter into any legal agreement which both parties agree to, even if it is not equitable. The important thing to remember is that the both parties should agree on the terms of the business agreement and that the details of the agreement are in writing.

Computerized Worksheets

The worksheets used in this bulletin will soon be available as a computer program that you can use on your home personal computer. The program will be available for downloading free at http://www.ag.ndsu.nodak.edu/hettinge/

Montadale Regeneration Project: Progress Report

Bert Moore, Wes Limesand, and Millie Brown

The Montadale Sheep Breeders Association Board of Directors, in a history-making move, initiated the Montadale Regeneration Project at their annual meeting in 1997. This project was to involve the return to the roots of the Montadale breed with the crossing of Border Cheviot rams on Columbia ewes. The intent of the project is to expand the genetic base while keeping the current breed standards. This would also increase the availability of quality breeding stock, allow the breed to expand, and generate new interest in the Montadale breed.

From crosses of Cheviots and Columbias initiated in 1932, E. H. Mattingly of Missouri at last felt he had found the combination of breeds that would make the "ideal sheep." The Cheviot breed, long known for its hardiness, vigor, and vitality, along with its small head, clean legs, open face, and high yielding choice meat quality, represented essential characteristics of this "perfect" breed. The Columbia was a large-framed, robust, wool-type sheep developed from a cross between the heavy, coarse-wooled Lincoln breed and the large, fine-wooled Rambouillet breed. Of particular interest to Mattingly was the exceptional meat quality demonstrated by the Columbia breed when compared with most other wool breeds. He believed the Columbia crossed on the Cheviot would produce the type of lambs desired (Wilkinson and Murdock, 1996).

The Montadale Regeneration Project was also initiated, in part, by the concern about the probable undocumented introduction of additional Columbia breeding into the breed. This, along with the desire to expand the genetic base with out-cross potential and increase availability of and interest in the Montadale breed added to the Montadale Association's wishes to go forth with this project.

NDSU Involvement

In the fall of 1997, seventeen NDSU Columbia ewes of mixed ages were mated to a Border Cheviot ram which was selected by the Board of Directors and the breed secretary. NDSU's Columbias are held in high regard on a national scale. The Boarder Cheviot ram used was obtained from one of the most highly respected breeders of that breed.

Results

Results of the fall 1997 matings are as follows: Fifteen ewes produced a total of 28 lambs for a 187% lambing percentage. Two lambs were born prematurely and were dead at birth. The average birth weight of all the lambs born alive was 11.6 pounds. All lambs demonstrated remarkable vigor at birth. Included in the 28 lambs were four sets of triplets, of which three of the sets were raised to weaning by their Columbia dams. Twenty of the 28 lambs born were ewe lambs which was fortunate. This provided an excellent nucleus of females for the continuation of the project. The average adjusted 90 day weights of the 26 live lambs was 100.8 pounds.

The ewe lambs from these matings were used in several classroom situations. They provided a number of excellent judging classes, for both the junior and senior livestock judging teams. They were also used as excellent examples in sheep production classes. In all instances, it gave unique chances to discuss breed development and the principles and theories behind the establishment of a breed. They also provided illustrations of the effective use of crossbreeding and subsequent heterosis obtained from crossbreeding.

A number of the lambs were on exhibit at national sheep events around the country. They created considerable interest at the National Montadale Show and Sale in Springfield, Illinois. They were also on exhibit at the Midwest Stud Ram Sale in Sedalia, Missouri, the largest purebred sheep sale on the North American continent.

Future Projections

All ewe lambs from the cross of the Border Cheviot rams and the Columbia ewes were exposed to a Montadale ram which was selected by the executive secretary of the Montadale Sheep Breeders Association. The results of these matings are eagerly being anticipated in April, 1999.

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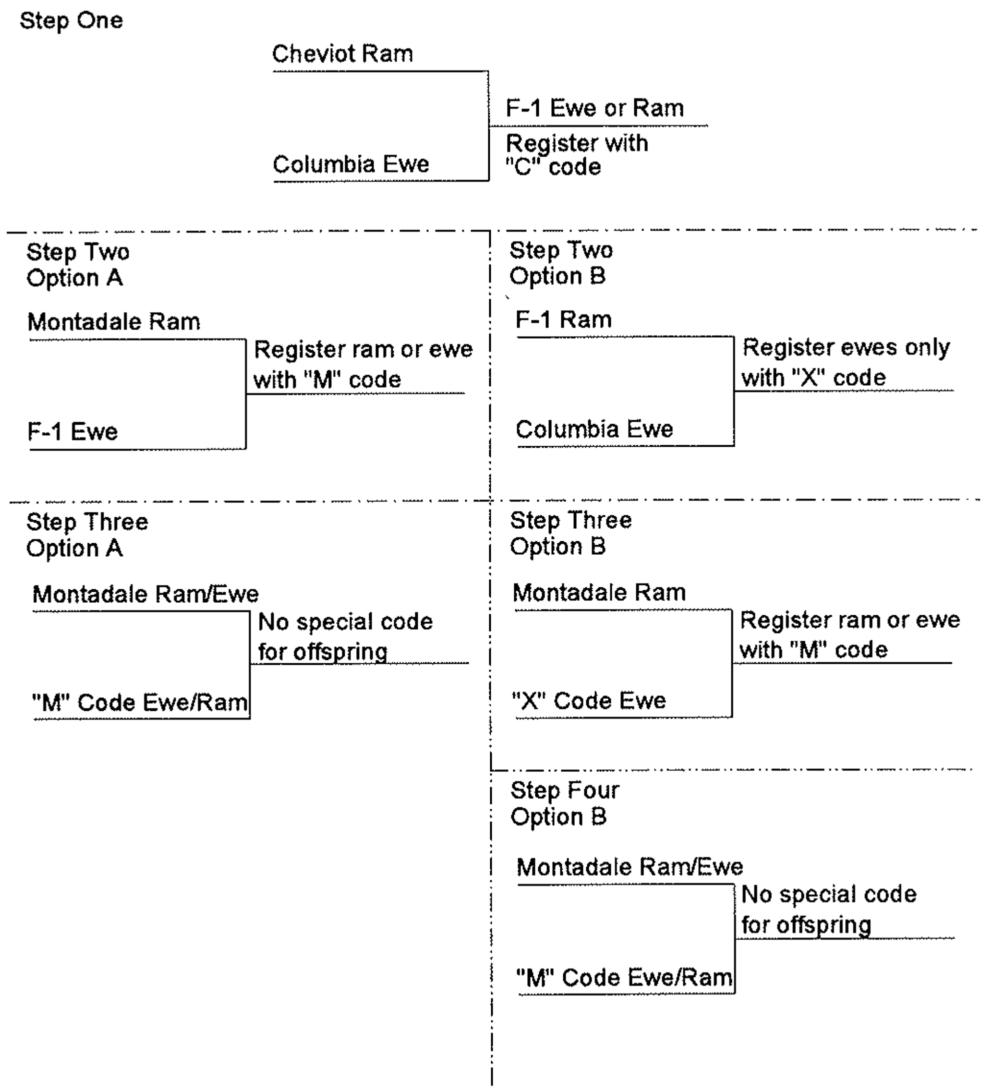
Wilkinson, R.D. and G.L. Murdock. 1996. History of the Mondadale Sheep. Fifty Years: From Dream to Reality. Montadale Sheep Breeders Assn., Inc.

MATING SCHEME FOR STEPS IN REGENERATION PROJECT



Multi-Species versus Single Species Grazing on Rangelands Infested with Leafy Spurge (A Three-Year Summary)

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Introduction

Grazing animals can help control leafy spurge by increasing the competitiveness of desirable plants through time of grazing and selective removal of the foliage (Lajeunesse et al. 1995). Lajeunesse et al. (1995) also stated that when grasses are grazed, they are temporarily weakened and plant competition is altered in favor of leafy spurge. They also reported that similar results are present when leafy spurge is grazed and the advantage shifts to the grasses. However, leafy spurge must be grazed intensive enough and at a sufficient stocking rate to deplete root reserves to reduce the competition of the leafy spurge (Sedivec et al. 1995).

Research has shown that Angora goats reduce leafy spurge infestations and is an excellent tool to control leafy spurge (Sedivec and Maine 1993, Hanson 1994, Prosser 1995, Sedivec et al. 1995). Sheep are also an excellent tool in controlling leafy spurge (Christenson et al. 1938, Helgeson and Thompson 1939, Helgeson and Longwell 1942, Landgraf et al. 1984, Kronberg and Walker 1993). However, many disagreements still exist over sheep consuming leafy spurge (Landgraf et al. 1984) because of the aversive chemical components found in the latex of leafy spurge. This latex has been reported to be an irritant, emetic, and purgative when consumed (Lym and Kirby 1987). Selleck et al. (1962) also report that this aversive chemical found within leafy spurge can cause scours and weakness in cattle, which can result in the death of the animal.

Prosser (1995) and Prosser et al. (1995) showed grazing cattle in combination with goats increased grass and grass-like use by cattle, reduced leafy spurge stem densities, and reduced overall leafy spurge production after two years of grazing compared with single species grazing of cattle. Since Prosser (1995) found a significant benefit with multi-species grazing using cattle and goats, and since both goats and sheep graze leafy spurge, great potential exists with cattle and sheep as a viable tool to better manage leafy spurge infested rangelands. However, no reports have documented the potential use of sheep and cattle together to improve graminoid species use, increase plant species richness, and control leafy spurge.

The objectives of this study were to: 1) determine if multi-species grazing with cattle and sheep on leafy spurge infested rangeland will reduce leafy spurge density compared to single class grazing and 2) determine if grazing leafy spurge infested rangeland with both cattle and sheep together will improve grazing efficiency and livestock performance compared with single class grazing program. This study is designed to be conducted for 10 years. This three-year summary will compete phase 1 of the project with plans to complete the project in 2005.

Study Area

This study was conducted on Section 32, T139N, R81W of Morton County owned by the North Dakota State Correctional 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 Correctional Center land and replicate three on the Northern Great Plains Research Center. Each of the replicates were subdivided into four 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 was 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 graminoid use or before 15 September.

Each 20-acre research block had one plot grazed by two yearling steers (CO), one grazed by ten mature ewes (SO), and one grazed by one yearling steer and five mature ewes (CS). Stocking rates were about 1.5 AUMs/acre for the CO, SO, and CS treatments, respectively. Stocking rates for this trial were designed for 3.5 months of grazing for the steers and 4.0 months of grazing for the ewes.

Methods

Objectives 1

Leafy spurge density counts were obtained by using permanent 109-yard (100 m) line transects and counts collected every five meters using an 11 in^2 (0.1 m^2) quadrat. Two transects were systematically placed in each of the four replicated treatments (CO, SO, CS, and NU). One transect was selected based on leafy spurge location within the treatments to assure full length of transect comprised leafy spurge and the second transect located on non-leafy spurge infested sites for a control. Leafy spurge densities were monitored over the three years to determine effectiveness of sheep grazing. Leafy spurge densities were collected annually at the end of May. All leafy spurge stems greater than 1 inch in height were counted to minimize counting seedlings (little to no seedlings survive in an established community).

Leafy spurge, grass and grass-like, 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 7.5 yd by 7.5 yd (7 m x 7 m) plots. A 7.5 yd (7 m) buffer strip was implemented to prevent an edge effect. Twenty-five plots were randomly selected and clipped within each NU using a 24 in^2 (0.25 m^2) frame.

Objective 2

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 7.5 yd by 7.5 yd (7 m x 7 m) plots. Twenty-five quadrats were randomly selected and clipped using 24 in^2 (0.25 m^2) frame on each grazed and non use treatment to determine disappearance.

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

Data Analysis

Treatment differences for leafy spurge stem density were tested between treatments and years using the multi-response permutation procedure (Biondini et al. 1988). Forage degree of use and livestock performance between treatments and years were analyzed using analysis of variance. Significant differences were tested at a p-value < 0.05.

Results and Discussion

A significant ($P<0.05$) reduction in leafy spurge stems occurred after two grazing seasons on the SO treatment. Leafy spurge was reduced from 10.4 stems/11 in^2 in 1996 to 6.7 stems in 1997 and 2.5 stems in 1998, a reduction of 36% after one year ($P>0.05$) and 75% after two years ($P<0.05$). There was no significant ($P>0.05$) change in leafy spurge stem density on the CS, CO, and NU treatments after two years (Table 1).

The leafy spurge stem density changes found in this study are very similar to results found in studies the use of Angora goats with and without cattle (Prosser 1995, Prosser et al. 1995, and Prosser et al. 1997). Prosser et al. (1997) showed that after one grazing season leafy spurge stem density was reduced by 30.8% on the goat only treatment; however, they found a reduction of 23.1% on the cattle and goat treatment. They also found that there was no change ($P>0.05$) in leafy spurge stem densities after one grazing season but a significant reduction after two years on the goat only trial.

Herbage production was similar (P>0.05) for all growing seasons in 1996, 1997, and 1998 (Table 2). Results would indicate that after three growing season leafy spurge has not effected the production of grass and grass-like plants, forbs, and shrub species production. Leafy spurge production also has not changed (P>0.05) during the three growing seasons.

Leafy spurge degree of disappearance increased on all treatments from 1996 to 1998 (Table 3). The SO treatment went from 76% to 98% leafy spurge disappearance from 1996 to 1998, and the CS treatment went from 62% to 88% from 1996 to 1998. There was an increase (P<0.05) in leafy spurge disappearance in the CO treatment with 23% disappearance in 1996 compared to 50% in 1997 and 1998. These results in leafy spurge 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 (Table 3). Grass and Grass-like degree of disappearance (P>0.05) was similar throughout the grazing seasons within and between grazing treatments.

Steer average daily gain (ADG) was not different (P>0.05) between treatments (CO and CS) for either years of the study (Table 4). There was no change (P>0.05) in steer ADG between years on the CS treatment. However, there was a decrease (P<0.05) in ADG between years 1996 and 1998 on the CO treatment. Ewe ADG was not different (P>0.05) between treatments (SO and CS) for either years of the study, similar to the steer performance results. There was a decrease (P<0.05) in ewe ADG between years 1996 and 1998 on both SO and CS treatments (Table 4). These results would indicate multi-species grazing improved the performance of the steers; however, had no negative or positive impact on sheep performance compared to single species grazing. In these three years, this improvement in steer performance was seen by having a less negative impact on performance versus the reduction in performance as seen on the CO treatment between years.

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Table 1. Leafy spurge stem densities per 11 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.

Treat-ment[1]	1996	1997	% change 1996 to 1997	1998	% change 1996 to 1998
	------------# of Stems/11 inch^2 quadrat----------				
CO	9.8 (1.2)[a]	12.0 (1.2)[a]	+22	10.8 (1.0)[a]	+10
SO	**10.4 (0.9)[a]**	**6.7 (0.7)[a]**	**-36**	**2.5 (0.6)[b]**	**-75**
CS	**11.6 (1.0)[a]**	**12.3 (1.0)[a]**	**+6**	**11.6 (1.0)[a]**	**0**
NU	9.8 (1.1)[a]	11.4 (1.3)[a]	+16	11.1 (1.2)[a]	+13

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

Table 2. Herbage production (lb/acre) (standard error in parentheses) on the non use treatment in 1996, 1997, and 1998.

Herbage[1]	1996	1997	1998
----	------------------------lb/acre------------------------		
Leafy spurge	**339 (66)[a]**	**396 (64)[a]**	**350 (47)[a]**
Grass & Grass-like	**1543 (128)[a]**	**1325 (157)[a]**	**1041 (77)[a]**
Forb	119 (42)[a]	84 (25)[a]	46 (13)[a]
Shrub	79 (61)[a]	13 (10)[a]	15 (8)[a]

[1] **Years with the same letter within each herbage class are not significantly different (P>0.05).**

Table 3. Degree of herbage disappearance on the cattle only (CO), sheep only (SO), and cattle and sheep (CS) treatments for the grazing season of 1996, 1997, and 1998.

1996

Treatment	**Grass & Grass-like**	**Forb**	**Shrub**	**Leafy Spurge**	**Total**
		-----------% Use ----------			
CO	*17%*	34%	85%	23%	**20%**
SO	*14%*	53%	56%	76%	**27%**
CS	*22%*	36%	90%	62%	**30%**

1997

Treatment	**Grass & Grass-like**	**Forb**	**Shrub**	**Leafy Spurge**	**Total**
		-----------% Use ----------			
CO	*30%*	26%	72%	50%	**33%**
SO	*38%*	74%	1%	86%	**49%**
CS	*29%*	54%	75%	66%	**38%**

1998

Treatment	**Grass & Grass-like**	**Forb**	**Shrub**	**Leafy Spurge**	**Total**
		-----------% Use ----------			
CO	*33%*	9%	60%	50%	**37%**
SO	*41%*	62%	45%	98%	**55%**
CS	*31%*	65%	90%	88%	**47%**

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, and 1998.

Treatment & Livestock Class[1]	1996[2]	1997[2]	1998[2]
	----------lb/day----------		
CO Steer	1.76 (0.07)[a]	1.61 (0.13)[ab]	1.23 (0.06)[bx]
CS Steer	1.53 (0.32)[a]	1.12 (0.16)[a]	0.96 (0.13)[ax]
SO Ewe	0.16 (0.02)[y]	0.07 (0.02)[yz]	0.04 (0.02)[z]
CS Ewe	0.16 (0.02)[y]	0.09 (0.03)[yz]	0.07 (0.02)[z]

[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).

Multi-Species Grazing on Leafy Spurge Infested Rangeland comparing Twice-Over Rotation Grazing versus Seasonlong Grazing (A Three-Year Summary)

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Introduction

Herbicides continue to be the primary method of attempted control and/or eradicate of leafy spurge (*Euphorbia esula* L.) (Lym et al. 1995). However, controlling large infestations with herbicides is not economically feasible (Bangsund et al. 1996). There is also a lack of labeled herbicides that provide effective control of leafy spurge in environmentally sensitive areas. This noxious weed, which is extremely persistent and competitive, has contributed significantly to economic losses to the livestock industry (Leitch et al. 1994).

Use of grazing as a biological control for leafy spurge has become more acceptable in the past ten years. Goats are an excellent tool to control and reduce leafy spurge infestations (Sedivec and Maine 1993, Hanson 1994, Prosser 1995, Sedivec et al. 1995). The use of sheep as a biological control method was proven in the late 1930's and early 1940's by Helgeson and Thompson (1939), and Helgeson and Longwell (1942). However, there have been many disagreements in the literature concerning the effective use of sheep on leafy spurge (Landgraf et al. 1984) due to the aversive chemicals found in the latex of leafy spurge. Research by Lym and Kirby (1987) has also shown that cattle totally or partially avoid leafy spurge infested sites and intensify use on non-infested sites.

Multi-species grazing, the concurrent use of rangeland by more than one kind of animal, has been advocated to maximize animal production on native rangeland (Merrill and Miller 1961). It is an important concept in rangeland management because rangelands usually consist of one or more classes of vegetation (Merrill et al. 1966). However, no published reports have documented the potential use of sheep and cattle in a multi-species grazing approach to improve graminoid species use, increase plant richness, and to control leafy spurge on leafy spurge infested rangeland.

The objectives of this study were to: 1) determine effects of multi-species grazing using twice-over rotation grazing system (TOR), seasonlong grazing treatments (SL), and nonuse treatment (NU) on leafy spurge control and 2) evaluate the degree of disappearance of herbage and livestock performance on TOR and SL using a multi-species grazing program.

Study Area

The research was conducted on two separate tracts of land in Morton County. The first tract was Sections 31 and 32, T139N, R81W, in south central North Dakota, approximately two miles southwest of Mandan. This tract consisted of 603 acres of native rangeland owned by the North Dakota State Correctional Center. The second tract was on the north half of Section 9, T138N, R81W on 237 acres of native rangeland operated by the Northern Great Plains Research Laboratory, approximately three miles south of Mandan. Both tracts are found in the Missouri Slope Prairie Region and associated with the Heart River Watershed drainage. 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). Leafy spurge infestations were mapped before the study and estimated to cover 30 percent of each tract of rangeland.

The TOR consisted of four pastures grazed from 15 May to 1 October by one heard of cow/calf pairs and mature dry ewes. A total of 96 animal units of cattle (85 - 1200 lb. cows with calves) and 33 animal units of sheep (200 - 135 lb. mature white-face ewes without lambs) or a total 532 AUMs grazed the TOR treatment in 1996 and 1997. Cattle animal units were reduced to 85 animal units of cattle (76 - 1200 lb. cows with calves) in 1998; however, sheep animal units remained the same and a total 491 AUMs grazed the TOR in 1998. The overall stocking rate was 0.88 AUMs/acre in 1996 and 1997 and 0.82 AUMs/acre in 1998 on the TOR treatment. Stocking rates were decreased due to below average winter snow cover and rain fall in the spring 1998.

The SL treatment was grazed moderately light in 1996 due to lack of range evaluation data and unknown carrying capacities. Twenty-seven animal units of cattle (35 - 700 lb. Yearling steers) and 8 animal units of sheep (48 - 135 lb. mature white-face ewes without lambs) or a total 144 AUMs grazed the SL treatment in 1996. The overall stocking rate was 0.68 AUMs/acre in 1996 on the SL treatment. The SL treatment was grazed by yearling steers and mature ewes and stocked with 37 animal units of cattle (49 - 705 lb. yearling steers) and 13 animal units of sheep (78 - 135 lb. mature white-face ewes without lambs) or a total 207 AUMs grazed in 1997 and 1998. The overall stocking rate was 0.88 AUMs/acre in 1996, 1997, and 1998 on the SL treatment.

Sheep were placed on pasture approximately 15 May each year when leafy spurge was ready for grazing and cattle placed on pasture 1 June when native cool season grass species reach grazing readiness (3-4 leaf stage). Livestock species were removed from the treatments when 50 to 60 percent degree of graminoid disappearance was reached or 1 October. During all three years livestock grazed until 1 October.

Methods

Objective 1

Leafy spurge density was counted in six 32 ft by 16 ft exclosures. Three exclosures were systematically placed in each of the TOR and SL treatments. Each 32 ft by 16 ft exclosure was subdivided in two 16 ft by 16 ft plots with one plot randomly assigned a grazed treatment (TOR or SL) and second plot an ungrazed treatment (NU). A 2.5 ft buffer was placed along the inside border of each grazed and ungrazed plot to prevent an edge effect. Each plot was further stratified into 11 in^2 (0.1 m^2) quadrats and each quadrat assigned a number. Ten 11 in^2 quadrats were randomly selected in each treatment for leafy spurge density counts. Leafy spurge densities were collected in the first week of June throughout the duration of the study.

Objective 2

Forage production and degree of disappearance for leafy spurge, graminoid, shrubs, and other forbs were determined using a pair-plot clipping technique (Milner and Hughes 1968). Eight cages were dispersed in each of the four pastures of the TOR. Four of the cages were systematically placed in leafy spurge infested sites and four in non-infested sites. Twelve cages were systematically placed in the SL, six cages placed on leafy spurge infested sites and six cages on non-infested sites. Two plots were clipped from each cage using a 24 $inch^2$ (0.25 m2) frames.

Livestock performance and production were determined for both cattle and sheep and expressed as average daily gain. Weights were taken when animals were allocated to and removed from each treatment.

Data Analysis

Differences in leafy spurge stem density were tested between treatments and years using the multi-response permutation procedure (Biondini et al. 1988). Forage degree of disappearance and livestock performance between treatments and years were analyzed using analysis of variance. Significant differences were tested at a p-value < 0.05.

Results and Discussion

Leafy spurge stem density did not change ($P>0.05$) on either the TOR, SL or NU treatments after two years of multi-species grazing. However, percent leafy spurge stem densities changes appear to show potential trends for each treatment. Leafy spurge stem densities were reduced by 13.2 % after one year and 20.1 % after two years of multi-species grazing on the SL treatment. Leafy spurge stem densities increase 20.5% after one year and decreased 3.0 % after two years of multi-species grazing on the TOR treatment. Both NU treatments showed increases in stem densities in 1997 and 1998, averaging an increase of 13.4 % after one year and 11.7 percent after two years. The results after two multi-species grazing showed a decrease in leafy spurge stem densities on both the TOR and SL treatments compared to increases on the NU treatments (Table 1).

These results followed similar trends found by Lym et al. (1997) comparing multi-species grazing with cattle and angora goats. They reported seasonlong grazing reduced leafy spurge stem density faster than rotational grazing, even in year two. Results of this study would support Lym et al. (1997) in that seasonlong grazing using a multi-species approach would reduce leafy spurge stem density faster than rotational grazing. In both treatments and years, there was evidence that sheep were removing the flowering parts of the plant and preventing most seed production by leafy spurge, which supports Barker's (1996) statement that sheep will remove the flowering parts of the plant and most seed production by mature leafy spurge plants.

Degree of leafy spurge disappearance on both treatments was similar throughout the three grazing seasons 1996, 1997, and 1998. The degree of leafy spurge disappearance varied from 41% to 61% over three grazing seasons in both treatments. Grass and grass-like species degree of use within leafy spurge infested communities increased on both treatments after the first grazing season (Table 2). Grass and grass-like plant species disappearance in leafy spurge infested sites was 1% on the SL and 2% on the TOR treatment. However, by the second grazing season, grass and grass-like degree of disappearance increased to 33% on the SL and 20% on the TOR on leafy spurge infested communities. In the third year, degree of grass and grass-like species disappearance showed a slight increase again on leafy spurge communities compared to 1997 (Table 2).

Cow average daily gain (ADG) was higher ($P<0.05$) on the TOR treatment in 1997 than 1996. However, cow ADG was lower ($P<0.05$) in 1998 than 1996 and 1997. Calf ADG was similar ($P>0.05$) throughout the three grazing seasons. Steer ADG was not different ($P>0.05$) between years 1996 and 1997, however, decreased ($P<0.05$) in 1998 compared to 1996 and 1997 on the SL treatment (Table 3).

Ewe ADG on the TOR treatment was lower ($P<0.05$) in 1997 and 1998 compared to 1996, dropping from 0.32 lb/day in 1996 to 0.25 lb/day and 0.26 lb/day in 1997 and 1998, respectively. Seasonlong ewe ADG increased ($P<0.05$) from 1996 to 1997; however, there was a significant decrease ($P<0.05$) in ewe ADG from 1997 to 1998 with 1996 and 1998 not different ($P>0.05$). When analysis ewe performance between treatments, ewe ADG was higher ($P<0.05$) on the TOR in 1996 and 1998 with no treatment differences ($P>0.05$) occurring in 1997.

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Table 1. Leafy spurge stem densities on the seasonlong (SL) and twice-over rotation (TOR) grazing treatment and ungrazed treatments (standard errors in parentheses) in 1996, 1997, and 1998.

Treatment	1996	1997	% change 1996 to 1997	1998	% change 1996 to 1998
			# / 11 $inch^2$		
SL[1]					
Grazed	14.4 (1.9)[a]	12.5 (1.0)[a]	*-13.2*	11.5 (1.5)[a]	-20.1
Ungrazed	14.7 (1.9)[a]	14.9 (1.0)[a]	+ 1.3	17.1 (1.3)[a]	+16.3
TOR[1]					
Grazed	13.2 (1.5)[a]	15.9 (1.4)[a]	*+20.5*	12.8 (1.1)[a]	- 3.0
Ungrazed	8.6 (1.3)[a]	10.8 (1.2)[a]	+25.6	9.2 (1.3)[a]	+7.0

[1] Years with the same letter within treatments are not significantly different (P>0.05).

Table 2. Herbage production (+/- the standard error) and degree of disappearance (%) on ungrazed (UG) and grazed (G) plots of the twice-over rotation (TOR) and seasonlong (SL) grazing treatments in 1996, 1997, and 1998.

1996

Site Treatment	Grass & Grass-like	Forb	Shrub	Leafy Spurge	Total
			lb/acre		
Native					
TOR-UG	*2468 ± 269*	*144 ± 56*	*6.5 ± 6.5*	*0 ± 0*	*2619*
TOR-G	1625 ± 160	148 ± 62	0 ± 0	0 ± 0	1773
% USE	34	+2	100	0	32
SL-UG	*2784 ± 306*	*344 ± 75*	*8 ± 8*	*0 ± 0*	*3136*
SL-G	2197 ± 300	406 ± 104	3 ± 3	0 ± 0	2643
% USE	21	+34	55	0	15
Leafy Spurge					
TOR-UG	*1419 ± 206*	*1.5 ± 1.5*	*0 ± 0*	*1144 ± 262*	*2412*
TOR-G	1390 ± 188	1.5 ± 1.5	0 ± 0	677 ± 168	1919
% USE	2	0	0	41	20
SL-UG	*1713 ± 154*	*6 ± 6*	*0 ± 0*	*856 ± 165*	*2576*
SL-G	1700 ± 143	19 ± 19	0 ± 0	454 ± 94	2173
% USE	1	+221	0	47	16

Table 2. Continue

			1997		
Treatment	**Grass & Grass-like**	**Forb**	**Shrub**	**Leafy Spurge**	**Total**
			----------lb/acre ----------		
Native					
TOR-UG	*1883 ± 156*	*120 ± 57*	*0*	*1.0 ± 1.0*	***2005***
TOR-G	1194 ± 130	42 ± 20	0	0.6 ± 0.6	**1237**
% USE	**37**	**51**	**0**	**40**	**38**
SL-UG	*2042 ± 322*	*162 ± 75*	*33 ± 18*	*0 ± 0*	***2238***
SL-G	1384 ± 179	47 ± 21	0 ± 0	0 ± 0	**1403**
% USE	**32**	**71**	**100**	**0**	**36**
Leafy Spurge					
TOR-UG	*1298 ± 249*	*35 ± 30*	*0*	*955 ± 187*	***2270***
TOR-G	1034 ± 132	4 ± 4	0	367 ± 120	**1404**
% USE	**20**	**89**	**0**	**61**	**38**
SL-UG	*1239 ± 169*	*2.7 ± 2.7*	*7 ± 7*	*822 ± 89*	***2073***
SL-G	830 ± 119	6.0 ± 6.0	0 ± 0	355 ± 88	**1221**
% USE	**33**	**+113**	**100**	**47**	**35**

Table 2 Continue

1998

Treatment	Grass & Grass-like	Forb	Shrub	Leafy Spurge	Total
		----------lb/acre --------			
Native					
TOR-UG	*1380 ± 89*	*104 ± 19*	*0*	*0 ± 0*	*1484*
TOR-G	1054 ± 101	66 ± 15	0	0 ± 0	1120
% USE	24	36	0	0	25
SL-UG	*1803 ± 144*	*119 ± 41*	*5 ± 5*	*0 ± 0*	*1925*
SL-G	1134 ± 107	80 ± 24	4 ± 4	0 ± 0	1218
% USE	37	32	20	0	37
Leafy Spurge					
TOR-UG	*1291 ± 154*	*36 ± 12*	*0*	*776 ± 100*	*2103*
TOR-G	947 ± 98	6 ± 3	0	299 ± 44	1252
% USE	27	83	0	61	40
SL-UG	*870 ± 124*	*0 ± 0*	*0 ± 0*	*480 ± 110*	*1350*
SL-G	521 ± 71	4 ± 4	0 ± 0	255 ± 77	780
% USE	40	+400	0	46	42

Table 3. Livestock average daily gains (standard errors in parentheses) for individual classes of livestock on treatments: twice-over rotation (TOR) and seasonlong (SL) for 1996, 1997, and 1998.

Treatment & Livestock Class[1]	1996[2]	1997[2]	1998[2]
		---------lb/day ---------	
TOR			
Cow	0.78 (0.05)[a]	1.00 (0.05)[b]	0.01 (0.04)[c]
Calf	2.33 (0.03)[a]	2.32 (0.03)[a]	2.42 (0.03)[a]
Ewe	0.32 (0.01)[a]	0.25 (0.01)[b]	0.26 (0.01)[b]
SL			
Steer	1.99 (0.04)[x]	1.84 (0.03)[x]	1.54 (0.04)[y]
Ewe	0.23 (0.03)[x]	0.28 (0.03)[yb]	0.22 (0.01)[x]

[1] **Years with the same letter within each treatment are not significantly different (P>0.05).**
[2] **Sheep (ewe) treatments with the same letter within each year are not significantly different (P>0.05).**

MULTI-SPECIES GRAZING OF LEAFY SPURGE INFESTED RANGELAND IN SOUTHWESTERN NORTH DAKOTA USING ROTATIONAL GRAZING

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Significance of Leafy Spurge

Leafy spurge (*Euphorbia esula* L.) is a competitive, noxious plant species of Eurasian origin now widely dispersed across the northern hemisphere, including the United States and Canada. The infestation is concentrated in southern Canada and the north-central United States (Whitson 1996). Leafy spurge was first observed in New England in 1827 and in North Dakota in 1909; it has since spread to all of North Dakota's 53 counties (Lym et al. 1993 in Hirsch and Leitch 1998). The N. D. Agricultural Experiment Station has researched leafy spurge since the 1920's; Canadian scientists are credited with the most extensive research on the species during the 1950's and 1960's (Messersmith and Lym 1990). N.D. Dept. of Ag. (1996) estimates are that leafy spurge infests one million acres in the state. This equates to six percent of North Dakota's untilled land--more leafy spurge infested land area than in any other state. Leafy spurge infestations in the four-state region of North Dakota, Montana, South Dakota, and Wyoming have significant economic consequences (Leitch et al. 1994). These economic consequences are enormous because the species' invasive characteristics allow it to displace native plant communities, chemical controls are very costly and difficult to apply in rugged terrain, and the plant is unsuitable for cattle grazing due to intrinsic aversive compounds, i.e, digestive tract irritants. Leafy spurge infestations may reduce grass production as much as 50%; cattle carrying capacity on native rangeland may be reduced by as much as 75% due to leafy spurge infestations (Lacey et al. 1984).

Leafy spurge is a perennial forb that begins growing in early spring that reproduces vegetatively and by seed. Lajeunesse et al. (1995) reported that the species produces an extensive adventitious root system with vertical roots as deep as 26 feet and horizontal roots extending as far as 15 feet per year; new shoots may sprout from buds significant distances from the parent plant. This root complex allows the plants access to extensive nutrient and water resources. Seeds and root pieces may be spread mechanically by man, grazing livestock, and wildlife; the seeds will float on water. Mature leafy spurge seed capsules explode–projecting seeds up to fifteen feet–and these seeds remain viable in the soil for as long as eight years (Lajeunesse et al. 1995).

Management of leafy spurge infestations may include physical control (cultivation, mowing and burning, and hand weeding), plant competition (reseeding and grazing management), biological control (naturally occurring insects and pathogens), and chemical control (herbicides) (Lajeunesse et al. 1995). Sheep and goats will consume the plant though Walker et al. (1994) demonstrated that goats had a higher preference for leafy spurge than sheep. The experience of ranchers and range researchers shows that goat and sheep grazing can be effective and relatively rapid in controlling leafy spurge infestations on native rangelands (Lacey et al. 1984).

Complementary dietary preferences and foraging behaviors among ungulate herbivores generally make multi-species grazing economically and ecologically advantageous over single-species grazing in any situation. Domestic goats, deer, and pronghorn are categorized as browsers (selective for forbs and shrubs), domestic sheep, burros, and mountain goats are intermediate feeders (variably selective for grasses, forbs, and shrubs) while cattle, horses, and bison are grazers (consuming primarily grasses) (Vallentine 1990). The principal objective of multi-species grazing is better utilization of grasslands and improved animal production. For these reasons the grazing habits of cattle and sheep complement one another and offer economical and ecological benefits (Esmail 1991).

These advantages may be accentuated when employing goats or sheep in multi-species grazing efforts on leafy spurge infested rangeland. These two species are generally able to overcome leafy spurge's intrinsic aversive compounds following a transition period. Leafy spurge plants are leafy and succulent with significant nutritive value (based on chemical composition) throughout much of the growing season (Fox et al. 1991) though Kronberg and Walker (1999) demonstrated that several factors may account for differences in animal preference for leafy spurge. Sedivec et al. (1995) stated that goats, and especially sheep, should be forced to graze leafy spurge in the spring to improve selectivity, making leafy spurge their dominant food source. Lacey et al. (1984) determined selective grazing of leafy spurge by goats and sheep to be an effective method for controlling large infestations by materially suppressing the noxious weed but that grazing cannot be considered a route to eradication.

Purpose of This Study

The objectives of this study are to determine if simultaneous grazing of leafy spurge infested rangeland with cattle and sheep employing a rotational grazing system in concert with insect controls will, first, enhance plant diversity and richness and reduce leafy spurge density compared to season-long grazing and, second, enhance livestock grazing efficiency compared to season-long grazing.

The hypotheses of this study are, first, plant species diversity and richness on leafy spurge infested rangeland will demonstrate greater improvement under a rotational grazing system managed with biological control and simultaneous cattle and sheep grazing as compared to season-long grazing and biological control. Second, livestock grazing efficiency will be enhanced on leafy spurge infested rangeland managed with a rotational grazing system using biological control while simultaneously grazed with cattle and sheep versus season-long grazing of cattle or sheep.

Study Area and Design

This project is being conducted on leafy spurge infested rangeland in southwestern North Dakota from 1998 through 2001. The study area is located six miles north of Sentinel Butte and 150 miles west of Bismarck. Two tracts of rangeland of 635 and 395 acres comprise the replicated multi-species grazing trial in the Badlands vegetative region of North Dakota. Vegetation in this region is typical of northern mixed grass prairie and is classified as a wheatgrass-grama-needlegrass plant community (Barker and Whitman 1989). Leafy spurge infests approximately forty to fifty percent of the land on these two study sites.

This research tests the effects of twice-over rotation and season-long grazing on leafy spurge infested rangeland using multi-species grazing with cattle and sheep in conjunction with a biological control program. Each of two tracts of land were blocked into four cells with one cell randomly selected as season-long treatment. The remaining three cells in each replicate are grazed using twice-over rotation grazing treatment. Four one-acre exclosures, containing forty to fifty percent leafy spurge, are excluded from grazing and classified as biological control treatments.

Fifty permanent 100-meter (109-yard) line transects are located in leafy spurge clumps (26 transects) and native range (devoid of leafy spurge) vegetation sites (24 transects) throughout the study area to monitor changes in (1) leafy spurge stem density, (2) grass and grass-like species frequency, diversity, and richness, (3) forb and shrub species, frequency, density, diversity, and richness, and (4) basal vegetative cover. Barbour et al. (1999) defined density as the number of plants and frequency as the percentage of area that contains at least one rooted individual of a given species. Species richness is simply the number of species per unit area; diversity is a combination of richness and evenness, i.e., species richness weighted by species evenness (Barbour et al. 1999).

Livestock performance and production data is collected for cattle and sheep for determination of average daily weight gain and gain per area. Livestock are weighed at the beginning and end of each grazing season.

Grazing Plan of the Study

Cattle will graze the study area from June 1 through September 15 while stocked in accordance with the recommended carrying capacity of the land as outlined in USDA Natural Resources Conservation Service (NRCS) technical guidelines (1984). Sheep will graze the study area from May 15 through September 15 while stocked at forty percent of carrying capacity without adjustments to cattle numbers. Stocking rates of the twice-over rotation grazing treatments are 0.28 and 0.31 animal unit months (AUMs) per acre. Type of cattle grazed is Hereford-Angus cross cow/calf pairs; type of sheep grazed is mature white-faced ewes.

Livestock graze the season-long treatment continuously throughout the grazing season. Livestock graze the twice-over rotation grazing treatment as one herd and rotate simultaneously. The entire herd of cattle and sheep graze one cell at a time, grazing forty percent of the available carrying capacity of the cell in the first rotation and sixty percent of available carrying capacity in the second rotation.

Summary

Leafy spurge infestations warrant continued study as the species ranks as one of the region's most devastating weeds. Expectations are that this study will offer additional insight into integrated management of leafy spurge infestations thereby enhancing rangeland productivity.

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Nitrogen, Phosphorus, pH, and Organic Matter on Leafy Spurge Infested Rangeland in Southwestern, North Dakota

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Acknowledgments: *We would like to thank Rick Olson and Lyndon Johnson for their assistance in collecting this information.*

Introduction

Soil samples were taken on N½ of section 29 of T141N, R103W of Golden Valley County. Section 29 is presently separated into four pastures and managed by two different grazing treatments (seasonlong and 3 pasture twice-over rotation) and is one of two sections of rangeland presently involved in a leafy spurge research/demonstration grazing study (part of TEAM Leafy Spurge). The study is looking at the use of multiple control measures in controlling leafy spurge using sheep and insects. Cow/calf pairs and ewes graze both sections, as a multi-species approach. The grasslike plant community on this section was dominated by blue grama, western wheatgrass, and threadleaf sedge on silty range sites, and western wheatgrass, inland salt grass, foxtail barley, and sandberg bluegrass dominated the saline lowland range sites.

The objective was to detect differences between non infested native sites and leafy spurge infested sites in soil nitrogen, phosphorus, organic matter, and pH. This study area displayed a mosaic pattern of dense green leafy spurge patches with an under story of graminoid species. Non infested sites showed evidence of been denude of elements needed for plant growth or a results of heavy grazing pressure in the past. Our hypothesis was that native sites would be lower in nitrogen, phosphorus, and organic matter, and have a higher pH in the soil depth of 0-6 inches, and over time there would be changes within treatments.

Procedure

A total of sixteen samples was systematically taken on the third week of July, on two different range sites within the study site. The two range sites chosen made up most of the study area. Eight samples (four leafy spurge sites and four native sites) were collect on a saline lowland site (lowland) and eight were collect on a silty range site (midland). Soil samples were taken from 0-6 inches in depth and were collect from both grazing treatments. We recorded each sampling site on a map so that we could return to the sites each year to detect any changes that might occur with the different grazing practice. We will take samples the third weekend of July each year throughout the duration of the grazing study (four years).

Results

Results showed that non infested sampling sites and infested sampling sites were similar in nitrogen, phosphorus, pH, and organic matter, with the exceptation of the pH level on lowland sites (figure 1, 2, and 3). The pH level was generally higher on non leafy spurge infested lowland sites than leafy spurge infested lowland sites. Soil analysis did show a negative correlation between pH and percent organic matter present. Sites with a higher pH had a lower percent of organic matter present in all sampling sites and treatments. Visual observation of the two range sites, silty and saline lowland, showed no difference in graminoid species richness and the number of grass species, within leafy spurge infested and non infested sites.

Future

In the future we plan to continue sampling the sites and increase the number of samples by systematically choosing other silty and saline lowlands in study area. The demonstration grazing study is a large scaled study consisting of two replicated grazing treatments, so we plan to expand our sampling to the second replication. Leafy spurge stem densities and soil moisture will be collected on both replications in 1999 and throughout the duration of the study.

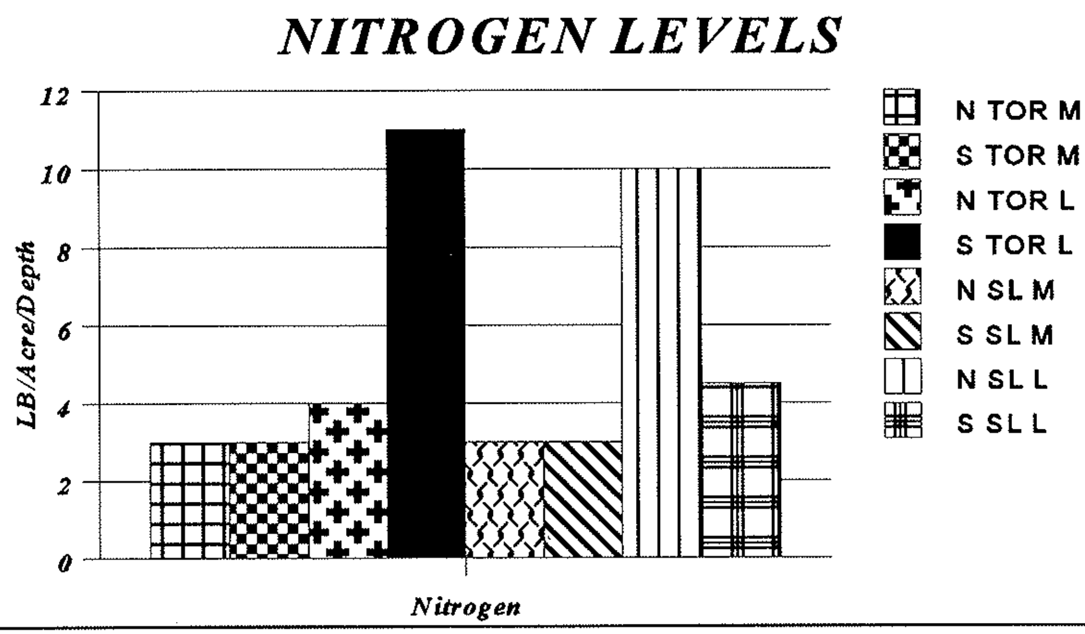


Figure 1. Level of nitrogen on leafy spurge infested sites (S) and non infested sites (N) in southwestern North Dakota, within treatments (twice-over rotation (TOR) and seasonlong (SL)) on midland (M) and saline lowland (L) sites, in 1998.

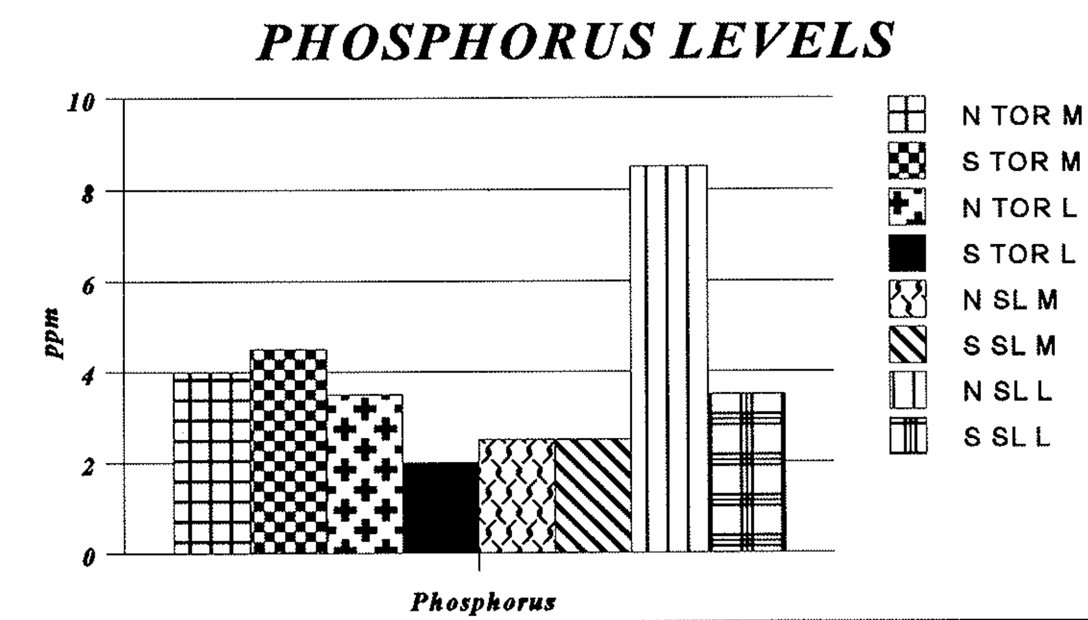
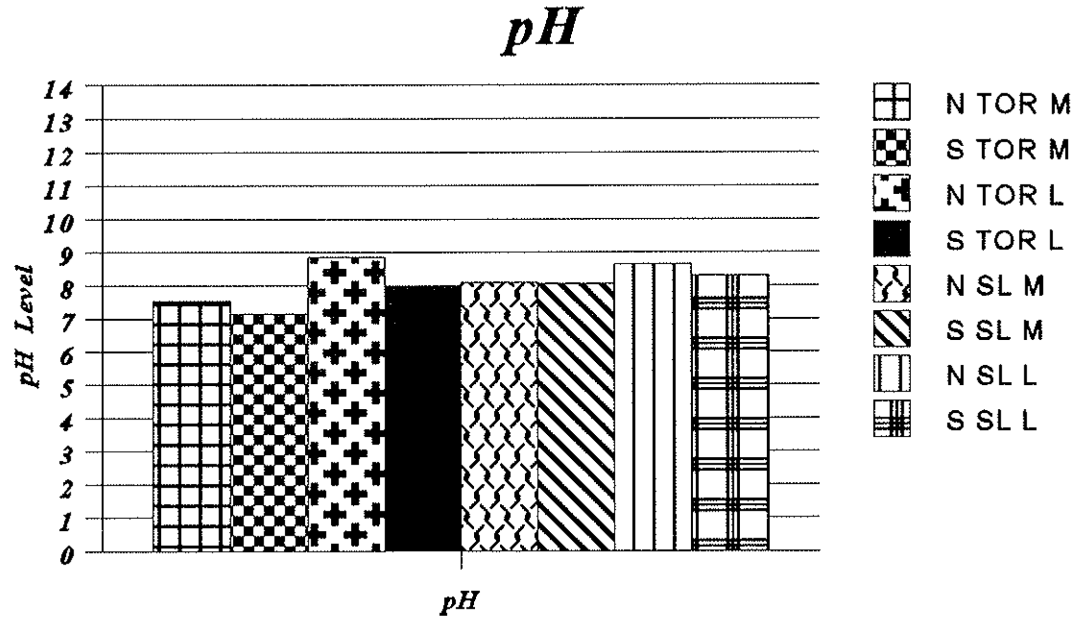


Figure 2. Level of phosphorus on leafy spurge infested sites (S) and non infested sites (N) in southwestern North Dakota, within treatments (twice-over rotation (TOR) and seasonlong (SL)) on midland (M) and saline lowland (L) sites, in 1998.



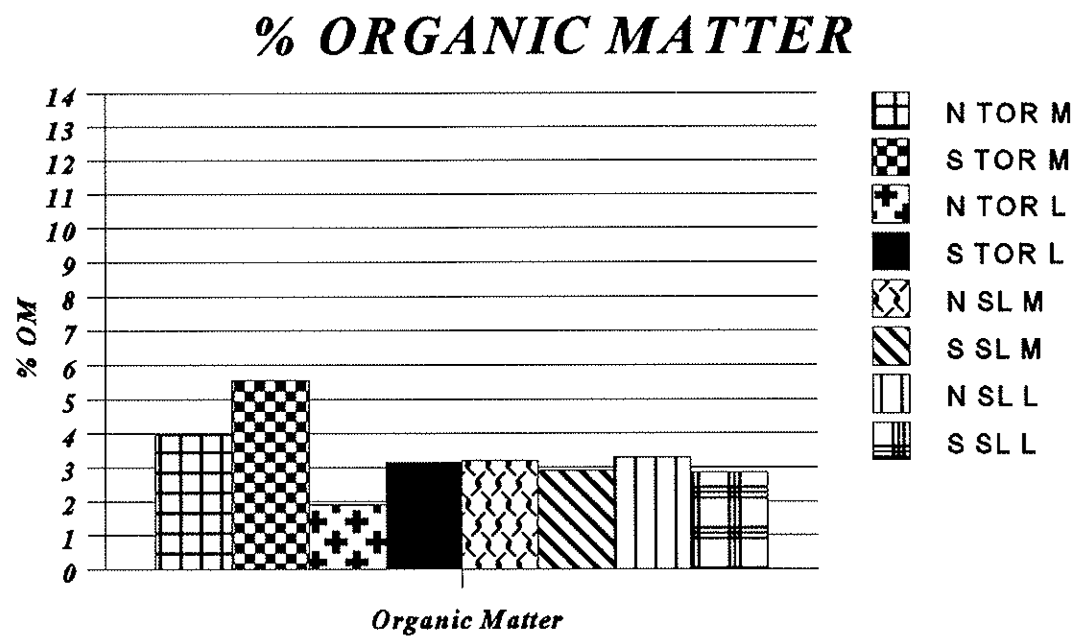


Figure 3. Level of pH and percentage of organic matter on leafy spurge infested sites (S) and non infested sites (N) in southwestern North Dakota, within treatments (twice-over rotation (TOR) and seasonlong (SL)) on midland (M) and saline lowland (L) sites, in 1998. Organic matter in this chart is the percent by ignition.

EKRE PROJECT - THE EWE FLOCK

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PRODUCTION GOALS OF THE EKRE EWE FLOCK

Flock Size: 125 ewes

Stocking Rate: 1 ewe per 5 acres

Ewe Type:

★Highly fertile - drop 200% lamb crop; 1998 drop was 178% as compared to 1997 ND average of 110% and National average of 108%.

★Heavy milkers - be able to raise twins.

★Moderate frame size 150 - 170 lbs.; lower feed requirements than a larger 200 - 250# ewe ; can run more ewes on given land area.

★Utilize speckled face ewes.

★Increase heterosis or hybrid vigor.

★Increase fertility, livability in lambs and milking ability.

Labor Inputs:

★Low inputs during grazing & maintenance periods (early spring - late fall).

★Highest requirements at lambing and lactation periods.

Yearly Management Calendar used on Ewe Flock: (All dates approximate)

May 15
◆Dry ewes brought to pasture.
◆Moved every 20 days to a different pasture.
◆No parasite problem (internal worms) because rotation has broken worm cycle.
◆Ewes are always moved to fresh ground.

Aug 20
◆Prebreeding.
◆Two vasectomized rams put with ewes to help bring ewes into estrus and close lambing interval.
◆No added grain or concentrates fed (no flushing).
◆New regrowth of spurge acts to increase the nutritional level of ewes; thus, lowering labor requirements as well as feed costs over more conventional methods of management.

Sept 10 ◆Breeding.
◆Rams put in - vasectomized rams taken out.
◆Three mature rams are used per 100 ewes.
1998 breeding rams:
Dorset ram used to produce moderate sized replacements
Hampshire & Columbia rams used to produce larger framed market lambs (135 - 150#)
◆In 1997 all ewes lambed in 3 weeks with the majority lambing in a 2-week period.

Nov 1 ◆Gestation
◆Ewes brought home from pasture. Able to utilize by-products of sugar beet plant.
◆Ewes put on ration of 75% beet tailings and 25% lower quality alfalfa or alfalfa grass hay.

Jan 1 ◆ Late Gestation
◆Tailings reduced to approximately 25% of ration - Hay quality and quantity increased.

Jan 15 ◆Begin feeding 1#/hd/day grain with 250mg. of Aureomycin or Terramycin added.
◆Shear ewes 2 to 4 week ahead of lambing.

Feb 1-5 ◆ Lambing Starts
◆Highest labor requirements at this time.
◆A 20% creep feed is put out for lambs at 7 to 10 days - lambs given free choice.
◆Lambing time labor requirements:
- Two overeating shots (initial shot and booster 3 weeks later)
- Docking and castrating
- Daily feeding
- Check lambs for pneumonia, starve outs, scours, etc.

Mar 1 ◆Preweaning
◆Lambing finished
◆At 45 to 50 days into lactation - take grain away. Ewes put on grass hay or lower quality hay to reduce milk production. This process lasts 2 - 3 weeks.

April 1-20 ◆ Weaning
◆Wean lambs at 60 - 75 days - Watch ewes for possible mastitis.
◆Ewes kept on grass hay or poorer quality hay until they are taken to pasture
◆Lambs are kept on feed-used for nutritional research projects or pushed for early markets. These prices are usually some of the highest of the year. This year lambs sold in June brought $1.02/lb lambs in Aug brought $.83/lb.

May 15 ◆ Dry ewes returned to pasture again

ECONOMIC SUMMARY FOR 1998

Flock of 50 ewes

Ewes lambed in Feb-March; Lamb Drop = 178%; Death Loss = 12.4% 89 lambs born; 78 lambs weaned.

Feed utilization by the ewes:

Nov/Dec - 75%beet tailings, 25%hay; ~cost per day of $.045 (1.5 lbs of hay at 3 cents/lb)

Total (61 days)/ewe = $2.75

Jan - 1 lb grain, 4 lbs hay; ~cost per day of $.16 (hay at 3 cents/lb and grain at 4 cents/lb)

Total (31 days)/ewe = $4.96

Feb/April 15 - 1.5 lb grain, 4 lbs hay; ~cost per day of $.18 (hay at 3 cents/lb and grain at 4 cents/lb)

Total (74 days)/ewe = $13.32

April 15/May 15 - 4 lbs hay; ~cost per day of $.12 (hay at 3 cents/lb)

Total (30 days)/ewe = $3.60

TOTAL = $24.63

May 15/Oct - Grazing on Ekre Property **(value versus 165 days @ 4 lbs hay/ day = $19.80)**

Lamb Marketing Options

May 21

78 lambs averaged 77.5 lbs; market that day in Sioux Falls was $1.00/lb

If lambs were sold they would gross $6045 ($77.50/head) or ***$120.90/ewe***.

August 18

76 lambs averaged 135.6 lbs (2 dead); lambs were sold for $.83/lb

They grossed $8553.36 ($112.55/head) or ***$171.07/ewe***.

Feeding Costs from May 21 to August 18 (89 days).

The lambs put on 58.1 pounds at a feed efficiency of 4.76 pounds of feed per pound of gain for a total 276.6 ponds of feed per lamb. The ADG for the lambs was 0.65 pounds per day. The ration cost approximately 5 cents a pound. Total feed cost per lamb was $13.83. (At a feed cost of 6 cents, the total cost would have been $16.60)

	PER HEAD	
Feeder Lamb Value (77.5 lb lamb @ $100/cwt)	$77.50	
Gross Income per Ewe	$120.90	
		Difference = $35.05
Market Lamb Value (135.6 lb lamb @ $83/cwt)	$112.55	
Gross Income per Ewe	$171.07	
Additional Profit by feeding the lambs out		
Miscellaneous costs/head	$2.00	
Feed (total ration, self feed) @5 cents $100.00/ton	$13.83	**Profit = $19.22**
Feed (total ration, self feed) @6 cents $120.00/ton	$16.60	**Profit = $16.45**

Effects of FSH Treatment on Egg Retrieval and Quality, in vitro Fertilization, and Ovulation of SMB Synchronized Ewes

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INTRODUCTION

The world population is increasing at dramatic rates; therefore the demand for food will continue to grow. In the United States, not only is the population increasing, but so is the average annual income. Consumers have more money to spend; they do not want to buy more food but instead want more specialized products. The consumers are demanding a more uniform, higher quality, nutritious product at a low price, therefore, requiring producers to raise animals that meet these specific demands. Altering herd genetics is a slow and expensive process because of the limitation of having a set number of offspring produced by each animal. However, through the use of assisted reproductive technology (ART) each animal has the ability to produce an increased number of offspring, thereby allowing the producer to more easily alter herd genetics to meet the consumers demands. Using ART, livestock producers will be able to increase the number of offspring produced by two genetically superior parents.

In recent years, there have been new introductions and improvements to ART for the creation, advancement and preservation of animal genetics as well as for the continued improvement of animal reproductive efficiency (Gordon, 1997). In sheep reproduction, ART has been introduced to obtain multiple embryos, in vivo or in vitro, and to obtain transgenic or cloned animals (Schnieke et al., 1997; Wilmut et al., 1997; Cognie, 1999). To obtain large numbers of oocytes (eggs) or embryos from ewes, the method of inducing follicular development with follicle stimulating hormone (FSH) is widely used (Gordon, 1997, Cognie, 1999). The ewe naturally releases FSH from the anterior pituitary gland in response to gonadotropin releasing hormone (GnRH) to promote follicular development. Injected into ewes for two or more days at regular intervals, FSH promotes development of a large number of follicles on each ovary (Jablonka-Shariff et al., 1994, 1996). The aim of this study was to determine the effects of FSH on the number of follicles, the recovery and quality of oocytes, the ability of these oocytes to undergo in vitro fertilization, and ovulation rates over time from ewes synchronized with norgestomet (a synthetic progestogen).

MATERIALS AND METHODS

Ewes of mixed breeds were used for these experiments during the reproductive season of fall and winter 1998. For experiments 1 and 2, ewes were implanted in the left ear with Synchro-Mate-B (1/2 implant; SMB; Merial Limited, Athens, GA) in the morning and left in place for 14 days. SMB contains norgestomet, a potent synthetic progestin that provides high blood levels of progestin which in turn prevents follicular development, thereby synchronizing estrus upon removal of the implant. On day 14 (day 0 = day of SMB implantation), SMB implants were removed through a small incision made in the skin at the distal end of the implant.

Experiment 1, part A: Induction of multiple follicular growth and oocyte collection. Ewes (n = 29) were randomly distributed to three groups which were given one of three treatments: no treatment (control, n = 10), FSH injected for two days (2D, n = 9) or 3 days (3D, n = 10). Beginning on the morning of Day 12 (3D group) or Day 13 (2D group) after SMB implantation, ewes received twice daily (morning and evening) intramuscular injections of FSH (porcine FSH with 10% luteinizing hormone; Sioux Biochemical, Sioux Center, IA). Injections were as follows: Day 1, 5 units (1.0 ml)/injection; Day 2, 4 units (0.8 ml)/injection; Day 3, 3 units (0.6 ml)/injection (total dose: 2 day treatment = 18 units; 3 day treatment = 24 units). SMB was removed on Day 14 and a laparotomy was performed on Day 15 at 15 hours after the removal of the SMB implant, in order to count follicles and retrieve oocytes.

At laparotomy, the ovaries were exteriorized and the number of follicles were counted on each ovary. In addition, for each follicle, the surface diameter was measured and follicles were classified as <3mm (small), 3-8mm (medium), and >8mm (large) before oocyte collection. Oocytes were then collected using a 22-gauge 1-inch needle and a syringe containing approximately 0.2 ml of collection media that consists of TCM-199 (Sigma, St. Louis, MO), 2% heat-inactivated fetal bovine serum (FBS; Gibco, Gaithersburg, MD), heparin (Sigma), and penicillin/streptomycin (Watson et al., 1994). Each collected follicle was washed/flushed three times with the collection media. The media and follicular fluid from each follicle was placed into separate petri dishes.

By using a stereoscope, each dish was searched and the recovered oocyte(s) was transferred to a petri dish with fresh collection media at which point all oocytes from individual ewes were combined. Oocytes were then evaluated based on morphology and categorized as healthy or atretic according to Thompson et al. (1995). All oocytes were washed three times in maturation media before being transferred into stabilized maturation media (TCM-199, 10% FBS, ovine FSH [oFSH-RP-1; NIAMDD-NIH, Bethesda, MD], ovine LH [oLH-26; NIADDK-NIH], estradiol [Sigma], glutamine [Sigma], sodium pyruvate [Sigma], and penicillin/streptomycin; Watson et al., 1994).

Experiment 1, part B: In vitro fertilization of collected oocytes.
Oocytes collected from ewes in part A were subjected to in vitro fertilization (IVF) and evaluated for fertilization rates. The oocytes were matured for 21-24 hours at 39^0 C, 5% CO_2, and 95% air. After maturation procedures, the oocytes were again evaluated for health based on morphology. Oocytes classified as healthy were separated and used for in vitro fertilization. The cumulus cells were removed by a 1% hyaluronidase (Type I-S; Sigma) treatment and the healthy oocytes were transferred to stabilized fertilization media, consisting of synthetic oviductal fluid (SOF; Tervit et al., 1972) and 2% heat inactivated sheep serum collected from sheep on day 3 of the estrous cycle (O'Brian et al., 1997).

Frozen semen, which was pooled from 4 NDSU rams, was thawed and viable sperm were separated using the swim up technique (Yovich, 1995). In the swim up technique, the healthy and viable sperm from a semen fraction swim into the media (Modified Sperm Washing Medium, Irvine Scientific, Santa Ana, CA) which lays on top of the thawed semen pool. This media containing the motile healthy sperm is then centrifuged, counted and used for in vitro fertilization. 0.5-1.0 x 10^6 sperm/ml was added to the oocytes (up to 20 oocytes/500 µl/well). The oocytes were incubated with the sperm for 17-20 hours at which time the embryos were washed three times with culture media without glucose (SOF supplemented with BSA, glutamine, MEM amino acids, BME amino acids [Sigma], and penicillin/streptomycin; Catt et al., 1997). The dishes were evaluated, 48-60 h after adding sperm to the oocytes, to determine the number of cleaved oocytes (i.e., embryos). Unfortunately, IVF data from all ewes is not reported herein because of a semen pool of poor quality used for IVF procedures at the beginning of this study. Rather, IVF data reported herein is only from oocytes subjected to IVF procedures from a second semen pool.

Experiment 2: Timing of ovulation.
This study was designed to determine when follicles would naturally ovulate in ewes treated with FSH. Starting on Day 12 of SMB implant, ewes (n = 16) received twice daily (morning and evening) intramuscular injections of FSH for four days as follows; Day 12, 5 units (1.0 ml)/injection; Day 13, 4 units (0.8 ml)/injection; Day 14 and 15, 3 units (0.6 ml)/injection (total dose = 30 units). SMB was removed on Day 14.

At 36, 48, and 60 hours after SMB removal, ewes were subjected to a laparoscopic examination to determine ovulation rates. Both ovaries were observed and the number of corpora hemorrhagica (CH), which represent recently ovulated follicles were counted. Six days after the last laparoscopic observation, ewes were subjected to a laparotomy. The number of corpora lutea (CL) on each ovary were counted. Ovulation rates (%) were then calculated for 36, 48, and 60 hours by dividing the number of CH observed at each time by the total number of CL at the time of laparotomy.

Statistical analysis

All data is reported as means ± the standard errors.

Experiment 1
Numbers of follicles and oocytes and percentages of matured oocytes and fertilized oocytes for non-treated and FSH-treated ewes were analyzed by using the general linear models (GLM) procedure of the Statistical Analysis System (SAS, 1985). When the F-test was significant, differences between specific means were evaluated using t-tests. Relationships between treatments in part A were evaluated using Duncan's test. The relationships betwen treatments in part B were evaluated using the Dunn's test.

Experiment 2
The number of CH and ovulation rates at several time points after SMB removal were analyzed using simple linear regression of the Statistical Analysis System (SAS, 1985).

RESULTS

Experiment 1: Part A
Table 1 presents number of small, medium and large follicles on ovaries of non-treated and FSH treated ewes.

Table 1. Number of small, medium and large follicles in non-treated and FSH-treated ewes.

Treatment	n	Number of Follicles			
		<3mm	3-8mm	> 8mm	Total
None	10	3.3±0.83	4.6±0.72 [a]	0.3±0.21	8.2 ±0.99 [a]
2D FSH	9	2.0±0.94	13.4±1.69 [b]	0.7±0.32	16.2±2.06 [b]
3D FSH	10	1.3±0.60	19.3 ±2.06 [c]	0.8±0.42	21.4±2.04 [c]

[a, b, c] - means ± SEM differ within a column, $p<0.01$.
n - number of ewes.

FSH treatment increased ($p < 0.01$) the number of medium and total number of follicles, but did not affect the number of small or large follicles. The 3D FSH-treatment group had greater ($p<0.01$) numbers of medium follicles and total numbers of follicles than the 2D FSH-treatment group.

Table 2 presents the number of oocytes recovered from small, medium and large follicles.

Table 2. Number of oocytes recovered from small, medium and large follicles for non-treated and FSH-treated ewes.

		Number of oocytes recovered			
Treatment	n	<3mm	3-8mm	>8mm	Total
None	10	3.1[a]±0.6	3.9[a]±0.7	0.2±0.1	6.4[a]±0.5
2D FSH	9	1.1[b]±0.6	9.2[b]±1.4	0.2±0.2	10.1[a,b]±1.6
3D FSH	10	0.7[b]±0.4	13.2[b]±1.8	0.5±0.4	14.4[b]±1.9

[a, b] - means ± SEM differ within a column, $p<0.02$.
n - number of ewes.

FSH treatment affected ($p<0.02$) the number of oocytes recovered for small and medium but not large follicles. The number of oocytes recovered from medium follicles and the total number of oocytes recovered was greater ($p<0.01$) in FSH-treated ewes than non-treated ewes.

Table 3 presents the total recovery rate and the proportion of healthy and atretic oocytes from non-treated and FSH-treated ewes.

Table 3. Recovery rate, and percentages of healthy and atretic oocytes for non-treated and FSH-treated ewes.

Treatment	n	Total recovery rate (%)*	% of healthy oocytes**	% of atretic oocytes**
None	10	76.1±5.5	67.7±5.9[a]	32.3±5.9
2 day FSH	9	62.1±6.1	87.3±5.6[b]	12.7±5.6
3 day FSH	10	61.0±7.1	95.1±2.3[b]	4.9±2.3

[a, b]- means ± SEM differ within a column , $p<0.05$.
n - number of ewes.
*Calculated by dividing the number follicles flushed by the number of oocytes found X 100.
**Percent healthy or atretic oocytes of the total oocytes recovered.

Recovery rate was similar across all treatment groups. The overall proportion of healthy oocytes was higher ($p<0.01$) in FSH-treated ewes than non-treated ewes.

Experiment 1: part B

The number and percentage of oocytes used for IVF and the number and percent of oocytes cleaved in non-treated and FSH-treated ewes is presented in Table 4.

Table 4: Number of oocytes used for in vitro fertilization and cleavage rate of oocytes from non-treated and FSH-treated ewes.

Treatment	n	# of oocytes used for IVF	% of oocytes used for IVF*	# of oocytes cleaved	Rate of cleavage (%)**
None	5	4.4 ± 1.3^a	63.8 ± 12.6	3.0 ± 1.0	67.6 ± 9.6^c
2D FSH	4	10.5 ± 2.6^b	84.4 ± 4.7	6.5 ± 1.5	70.5 ± 13.7^c
3D FSH	7	10.4 ± 2.0^b	85.3 ± 6.1	4.7 ± 1.3	42.3 ± 5.9^d

[a,b,c,d] - means ± SEM differ within a column, $p<0.02$.

n - number of ewes.

* Calculated by dividing the number of healthy oocytes used for IVF by the number recovered X 100.

** Calculated by dividing the number of oocytes cleaved by the number of oocytes used for IVF X 100.

The number of healthy oocytes used for IVF was higher ($p<0.02$) in FSH-treated than non-treated ewes. However, the percent of healthy oocytes used for IVF and the number of oocytes cleaved after IVF procedures was similar for all treatments. The cleavage rate was lower ($p<0.01$) for the 3D FSH-treated group than for the non-treated ewes or the 2D FSH-treated group.

Experiment 2

Experiment 2 was designed to determine timing of ovulation in ewes treated with FSH. Number of ovulations and ovulation rates are presented in Table 5.

Table 5: Number of ovulations and ovulation rates at several time points after SMB removal in FSH-treated ewes.

Time	n	# of CH	Ovulation Rate (%)*
36 Hours	16	0.63 ± 0.26^a	3.99 ± 1.7^a
48 Hours	13	8.69 ± 1.74^b	53.6 ± 7.7^b
60 Hours	16	10.69 ± 1.59^c	66.8 ± 6.2^c
Laparotomy	16	17.31 ± 2.46^d	100^d

[a,b,c] -means ± SEM differ with in column, $p<0.01$.

d - not used in statistical analysis.

n - number of ewes.

*Calculated by dividing of the number of CH observed at laparoscopy by the total number of CL observed at time of laparotomy X 100.

The number of CH and the ovulation rate differed (p<0.01) among different time points. The number of CH increased from 0.63 to 10.7, and the ovulation rate increased from 4% to 67% from 36 to 60 hours after SMB removal.

Figure 1 shows the linear relationship of ovulations over 3 time points in FSH-treated ewes.

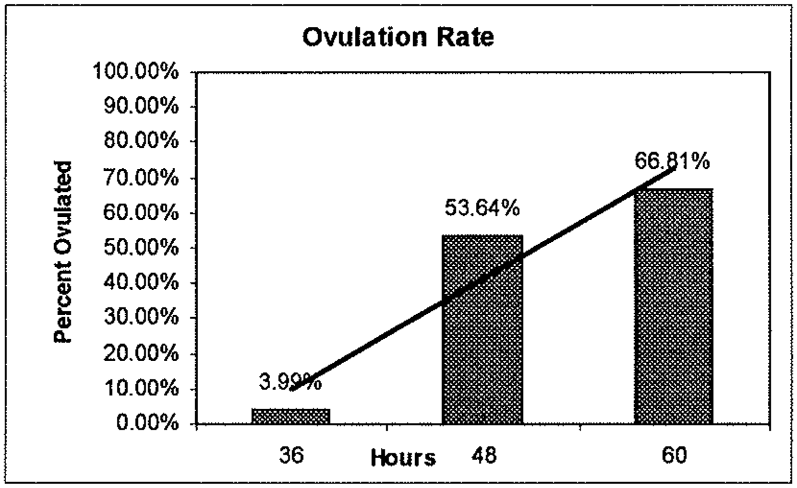

Figure 1: Ovulation rate at several time points in FSH-treated ewes.

The trendline represents the rate of ovulations over the 60 hour period. Both the number of CH and the ovulation rate increased linearly ($R^2 = 0.39$ and 0.58, respectively, $p < 0.01$) from 36 to 60 hours after SMB removal (Figure 1). At 48 hours, 54% of the follicles ovulated and at 60 hours 67% have ovulated. However, approximately 33% still remained unovulated 60 hours after implant removal.

DISCUSSION

As discussed earlier, assisted reproductive technologies are powerful tools in the animal industry for genetic improvement and also for enhancing reproductive efficiency. In order for ART methods to be efficient, the number of follicles and the number of oocytes and embryos obtained from animals must be maximized. Unfortunately, less than optimal protocols for induction of multiple follicular growth and superovulation are currently used in the animal industry (Redmer et al., 1998). Along with improving these techniques, oocyte retrieval, maturation, and in vitro fertilization techniques, need improvement.

In the present study, follicular growth in ewes was induced by FSH and synchronized with SMB. Most studies use other methods for synchronization, such as CIDR®, intravaginal sponges, or medroxyprogesterone acetate (Gordon, 1997). However, in the United States, these other products have not been commercially available or are not particularly reliable for these procedures. Please note that SMB used in this report is approved only for use in cattle.

In the present study of FSH induced follicular development, the total number of follicles from ewes treated with FSH for 2 days was 16, and for 3 days was 21. In addition, non-treated ewes had the smallest number of follicles with an average of 8. These data support other reports that FSH treatments are an effective way to induce follicular development in ewes (Jablonka-Shariff et al., 1994, 1996; Gordon, 1997).

For ART, multiple follicular stimulation is only effective if multiple oocytes or embryos can be collected. In our study, the majority of the oocytes were collected from medium sized follicles. We did recover over half of the oocytes from the follicles that were less than 3 mm. However, it was more difficult to aspirate oocytes from small follicles because the needles used for collecting were often too large for the follicle and flushing with media was difficult. Baldassarre et al. (1994) reported that it was easier to collect oocytes from follicles smaller than the 5 mm. They found that the larger follicles were difficult to aspirate because the contents appeared more dense and the large follicles tended to 'explode.' We avoided these problems by using media containing heparin and by puncturing each follicle through the ovarian stroma. In our experiment it was easier to collect oocytes from the medium and large follicles. In addition, in FSH-treated ewes the medium follicles constituted 80-90% of the total follicles. Collecting oocytes from these follicles is essential, and consistently high recovery rates is critical to maximize efficiency of these techniques.

Along with consistently high recovery rates, successful in vitro maturation and in vitro fertilization must be achieved. Determining how superovulation techniques affect the quality of oocytes can improve these techniques. Part A of experiment 1 showed that the number of healthy oocytes was higher in FSH-treated ewes than in non-treated ewes. However, part B of experiment 1 demonstrates that the percent of healthy oocytes after maturation was not significantly different among treatment groups, but tended to be higher in the FSH-treated ewes than the non-treated ewes. If the number of animals in this study was higher, perhaps, statistically we would have seen a difference.

The percent of oocytes cleaved was higher in the non-treated ewes and the ewes treated with FSH for 2 days than ewes treated with FSH for 3 days. The cleavage rate for ewes treated with FSH for 3 days was only 42%. The non-treated ewes and ewes treated with FSH for 2 days had a cleavage rate of approximately 70%. This is similar to the 68% cleavage rate reported by Slavik et al. (1992) and 72% by Ledda et al. (1997). However, O'Brien et al (1996, 1997), and Watson et al. (1994) reported cleavage rates of about 80%. Again, increasing cleavage rates through the use of appropriate follicular induction techniques only prove to be a key factor in the overall efficiency of ART.

Experiment 2 was designed to determined the ovulation rate over time in ewes that were synchronized with SMB and stimulated with FSH. Between 36 hours and 48 hours after SMB removal, 50% of the ovulations occurred, with an additional 13% occurring between 48 and 60 hours. However, it is interesting to note that 33% of the follicles had not ovulated by 60 hours. Previous studies show that the optimal time to inseminate is between 54 and 60 hours after progestin removal (Findlater et al., 1991). Our data shows that more research needs to be conducted to determine the optimal time for inseminating ewes that are treated with SMB and FSH.

The results of this and future studies will ultimately lead to improved and efficient methods for obtaining large numbers of high quality oocytes and embryos for transfer programs. Improvement in these techniques will enhance the overall efficiencies of ART for farm use.

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Ranch Operators' Perceptions of Leafy Spurge

Randall S. Sell, Dean A. Bangsund, F. Larry Leistritz, and Dan Nudell*

Introduction

Leafy spurge (*Euphorbia esula* L.) is an exotic, noxious perennial weed that has become widely distributed in the northern Great Plains. Considerable research has been conducted to develop effective controls for leafy spurge; however, current control techniques have proven ineffective in eradicating the plant. Despite advancements in the efficacy of leafy spurge controls and an increased awareness of the destructive capabilities of the weed, much of the Upper Midwest remains infested and continues to combat expanding infestations.

In 1997, The Ecological Areawide Management of Leafy Spurge project (more commonly called **TEAM Leafy Spurge**) was initiated to pull together state, federal, and local agencies and private landowners to develop and integrate sustainable leafy spurge management methods, and to transfer economically and ecologically proven technologies to manage leafy spurge to land managers. This study highlights a survey of ranchers, which was initiated to evaluate managerial, institutional, and social factors that may affect the rate and extent of implementation of various control strategies in the **TEAM Leafy Spurge** demonstration counties.

Methods

Ranchers in a five-county region in Montana, North Dakota, South Dakota, and Wyoming were surveyed to obtain their opinions and views regarding weed management and problems associated with leafy spurge (Figure 1). A total of 187 questionnaires were returned from a mailing list of 459 ranchers.

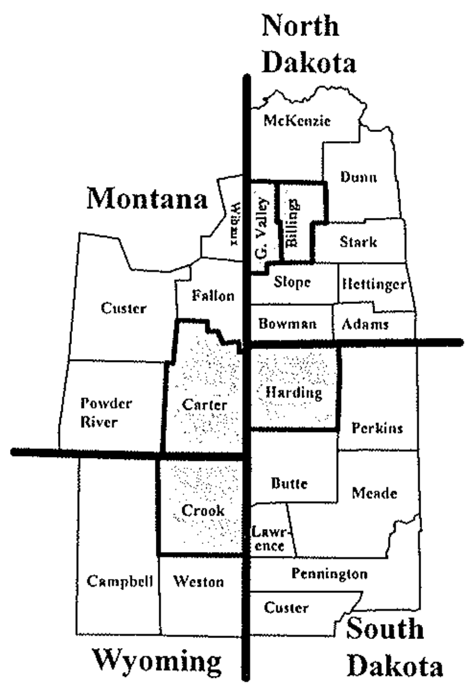

Figure 1. Counties Included in TEAM Leafy Spurge

*Sell and Bangsund are research scientists, and Leistritz is a professor at the Department of Agricultural Economics, North Dakota State University, Fargo; Nudell is a research station scientist at the Hettinger Research and Extension Center, North Dakota State University, Hettinger.

Results

The survey was designed to **(1)** assess how weed problems rank among rancher concerns, **(2)** identify which weeds generate the most problems, with particular emphasis on leafy spurge, **(3)** identify what measures ranchers take to prevent the spread of leafy spurge, **(4)** determine which leafy spurge control strategies ranchers consider effective and economical, **(5)** determine the reasons for not using various leafy spurge controls, **(6)** determine where ranchers get weed management information, what information they desire, and in what form they wish to receive it, and **(7)** assess ranchers' opinions and perceptions on general weed management and leafy spurge control.

General Characteristics

There were 34, 53, 46, and 54 completed surveys from Montana, North Dakota, South Dakota, and Wyoming, respectively. Survey response rate ranged from 49% in Montana to 35% in South Dakota. Average ranch size (acres and animals) was smallest in North Dakota and largest in Wyoming. The characteristics of ranchers responding, averaged across all states included:

- Average operator age was 53
- Average ranch size--6,900 acres operated
- 91% of those surveyed had cattle, with an average of 444 head
- 28% of those surveyed had sheep, with an average of 1,175 head
- 80% of gross rancher income came from grazing livestock
- 72% of those surveyed used public rangeland
- 56% of those surveyed had leafy spurge on their ranch
- Of ranchers who had leafy spurge, the average infestation was 2.5% of operated acres
- 46% of ranchers regularly use computers on their ranch

General Ranching Issues

Ranchers were asked to indicate which ranching issues were a *major*, *minor*, or *not a* problem. The overall responses were:

- The worst problem was livestock prices (79% of ranchers said it was a *major* problem).
- Adverse weather and cost of inputs also ranked high as *major* problems (63% and 53% of ranchers said these were *major* problems, respectively).
- About one-third of all ranchers said the following were *major* problems: predators, regulations affecting public rangeland, and noxious weeds.
- Availability of grazing land and use of CRP were less important problems (27% and 14% of ranchers indicated these were *major* problems, respectively).

Ranchers were also asked if those same issues had *become worse*, *stayed the same*, or *improved* over the last 5 years. The overall responses were:

- Over 67% of ranchers indicated that livestock prices had become worse over the last 5 years.
- Between 50 and 60% of ranchers said that the cost of inputs and adverse weather had become worse over the last 5 years.
- Problems with predators and noxious weeds followed with 47% and 42%

of ranchers indicating that these problems had become worse, respectively.

• About one-third of all ranchers said that availability of grazing land had become worse in the last 5 years.

When the views of ranchers with leafy spurge were compared to the views of ranchers without leafy spurge, the following perceptions were noted:

• Ranchers with leafy spurge considered regulations affecting public rangeland, noxious weeds, and availability of grazing land to be greater problems than those without leafy spurge.

• Similarly, a greater percentage ranchers with leafy spurge felt that regulations affecting public grazing land, availability of grazing land, and noxious weeds had become worse over the last 5 years than ranchers without leafy spurge.

• Conversely, a greater percentage of ranchers without leafy spurge felt that predators had become a worse problem over the last 5 years than those with leafy spurge.

• When compared as separate groups, nearly equal percentages of both ranchers with leafy spurge (68%) and those without leafy spurge (66%) felt that livestock prices and the cost of inputs had become worse in the last 5 years.

Ranking of Problem Weeds

Ranchers were asked to indicate which weeds were a *major*, *minor*, or *not a* problem in their area. The overall responses were:

• Leafy spurge received the most consideration as a *major* weed problem among all ranchers (49% of ranchers considered it a *major* problem--the next weeds [field bindweed and thistles] only had 25% of the ranchers who felt they were a *major* problem).

• After leafy spurge, the weeds that were considered *major* problems, in order of rank, included field bindweed, thistles, annual bromegrass, sagebrush, knapweeds, and prickly pear.

• However, the rank of problem weeds was even more pronounced when ranchers were asked which weed was the *single most important weed.* About 57% of all ranchers considered leafy spurge the *most* serious problem weed, compared to 12% who ranked thistles as the *most* important weed. Other weeds (such as hounds tongue, field pennycress, cheatgrass) were considered the *most* important problem weeds by 9% of ranchers.

When the views of ranchers with leafy spurge were compared to the views of ranchers without leafy spurge, the following perceptions were noted:

• Among ranchers without leafy spurge, more ranchers indicated that field bindweed was a *major* problem than leafy spurge.

• Leafy spurge was still considered the *single most important weed* to both ranchers with leafy spurge and to those without leafy spurge. However, ranchers without leafy spurge ranked other weeds, such as hounds tongue, field pennycress, cheatgrass, annual bromegrass, and sagebrush as the *most* important weed more often than ranchers with leafy spurge.

Other notes regarding weed problems included:

• Over 65% of ranchers in the survey classified the weed problem on their ranch as *minor*, compared to 17% who indicated it was either *not a* problem or indicated it was a *major* problem.

Preventing Spread of Leafy Spurge

Ranchers were asked to identify all the measures or practices taken to prevent the spread of leafy spurge. Nearly all ranchers surveyed were actively involved in preventing weeds from spreading.

- Over 95% of ranchers routinely check range for invading plants.
- Over 90% of ranchers aggressively destroy weed plants when they are discovered.
- Nearly 80% of ranchers keep trucks/machinery free of weeds.
- About 80% spot spray near fringe or boundary areas.
- About 70% of ranchers purchase only weed-free hay.
- According to ranchers, the leading causes of leafy spurge expansion, by rank, included "spread from adjoining land," "not recognized as threat until too late," "lack of cost-effective controls," and "spread by man's actions."

Views on the Most Effective and Economical Leafy Spurge Controls

Ranchers were asked to rate the effectiveness of various control methods for leafy spurge. Opinions were solicited regardless of whether the rancher had leafy spurge. Herbicides, biological control, grazing, and tillage were assigned a rank of *not effective*, *partially effective*, or *very effective*.

- Over 50% of ranchers indicated that tillage was *not effective* in controlling leafy spurge.
- A greater percentage (29%) of ranchers with leafy spurge felt that sheep and goat grazing was *not effective* in controlling leafy spurge than ranchers without leafy spurge (11%).
- Only 5% of ranchers with leafy spurge considered herbicides *not effective* in controlling leafy spurge. However, only one-third of ranchers with leafy spurge rated herbicides as *very effective*.
- Less than 20% of ranchers rated biological controls as *very effective*.
- About 31% of ranchers without leafy spurge thought grazing controls were *very effective*; however, only 20% of those with leafy spurge considered grazing to be *very effective*.

Ranchers were also asked if "it pays" to use the same controls.

- Over 77 percent of ranchers with leafy spurge indicated that it pays to use herbicides to control leafy spurge; however, only 60% of ranchers without leafy spurge felt similarly.
- About two-thirds of all ranchers felt that it pays to use biological controls, and 56% of ranchers felt it pays to use grazing controls.

Ranchers with leafy spurge were asked to identify the controls they have used in the past and indicate if they were planning to use those controls in the future.

- Over 97% of ranchers with leafy spurge have used herbicides on leafy spurge.
- About 54% of ranchers have used biological controls on leafy spurge.
- Less than one-third of ranchers have used grazing or tillage to control leafy spurge.
- All (100%) ranchers with leafy spurge are planning to use herbicides in the future.
- Over 50% of ranchers indicate they are planning to use biological controls in the future.
- Only 25% of ranchers are planning to try grazing or tillage on leafy spurge in the future.

Reasons for not Using Leafy Spurge Controls

In an effort to better understand why ranchers may not use various controls on leafy spurge, a list of likely reasons were presented for each control. Ranchers were asked to indicate all of the reasons that apply. The top four reasons for not using each control method are listed with the percentage of ranchers indicating that reason.

- Reasons for not using **herbicides**:

Environmental restrictions (water, trees, sensitive crops) (62% of ranchers).

Acreage of infestations too large--prohibitively expensive (52% of ranchers).

Herbicides are not economical (46% of ranchers).

Infestations are inaccessible to sprayers (42% of ranchers).

- Reasons for not using **biological controls**:

Biological control takes too long (48% of ranchers).

Limited access to collect biological agents (45% of ranchers).

Do not know where or how to collect agents (36% of ranchers).

Lack knowledge to properly use the agents (30% of ranchers).

- Reasons for not using **sheep and goats**:

Lack the proper equipment (fences, water, shelter) (72% of ranchers).

Sheep/goats compete for the same forage as cattle (44% of ranchers).

Lack the expertise/knowledge to work with sheep/goats (41% or ranchers).

Sheep and goats are too time consuming to use (40% of ranchers).

- Reasons for not using **tillage, reseeding, mowing, burning**, etc.:

Land is not suitable for tillage (85% of ranchers).

These methods are ineffective (36% of ranchers).

Do not have time to work with these controls (27% of ranchers).

Lack the proper equipment (22% of ranchers).

Where do Ranchers Get Their Information

Given a list of possible *information sources*, ranchers were asked to indicate how frequently they used that source with regard to weed management. Ranchers were also asked *what information* they would like to receive pertaining to leafy spurge control and in *what form* they would like the information.

- Nearly 50% of ranchers use the Extension Service/county agent frequently.
- County weed boards/officers were used frequently by 46% of ranchers.
- About 43% of ranchers used other ranchers/neighbors frequently as sources of information.
- About 25% of ranchers indicated they used weed control seminars, herbicide dealers, and farm/ranch magazines frequently for information on weed control.
- Over 46% of ranchers indicated they would like information on the effectiveness of various herbicide treatments.
- Nearly 44% of ranchers wanted information on the economics of herbicide treatments.
- About 40% of ranchers would like information on the economics of biological control.

• Nearly 39% of ranchers requested information on how to use biological control.

• The most popular form of information was a pamphlet or bulletin available through their extension service or county agent (49% of ranchers).

• About 41% of ranchers would like testimonials from other ranchers.

• Demonstration plots showing the effectiveness of various treatments was indicated as a source by 38% of ranchers.

• About one-third of ranchers would like video cassettes, personal requests and visits, and books about leafy spurge control.

Opinions and Perceptions About Weed Management

Ranchers were asked to indicate if they agreed or disagreed with several statements regarding weed management, land management, and leafy spurge. The statements were ranked based on a score of 1 to 5, where 1 was strongly disagree and 5 was strongly agree. The top five statements that ranchers agreed and disagreed with are presented.

Ranchers Agree	Score
I am concerned about controlling weeds in rangeland	4.8
Leafy spurge is a long-term management problem	4.6
State and Federal government agencies agencies are not doing enough to control problem weeds on public grazing land	4.5
Rangeland weeds represent a problem to all ranchers	4.4
Biological agents released to control leafy spurge are safe for crops and native plants	4.2

Ranchers Disagree	Score
Public land managers are doing a good job of controlling weeds on public land	1.7
Weed infestations have no effect on the market (sale) value of rangeland	1.7
It seldom makes economic sense to to control weeds on rangeland	1.9
Leafy spurge is virtually impossible to control with current control methods and techniques	2.7
It does not pay to control weeds on my land when my neighbor does not control his weeds	2.7

Conclusions

Among a list of general ranching problems, dealing with weeds ranked in the middle. Weeds were considered a greater problem for ranchers who have leafy spurge than for those who do not have leafy spurge; however, even among ranchers with leafy spurge, there was strong agreement that other ranching issues were of greater concern. Ranchers felt weeds are an important problem, but are not the most serious problem ranchers face.

Leafy spurge was ranked as the most important weed regardless of whether or not a rancher had leafy spurge. To ranchers with leafy spurge, leafy spurge clearly out ranked all other weeds in importance. However, to ranchers without leafy spurge, concerns over the most important problem weeds were more evenly distributed among a variety of weeds. For those ranchers who do not have leafy spurge, all the other weeds are probably nearly equal in the difficulty of control or pose similar production problems.

Most ranchers, regardless of whether they had leafy spurge, felt that tillage, in combination with reseeding, was not effective in controlling leafy spurge, compared to only 7 percent of all ranchers who thought herbicides were not effective in controlling leafy spurge. Only a minor percentage of ranchers with leafy spurge rated any control measure as very effective, reinforcing the difficulty in controlling the weed. Little difference exists between ranchers with leafy spurge and those without leafy spurge when rating the economics of leafy spurge controls. Nearly 60 percent of all ranchers felt that "it pays" to use all three types of controls--herbicides, biological control, and grazing controls. The majority of ranchers with leafy spurge are planning on combating the weed with herbicides and biological agents in the future.

The reasons for not using the various leafy spurge controls generally fell into environmental, educational, and financial categories. In many cases, little can be done to remove the environmental constraints (especially those presented by topography, water, trees, and other circumstances). However, the financial constraints can be addressed through cost-share programs either offered locally or through state agencies. Other considerations for not using some controls included lacking sufficient knowledge to work with the various controls (e.g., grazing and biological controls). Those obstacles can be addressed by workshops, demonstrations, and other educational opportunities provided by universities and government agencies.

Ranchers depend heavily on their Extension Service or county extension agents and local weed control officers for information on weed control. The effectiveness and economics of herbicide and biological controls were the *types of information* most requested by ranchers. The most requested *forms of information* would be pamphlets/bulletins available locally, testimonials by other ranchers, and demonstration plots showing the effectiveness of various controls. Results indicate that existing information systems, already available to ranchers, would be the best way to route information on leafy spurge control.

The responses of ranchers to various statements on weed and range management indicated that ranchers, as a group, are generally very concerned about weeds in rangeland. They generally feel it makes economic sense to control weeds in rangeland, and feel very strongly that public land agencies are not doing enough to control weeds on public land. Many ranchers realize the difficulty in controlling leafy spurge, but are still planning on fighting the weed in the future.

How to Obtain Additional Information

This document is a summary of a more comprehensive report on the survey of ranchers in the **TEAM Leafy Spurge** counties. The main report contains additional information, including comparisons of attitudes and perceptions of ranchers by state. Additional copies of this summary and single copies of the main report, Ranch Operators' Perceptions of Leafy Spurge, are available free of charge. Please address your inquiry to Carol Jensen, Department of Agricultural Economics, P.O. Box 5636, North Dakota State University, Fargo, ND 58105-5636, (Phone 701-231-7441, Fax 701-231-7400), E-mail: cjensen@ndsuext.nodak.edu or these documents are available on the world wide web at http://agecon.lib.umn.edu/ndsu.html

Acknowledgments

This study contributes to an integrated pest management (IPM) demonstration project, titled *The Ecological Areawide Management of Leafy Spurge* (**TEAM Leafy Spurge**). Funding for this work was provided by **TEAM Leafy Spurge**. We also appreciate the input provided by our colleagues at North Dakota State University and those at cooperating institutions and agencies.

Sincere appreciation is extended to all the ranchers who took the time to complete and mail back the questionnaire. Without their input, this portion of the project would not have been possible.

TEAM Leafy Spurge
USDA ARS
USDA-FS
USDI-BLM
USDI-NPS
ND Dept. of Ag
MT Dept. of Ag
SD Dept. of Ag
ND State Univ.
MT State Univ.
SD State Univ.
Univ. WY
WY Weed & Pest
Producers
USDA APHIS
TEAM Leafy Spurge

1997-98 Dakota Performance Ram Test Summary

Prepared by Jeff Held, SDSU Extension Sheep Specialist

The 1997-98 Dakota Performance Ram Test concluded in early-March at the Hettinger Research and Extension Center in Hettinger, ND. More than fifty rams were tested for wool, growth and carcass traits over the 150-day testing period. Five breeds were represented in the program: Rambouillet, Columbia, Merino, Corriedale and Polypay, yet the majority were Rambouillets. Consignors were from North and South Dakota, Kansas and Missouri.

This impressive set of rams was on display during an open house at the Hettinger station. They were freshly sheared at that time, many commented on the high quality and uniformity among the rams coming off test. The data collected certainly supported these observations. Performance information on the top performing rams by breed is summarized in tables 1- 4.

PERFORMANCE SUMMARY

Top Indexing Individuals

In table 1 the top rams are ranked using an index formula developed by the American Rambouillet Sheep Association. The index includes performance measures on clean fleece weight, staple length, fleece fiber diameter and uniformity, and average daily gain. To reach a high index score an individual ram would need to excel in both wool and body growth. In essence the index provides a composite measure of overall performance. Rambouillet rams that index in the top 30% of the rams on test and meet specific wool and growth criteria are eligible for certificate of merit status. This year more than 50 % of the top indexing Rambouillet rams met certification criteria.

Growth Performance

Table 2 lists the top rams by breed for growth performance. The average growth rate for all rams on test was at 0.80 pounds per day. Excellent growth performance considering they come on test at or above 100 pounds. Burton Anderson Family from Highmore, SD consigned the highest growth performance ram. Test ID #40 had an average daily gain of 1.07 pounds, this ram was also the top indexing Rambouillet ram. Selecting sires with demonstrated superior growth traits can significantly increase annual pounds of lamb produced per ewe. A ram adding 0.05 pounds per day of body weight gain to his offspring would produce 5 more pounds of lamb in 100 days. In a 500-head ewe flock with a 120% lamb crop weaned in the fall off grass, total pounds of lamb produced would increase by 3,000 pounds.

Clean Fleece Production

Clean fleece weight is an important economic consideration in a sheep operation. In table 3 the top rams for clean wool production are given. A Columbia ram from Paul Noeske, Jr., Oriska, ND produced the greatest quantity of clean pounds of wool for any ram on test. The calculated 365-day clean wool harvest was at 17.5 pounds, more than 5 pounds greater than the average for the Columbia breed. As in past tests the variation in clean fleece weight from ram to ram within a breed is high. For example the clean fleece weights for Rambouillet rams ranged from 17.4 to 8.4 pounds, more than a two-fold range from top to bottom. Interestingly, the results show that higher clean fleece weights tend to correspond with medium grades fleeces, grade 58's plus or minus a grade. Ideally producers would like to identify rams with finer grades yet excel in clean wool production. Using this performance test program we can identify rams which combine those traits.

Carcass Merit

Ultrasound measurements for fat depth and ribeye area are reported in Table 4. These measurements were taken at the beginning and end of the test. Both traits were measured at the same location on the live animal, the juncture of the 12-13 th rib. These data are not used in the index equation reported earlier, but animals were ranked by final ribeye area within a breed. We would expect larger ribeye measurements and lower fat thickness measurements coupled with higher growth performance rams. Generally the results show a trend supporting the expected relationship. In the future we expect to calculate lean growth per day on test to better express differences among rams rather than ranking based solely on actual size. Ultrasound information on carcass merit in cattle and swine is used extensively for selection decisions. This technology is taking hold in the sheep industry, it provides producers another tool for selection of superior sires.

Acknowledgements

The ram testing committee truly appreciates the support for the ram test given by consignors, producers and academic staff at North and South Dakota State University. A special thanks to Tim Faller, Superintendent at the Hettinger Research and Extension Center at Hettinger, ND and Dave Pearson, Shepherd at the Hettinger location. Their assistance and cooperation was certainly a key to the success of the ram test program this past year.

For those producers interested in a complete set of final ram test results and consignor information contact Jeff Held, SDSU Extension Sheep Specialist, Box 2170, Brookings, SD 57007.

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Table 1 T ID Producer	ADG	CL FL 365-d	SIDE GRADE	BRITCH GRADE	STAPLE LENGTH	Index	Index Ratio	ELIGIBLE FOR MERIT
Rambouillets								
40 ANDERSON FAM.	1.07	16.5	62	60	4.4	140.69	134.94	YES
4 P. NOESKE	0.91	17.4	58	54	4.5	131.32	125.96	NO
30 VEIT	0.94	16.4	60	56	5.3	129.67	124.37	YES
36 D. BENZ	0.90	15.9	58	54	5.2	125.46	120.33	NO
19 J&T LYNN	0.83	13.6	62	60	4.9	117.64	112.84	YES
41 ANDERSON FAM.	0.82	14.0	56	54	4.7	115.56	110.84	NO
5 CIRCLE CROSS	0.90	13.0	56	54	4.4	112.83	108.22	NO
9 K&M HAGBOM	0.81	12.8	60	60	4.9	112.18	107.59	YES
27 L. CHAPMAN	0.99	11.4	60	56	4.6	111.73	107.17	YES
33 COOK	0.86	11.9	60	58	5.4	111.01	106.47	YES
34 COOK	0.81	13.1	54	54	4.3	110.24	105.73	NO
16 RM MERTZ	0.91	11.3	62	60	4.1	109.62	105.14	YES
2 WOOLY ACRES	0.74	14.3	58	58	4.9	109.12	104.66	NO
Overall Averages	**0.80**	**12.16**	**60**	**56**	**4.3**	**104.26**	**100.00**	
COLUMBIA								
103 H. OSBORNE	0.96	17.5	54	50	4.6	135.79	129.85	
102 D. OSBORNE	0.83	12.7	50	50	4.2	109.99	105.18	
105 HETTINGER	0.82	13.2	50	48	4.9	108.60	103.84	
104 HETTINGER	0.81	9.8	58	58	4.4	100.80	96.38	
101 NDSU	0.81	10.0	50	48	3.7	92.53	88.47	
100 NDSU	0.55	9.1	56	54	4.9	79.74	76.25	
Averages	**0.80**	**12.1**	**54**	**50**	**4.4**	**104.60**	**100.00**	
CORRIEDALE								
201 JIM CROUCH	0.88	10.8	50	46	4.9	103.90	104.03	
200 M&M LVSTK	0.79	12.7	54	46	3.9	95.85	95.97	
Averages	**0.83**	**11.8**	**50**	**46**	**4.4**	**99.88**	**100.00**	
MERINO								
300 SCHALESKY	0.52	11.0	70	64	5.3	97.60	100.00	
Averages	**0.52**	**11.0**	**70**	**64**	**5.3**	**97.60**	**100.00**	
POLYPAY								
400 PRAIRIE ROSE	0.74	10.4	50	44	5.5	89.33	123.86	
401 PRAIRIE ROSE	0.59	6.7	56	46	3.8	54.90	76.12	
Averages	**0.67**	**8.6**	**54**	**44**	**4.7**	**72.12**	**100.00**	

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Table 2 T ID Producer	INITIAL WEIGHT	FINAL WEIGHT	TEST GAIN	ADG	Index	ADG Ratio
Rambouillets						
40 ANDERSON FAM.	111	261	150	1.07	140.69	133.93
6 CIRCLE CROSS	129	272	143	1.02	106.42	127.68
27 L. CHAPMAN	114	253	139	0.99	111.73	124.11
30 VEIT	140	271	131	0.94	129.67	116.96
4 P. NOESKE	138	266	128	0.91	131.32	114.29
16 RM MERTZ	106	233	127	0.91	109.62	113.39
36 D. BENZ	111	237	126	0.90	125.46	112.50
5 CIRCLE CROSS	118	244	126	0.90	112.83	112.50
17 RM MERTZ	90	215	125	0.89	105.42	111.61
21 J&T LYNN	93	218	125	0.89	105.07	111.61
38 GERMANN	125	248	123	0.88	104.09	109.82
42 ANDERSON FAM.	80	202	122	0.87	105.55	108.93
33 COOK	125	245	120	0.86	111.01	107.14
22 MATT BENZ	154	272	118	0.84	108.75	105.36
20 J&T LYNN	106	224	118	0.84	108.21	105.36
Overall Averages	**115**	**227**	**112.4**	**0.80**	**104.26**	**100.00**
COLUMBIA						
103 H. OSBORNE	110	244	134	0.96	135.79	119.64
102 D. OSBORNE	116	232	116	0.83	109.99	103.57
105 HETTINGER	101	216	115	0.82	108.60	102.68
104 HETTINGER	99	213	114	0.81	100.80	101.79
101 NDSU	114	228	114	0.81	92.53	101.79
100 NDSU	125	202	77	0.55	79.74	68.75
Averages	**111**	**223**	**112**	**0.80**	**104.60**	**100.00**
CORRIEDALE						
201 JIM CROUCH	131	254	123	0.88	103.90	105.85
200 M&M LVSTK	120	230	110	0.79	95.85	94.66
Averages	**126**	**242**	**117**	**0.83**	**99.88**	**100.00**
MERINO						
300 SCHALESKY	92	165	73	0.52	97.60	100.00
Averages	**92**	**165**	**73**	**0.52**	**97.60**	**100.00**
POLYPAY						
400 PRAIRIE ROSE	100	204	104	0.74	89.33	110.87
401 PRAIRIE ROSE	94	177	83	0.59	54.90	88.49
Averages	**97**	**191**	**94**	**0.67**	**72.12**	**100.00**

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TABLE 3 T ID Producer	GREASE FLEECE 365-d	% YIELD	CLEAN FLEECE 365-d	SIDE GRADE	BRITCH GRADE	STAPLE LENGTH	Index	CLEAN FLEECE Ratio
Rambouillets								
4 P. NOESKE	33.5	51.9	17.4	58	54	4.5	131.32	142.93
40 ANDERSON FAM.	27.9	55.4	16.5	62	60	4.4	140.69	135.63
30 VEIT	30.2	58.2	16.4	60	56	5.3	129.67	135.25
36 D. BENZ	29.8	50.3	15.9	58	54	5.2	125.46	130.72
2 WOOLY ACRES	25.6	55.9	14.3	58	58	4.9	109.12	117.60
41 ANDERSON FAM.	23.3	59.1	14.0	56	54	4.7	115.56	115.32
11 ERK BROS.	23.7	58.7	13.9	58	50	4.9	107.26	114.51
23 MATT BENZ	26.5	51.5	13.7	60	56	4.2	102.57	112.28
19 J&T LYNN	23.3	58.5	13.6	62	60	4.9	117.64	111.88
31 VEIT	22.1	54.4	13.5	60	56	4.5	92.62	110.83
39 ANDERSON FAM.	24.2	53.9	13.4	58	56	4.5	101.86	110.19
12 ERK BROS.	26.0	50.6	13.2	60	56	4.1	103.95	108.38
34 COOK	25.6	51.3	13.1	54	54	4.3	110.24	108.13
5 CIRCLE CROSS	23.3	55.9	13.0	56	54	4.4	112.83	106.91
18 J&T LYNN	23.3	55.8	13.0	60	56	4.6	103.40	106.72
Overall Averages	**22.9**	**53.0**	**12.16**	**60**	**56**	**4.3**	**104.26**	**100.00**
COLUMBIA								
103 H. OSBORNE	31.2	47.8	17.5	54	50	4.6	135.79	144.22
105 HETTINGER	23.7	56.0	13.2	50	48	4.9	108.60	109.09
102 D. OSBORNE	24.7	49.0	12.7	50	50	4.2	109.99	104.72
101 NDSU	20.9	44.4	10.0	50	48	3.7	92.53	82.68
104 HETTINGER	19.1	51.4	9.8	58	58	4.4	100.80	81.32
100 NDSU	18.6	61.0	9.1	56	54	4.9	79.74	75.34
Averages	**23.0**	**51.6**	**12.1**	**54**	**50**	**4.4**	**104.60**	**100.00**
CORRIEDALE								
200 M&M LVSTK	20.5	60.9	12.7	54	46	3.9	95.85	107.44
201 JIM CROUCH	17.2	63.0	10.8	50	46	4.9	103.90	91.53
Averages	**18.8**	**62.0**	**11.8**	**50**	**46**	**4.4**	**99.88**	**100.00**
MERINO								
300 SCHALESKY	20.5	53.5	11.0	70	64	5.3	97.60	100.00
Averages	**20.5**	**53.5**	**11.0**	**70**	**64**	**5.3**	**97.60**	**100.00**
POLYPAY								
400 PRAIRIE ROSE	15.8	74.3	10.4	50	44	5.5	89.33	121.45
401 PRAIRIE ROSE	11.6	57.8	6.7	56	46	3.8	54.90	77.91
Averages	**13.7**	**66.1**	**8.6**	**54**	**44**	**4.7**	**72.12**	**100.00**

1997-98 Dakota Ram Test- Carcass Merit

Table 4

TID	Producer	INITIAL WT	FINAL WT	TEST GAIN	ADG	INITIAL REA	FAT DEPTH	Final REA	FAT DEPTH
Rambouillets									
27	LENARD CHAPMAN	114	253	139	0.99	2.25	0.20	4.60	0.28
6	CIRCLE CROSS	129	272	143	1.02	2.30	0.20	4.20	0.20
3	PAUL D. NOESKE	142	246	104	0.74	2.60	0.24	4.00	0.31
35	TW & F SCHALESKY	121	236	115	0.82	2.60	0.16	3.80	0.20
17	RM MERTZ	90	215	125	0.89	2.00	0.20	3.80	0.28
26	LENARD CHAPMAN	93	208	115	0.82	1.70	0.16	3.80	0.28
41	ANDERSON FAMILY	125	240	115	0.82	2.50	0.16	3.80	0.31
14	JOHN BODE	134	236	102	0.73	2.60	0.24	3.70	0.35
37	GERMANN RANCH	128	236	108	0.77	2.10	0.20	3.60	0.31
30	VEIT RAMBOUILLETS	140	271	131	0.94	2.60	0.20	3.60	0.35
34	COOK SISTERS	138	251	113	0.81	2.30	0.20	3.60	0.35
23	MATT BENZ	163	263	100	0.71	2.80	0.20	3.60	0.39
40	ANDERSON FAMILY	111	261	150	1.07	2.50	0.12	3.60	0.45
4	PAUL D. NOESKE	138	266	128	0.91	2.60	0.28	3.55	0.28
12	ERK BROTHERS	102	214	112	0.80	2.20	0.20	3.50	0.24
Overall Averages		**115**	**227**	**112**	**0.80**	**2.22**	**0.21**	**3.44**	**0.32**
COLUMBIA									
103	HAROLD OSBORNE	110	244	134	0.96	2.20	0.20	3.60	0.24
105	HETTINGER	101	216	115	0.82	2.10	0.20	3.60	0.28
101	NDSU	114	228	114	0.81	2.60	0.16	3.40	0.20
104	HETTINGER	99	213	114	0.81	2.00	0.16	3.40	0.28
102	DON OSBORNE	116	232	116	0.83	2.20	0.16	3.15	0.28
100	NDSU	125	202	77	0.55	2.50	0.20	2.95	0.20
Averages		**111**	**223**	**112**	**0.80**	**2.27**	**0.18**	**3.35**	**0.24**
CORRIEDALE									
200	M&M LIVESTOCK	120	230	110	0.79	2.20	0.28	3.50	0.39
201	JIM CROUCH	131	254	123	0.88	2.50	0.20	3.05	0.39
Averages		**126**	**242**	**117**	**0.83**	**2.35**	**0.24**	**3.28**	**0.39**
MERINO									
300	TW & F SCHALESKY	92	165	73	0.52	2.30	0.24	3.30	0.35
Averages		**92**	**165**	**73**	**0.52**	**2.30**	**0.24**	**3.30**	**0.35**
POLYPAY									
401	PR ROSE POLYPAY	94	177	83	0.59	2.20	0.20	2.90	0.20
400	PR ROSE POLYPAY	100	204	104	0.74	2.15	0.24	2.60	0.24
Averages		**97**	**191**	**94**	**0.67**	**2.18**	**0.22**	**2.75**	**0.22**

Abbreviations:
TID=Test identification
FID=Flock identification
H/P=Horned or Polled
B Date=Birth date
ADG=Average daily gain
Fat Depth=External fat at 12-13th rib
REA = Ribeye area, expressed as square inches

** Weight measurements = pounds

Energy value of field peas (*Pisum sativum*) in lamb finishing diets.

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Introduction

Acres planted into field peas in North Dakota have dramatically increased from 14,545 acres in 1994 to 102,849 acres in 1997. With the increased availability of field peas for use in livestock rations, there is a need to understand how field peas compare as a feedstuff to other traditionally used feedstuffs in North Dakota. The current research that has been done comparing field peas to barley and soybean meal (SBM) shows that cattle and lambs perform similarly when field peas replace barley and SBM.

Poland and Faller (1998) replaced barley and (SBM) with field peas in a lamb finishing trial. They concluded that field peas can be a suitable replacement for SBM and barley. Poland and Landblom (1996) had similar conclusions when field peas replaced SBM and barley being fed to growing calves.

The objective of this experiment was to evaluate the energy content of field peas in lamb finishing diets.

Materials and Methods

One hundred sheep were allotted to 20 pens in a randomized complete block design. Four diets were fed where peas replaced corn at 0, 15, 30, or 45% of the diet. The diet contained 75% dry rolled corn or peas, 10% alfalfa hay, 5% de-sugared molasses (CSB), and 10% supplement. Diets (Table 1) contained a minimum of 15% crude protein, .70% calcium, .36% phosphorus, 1.22% potassium, 1.74 Ca:P and 25 g lasolacid/T. Diets contained .20% blood meal and .80% feather meal to ensure that metabolizable protein did not limit gain. Diets also contained 6.0% soybean meal, .50% ammonium chloride and .19% urea. Vitamins and minerals were included to meet or exceed NRC recommendations. Sheep were blocked by weight and sex and allotted randomly to one of four treatments (5 pens/treatment).

Initial and final weights were an average of two consecutive day weights. Performance measurements (n = 5) included average daily gain (ADG), dry matter intake (DMI), and feed/gain (F/G). The lambs were slaughtered on August 18. Due to the selection of ewe lambs for replacement ewes only carcass data from the ram lambs was used to evaluate treatment effect. Ram lambs (3 pens/treatment) were slaughtered on d 89. Carcass characteristics (n = 3) included hot carcass weight (HCW), leg score, conformation score, flank streaking, marbling, color score, ribeye area (REA), fat thickness, body wall thickness, yield grade, and dressing percentage.

Results and Discussion

All lambs were used in the evaluation of performance measurements (Table 2). DMI had a cubic response (P = .02) where there was an increase in DMI from the 0% field pea diet (3.50 lb/d) to the 15% field pea diet (3.64 lb/d) and then a decrease for the 30% field pea diet (3.42 lb/d). All other performance characteristics were not affected by treatment (P > .14). Only ram lambs were used in the evaluation of carcass characteristics (Table 3). Flank streaking had a quadratic response (P = .10). There was a decrease in flank streaking from the 0% diet to the 15% diet and then an increase in flank streaking for the 45% diet resulting in a quadratic response. There were no other carcass characteristics affected by treatment (P > .18). Based on lamb performance, there was a linear increase (P = .10) in dietary NE_m and NE_g as percentage of field peas in the diet increased (Table 4). The calculated NE_m and NE_g of field peas were 116 Mcal/cwt and 83 Mcal/cwt, respectively. Field peas have an NE_g 24% greater than that of corn (83 vs 67 Mcal/cwt) when fed to feedlot lambs.

References

Poland, W.W. and D.G. Landblom. 1996. Feeding value of field pea and hull-less oat in growing calf diets. ND Cow/calf conference and beef cattle and range research report, North Dakota State University, pp3-11.

Poland, W.W. and T.C. Faller. 1998. Field pea as a feedstuff for growing lambs. Western Dakota Sheep Day Report. North Dakota State University, pp16-20.

Table 1. Diet composition and nutrient composition[a]

	% Field Peas in Diet (DM Basis)			
Item	0	15	30	45
Ingredient				
Corn, %	75	60	45	30
Field Peas, %	0	15	30	45
Alfalfa Hay, %	10	10	10	10
CSB, %	5	5	5	5
Supplement, %	10	10	10	10
Nutrient				
Crude Protein,%	15.0	17.1	19.2	21.3
Calcium, %	.70	.70	.70	.70
Phoshporus, %	.36	.37	.39	.40
Ca:P	1.96	1.88	1.80	1.74
Potassium, %	1.22	1.32	1.43	1.53

[a] Nutrient compositions are calculated from book values

Table 2. Effects of field pea on feedlot performance

Item	Percentage Field Peas in Diet (dry matter basis) 0	15	30	45	SEM
Weight, lb					
Initial	73.8	75.3	72.1	77.1	2.8
Final	134.9	141.4	137.9	144.4	3.6
ADG, lb/day	.69	.74	.74	.76	.04
DMI, lb/day	3.50	3.64	3.42	3.57	.06
Efficiency					
Gain/Feed	.197	.205	.218	.213	.01
Feed/Gain [a]	5.09	4.88	4.59	4.71	--

[a] Feed/Gain was calculated as Gain/Feed, F/G is a reciprocal of G/F.

Table 3. Effects of field pea on carcass characteristics

Item	Percentage Field Peas in Diet (dry matter basis) 0	15	30	45	SEM
Flank Streaking[a]	396	359	357	374	14
Marbling[a]	379	392	385	383	13
REA, in^2	2.73	2.76	2.61	2.67	.08
Fat, in	.22	.18	.20	.19	.03
Bodywall, in [b]	.87	.84	.78	.81	.09
HCW, lb	70.9	72.4	69.0	75.5	3.0

[a] 300 equals slight, 400 equals small.

[b] Bodywall thickness is measured at 12[th] rib and is an indicator of carcass leanness.

Table 4. Effects of field peas on dietary NE_m and NE_g

Item	Percentage Field Peas in Diet (dry matter basis) 0	15	30	45	SEM
NE_m,Mcal/cwt [a]	94.5	98.2	100.9	102.3	3.2
NE_g,Mcal/cwt [a]	64.1	67.3	70.0	70.9	2.7

[a] Dietary NE_m and Dietary NE_g.

SECTION II
MANAGEMENT SECTION

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40TH ANNUAL SHEEP DAY

HETTINGER RESEARCH EXTENSION CENTER
HETTINGER, NORTH DAKOTA

FEBRUARY 10, 1999

FLOCK CALENDAR OUTLINE

The following guidelines are neither inclusive nor intended to fit every sheep operation. Each operation is different, therefore each "calendar of events" should be tailored to each flock's needs.

PRIOR TO BREEDING

1. Bag and mouth ewes and cull those that are not sound.

2. Replace culled ewes with top-end yearlings or ewe lambs.

3. Keep replacement ewe lambs on growing ration.

4. Evaluate sires:

   a. Be sure they are vigorous, healthy and in good breeding condition.

   b. Rams should be conditioned at least a month before the breeding season. Flush rams in poor condition.

   c. Allow at least two mature rams (preferably three) or four buck lambs per 100 ewes.

   d. Utilize production records to evaluate anticipated breeding ability.

5. Flush ewes:

   a. 1 pound grain/day two weeks to five weeks before breeding (usually 17 days).

   b. If ewes are over-conditioned, the effect of flushing will be lessened.

6. Vaccinate ewes for vibriosis and enzootic abortion (EAE).

7. Identify all ewes and rams with ear tags, paint brands or tattoos.

BREEDING

1. The ovulation rate of a ewe tends to be lowered at the first part of the breeding season. Vasectomized or teaser rams run with the ewes through the first heat period tend to stimulate them and increase the ovulation rate at the second heat period.

2. Use a ram marking harness or painted brisket to monitor breeding. Soft gun grease with paint pigment mixed in works well for painting the brisket. A color sequence of orange, red and black is recommended with colors being changed every 17 days.

LAMBING

1. Be prepared for the first lambs 142 days after turning the rams in with the ewes, even though the average pregnancy period is 148 days.

2. Watch ewes closely. Extra effort will be repaid with more lambs at weaning time. Saving lambs involves a 24-hour surveillance. Additional help at this time is money well spent.

3. Put ewe and lambs in lambing pen (jug) after lambing (not before).

4. Grain feeding the ewes during the first three days after lambing is **not** necessary!

5. Be available to provide assistance if ewe has troubles.

6. Disinfect lamb's navel with iodine as soon after birth as possible.

7. Be sure both teats are functioning and lambs nurse as soon as possible.

8. Use additional heat sources (heat lamps, etc.) in cold weather.

9. Brand ewe and lambs with identical number on same sides. Identify lambs with ear tags, tattoos or both.

10. Turn ewe and lambs out of jug as soon as all are doing well (one to three days).

11. Bunch up ewes and lambs in small groups of four to eight ewes and then combine groups until they are a workable size unit.

12. Castrate and dock lambs as soon as they are strong and have a good start (two days to two weeks of age). Use a tetanus toxoid if tetanus has been a problem on the farm (toxoids are not immediate protection. It takes at least 10 days for immunity to build).

13. Vaccinate lambs for soremouth at one to two weeks of age if it has been a problem in the flock.

14. Provide a place for orphaned lambs. Make decision on what lambs to orphan as soon after birth as possible for the best success. Few ewes can successfully nurse more than two lambs.

3. Leave rams in NO LONGER than 51 days (35 days is more desirable).

   a. An exception may be with ewe lambs. Allowing them four heat cycles or 68 days may be beneficial.

4. Remove rams from ewes after the season (don't winter rams with ewes).

PRIOR TO LAMBING - EARLY PREGNANCY (First 15 Weeks)

1. Watch general health of ewes. If possible sort off thin ewes and give them extra feed so they can catch up.

2. Feed the poor quality roughage you have on hand during this period, saving the better for lambing.

3. An exception to the above is feeding pregnant ewe lambs. They should receive good quality roughage and grain (about 20 percent of the ration) during this period.

LAST SIX WEEKS BEFORE LAMBING

1. Trim hooves and treat for internal parasites.

2. Six to four weeks before lambing feed 1/4 to 1/3 pound grain/ewe/day.

3. Shear ewes before lambing (with highly prolific ewes at least a month before is preferred). Keep feeding schedule regular and watch weather conditions immediately after shearing (cold).

4. Vaccinate ewes for enterotoxemia.

5. Control ticks and lice immediately after shearing.

6. Four weeks before lambing increase grain to 1/2 to 3/4 pound/ewe/day (usually done immediately after shearing).

7. Give A-D-E preparations to ewes if pastures and/or roughage are or have been poor quality.

8. Feed selenium-vitamin E or use an injectable product if white muscle is a problem. **Caution** Don't do both.

9. Check facilities and equipment to be sure everything is ready for lambing.

10. Two weeks before lambing increase grain to 1 pound per ewe per day.

REARING LAMBS ARTIFICIALLY (ORPHANS) - MANAGEMENT TIPS

Within 2 to 4 hours after birth, decide which lambs among those from multiple births you should remove. Look for the weaker, or smaller ones to choose for artificial rearing. It is important to make this decision early. Relatively weak lambs remaining with the ewes can experience more stress than those reared artificially. Consider the following tips:

* It is essential that newborn lambs receive colostrum milk. Cow's colostrum will work if ewe's milk is not available. Do not dilute with water or warm too quickly if colostrum is frozen.

* Lambs should be removed from sight and hearing distance of ewe.

* Provide a warm, dry, draft-free area to start lambs.

* Use a good milk replacer that is 30% fat and at least 24% protein. Each lamb will require from 15 to 20 pounds of replacer to weaning.

* Use good equipment. Self priming nipple and tube assemblies have been found to be excellent for starting lambs.

* Lambs may require some assistance the first day or two to teach them to nurse on whatever feeding device is used.

* Start on nurser quickly. Young lambs start easier.

* Self feed cold milk replacer after lambs are started. Milk replacers should be mixed with warm water for best results and then cooled down. Lambs fed cold milk grow well with less problems from scours and other digestive disturbance. Cold milk keeps better too.

* There is a Formaldehyde solution commercially available that retards bacterial growth in milk (1 cc/gallon milk).

* Hang a light over the milk replacer feeding device and dry ration feeder.

* Avoid placing young lambs with older lambs, as they may be pushed aside and not be able to obtain milk replacer. Remember that lambs nursing ewes drink 25 to 40 times per 24 hours. Best results have been obtained when lambs are fed in groups of 3 to 4 initially. After lambs are successfully trained, they can be handled in groups of 25.

* Inject lambs in the first few days with Iron Dextran, Vitamin A-D-E, and Selenium-Vitamin E. At 15 days of age, vaccinate for overeating (Colostridum perfringen type C & D).

END OF LAMBING TO WEANING

1. Feed ewes according to number of lambs suckling. Ewes with twins and triplets should receive a higher plane of nutrition.

2. Provide creep feed for lambs (especially those born during the winter and early spring).

3. Vaccinate lambs for overeating at five weeks and seven weeks of age.

WEANING

1. Wean ewes from lambs, not lambs from the ewes. If possible, remove ewes from pen out of sight and sound of lambs. If lambs have to be moved to new quarters, leave a couple of ewes with them for a few days to lead the lambs to feed and water locations.

2. Lambs should be weaned between 50 and 60 days of age or when they weigh at least 40 pounds and are eating creep and drinking water. The advantage of early weaning is that the ewe's milk production drops off to almost nothing after eight weeks of lactation.

3. Grain should be removed from the ewe's diet at least one week prior to weaning and low quality roughage should be fed. Restriction of hay and water to the ewe following weaning lessens the chance of mastitis to occur. Poorer quality roughage should be fed to the ewes for at least 10 to 14 days following weaning.

4. Handle the ewes as little as possible for about 10 days following weaning. Tight udders bruise easily. If possible, bed the area where the ewes will rest heavily with straw to form a soft bed for the ewes to lay on.

WEANING TO PRE-BREEDING

1. If ewes go to pasture, treat for internal parasites.

2. Feed a maintenance ration to the ewes. Put ewe lambs that lambed back on a growing ration once they have quit milking.

3. Adjust ewe's conditions so they can be effectively flushed for next breeding season. Don't get ewes too fat prior to breeding.

* Provide lambs a high-quality creep feed as soon as possible. Provide ample fresh water in front of lambs at all times. Do not feed hay or oats the first three weeks of age as it encourages bloat. Caution! Do not feed leafy alfalfa until two weeks after weaning, as it may encourage bloat.

* Wean lambs abruptly at 21-30 days of age. When to wean depends upon whether lambs are eating creep feed and drinking water. Newly weaned lambs will go backwards for several days. Don't be alarmed, they will make compensating gains later on.