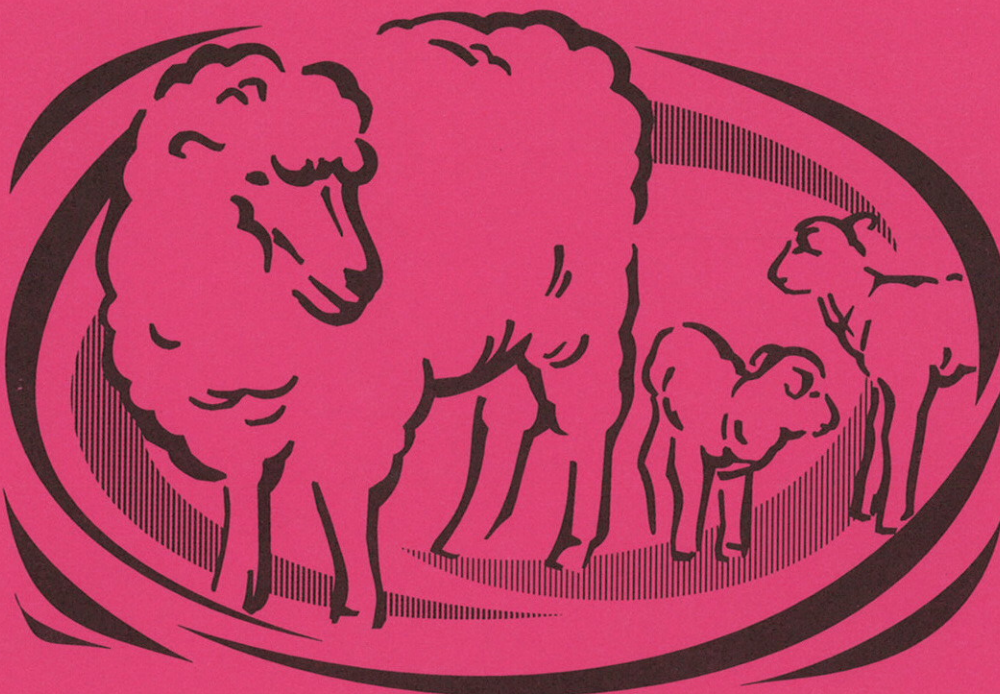
REPORT NO. 39



WESTERN DAKOTA SHEEP DAY

February 11, 1998

HETTINGER ARMORY

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

February 11, 1998

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
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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 $2.30 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 Mr. Roger Haugen Dr. Woodrow Poland Mr. Dan Nudell Mr. Jack Dahl Dr. Jeff Held
12:00 NOON	LUNCH: AMERICAN LAMB DINNER
1:00 PM	WELCOME North Dakota State University
1:10 PM	"MEETING FLOCK HEALTH NEEDS WITH DECLINING RESOURCES" Dr. Jay Bobb, Veterinarian Pipestone Veterinary Clinic Pipestone, Minnesota
1:45 PM	"HOW WILL THE FUTURE EFFECT MY AG ENTERPRISE?" Dr. David Saxowsky NDSU Department of Agricultural Economics Fargo, North Dakota
2:20 PM	"CRITICAL SUCCESS FACTORS TO A PROFITABLE SHEEP ENTERPRISE" Dan Nudell, Research Economist Hettinger Research Extension Center
2:55 PM	"WHY SHEEP WORK AT MY PLACE" Dennis Kubischta, Producer Hope, North Dakota
3:20 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 "SPINNING AND KNITTING" and "LAMB COOKERY".

SHEEP DAY DIGEST

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

SECTION I
REPORTS OF RESEARCH IN PROGRESS AT THE HETTINGER RESEARCH AND EXTENSION CENTER AND MAIN STATION NORTH DAKOTA STATE UNIVERSITY

MR. TIMOTHY C. FALLER
HETTINGER RESEARCH EXTENSION CENTER

DR. PAUL BERG
DEPT. OF ANIMAL & RANGE SCIENCES

MR. ROGER HAUGEN
DEPT. OF ANIMAL & RANGE SCIENCES

MR. DAN NUDELL
HETTINGER RESEARCH EXTENSION CENTER

JACK DAHL
HETTINGER RESEARCH EXTENSION CENTER

DR. WOODROW POLAND
DICKINSON RESEARCH EXTENSION CENTER

DR. BERT MOORE
DEPT. OF ANIMAL & RANGE SCIENCES

DR. DALE REDMER
DEPT. OF ANIMAL & RANGE SCIENCES

WES LIMESAND
DEPT. OF ANIMAL & RANGE SCIENCES

DR. LARRY REYNOLDS
DEPT. OF ANIMAL & RANGE SCIENCES

AT THE
39TH ANNUAL SHEEP DAY

HETTINGER RESEARCH EXTENSION CENTER
HETTINGER, NORTH DAKOTA

FEBRUARY 11, 1998

NORTH DAKOTA STATE UNIVERSITY
1997 ANNUAL REPORT TO 38TH ANNUAL SHEEP DAY

Objective 2: Evaluate genetic and environmental strategies to improve the efficiency of lean tissue accretion in lambs.

A. Lean lamb production in known sire breeds through implementation of an expected progeny difference formula (P.T. Berg, T.C. Faller, and N.M. Maddux).

OBJECTIVE

Evaluate genetic control of lean tissue through the identification of sire lines within breeds which are capable of producing rapidly growing, lean lambs at heavy slaughter weights.

PROCEDURE

The first portion of the project was to establish a dependent variable which could be used for evaluating techniques to predict lean mass. Carcasses were fabricated into NAMPS specifications for shoulder, rack, loin, and leg and weighed. The wholesale cuts were then denuded of subcutaneous fat so that muscle was exposed over 85% of the surface and weighed again. The sum weight of the four major cuts represents the weight of the lamb carcass which is actually for sale (with the exception of the stew or ground lamb produced from the breast shank and foreshank). This weight (TRP) was used as the dependant variable in the establishment of all the prediction formulas.

The second portion of the project formulated prediction equations using BIA live and carcass readings and anatomical measurements. Data has been compiled for groups with known breed and sire. A Columbia flock was randomly assigned to three different groups to test the effectiveness of BIA as a live animal selection tool. The TRP index, based on live BIA readings, was used to rank the lambs at 2, 4, and 6 months of age. Only the 6 month readings prove valuable in lean tissue prediction. The groups were assigned to a high lean (HL), low lean (LL), or control (CT) group based on the ranks in a divergent selection trial. Those assigned to the HL group possessed high rates of lean tissue accretion, based on BIA index readings. The LL group utilized those lambs with low lean tissue accretion, based on the BIA index. A control flock of similar size was maintained.

RESULTS

490 lambs have been processed and evaluated during this project. Individual carcass measurements were taken and evaluated as TRP predictors of both pounds and percent of carcass weight. Certainly, within the fabrication sequence of carcass processing actual wholesale cut weights are valuable as TRP predictors, but are not efficient in predicting percent TRP. Also, carcasses that are cut out and peeled of fat are limited due to time and space restraints. Therefore, the establishment of two formulas using BIA and one utilizing only anatomical data were developed. These formulas proved to be very accurate and do not depreciate the value of the carcasses. One BIA prediction formula is designed for robotic use and is not presented here. The BIA formula utilized in this data set uses the similar anatomical positions of the electrode placement as done on the live animal. This formula, having an R^2 of .91 is as follows:

BIA Lean C = 6.7178 - (.4818*cold carc wt) - (.0314*Rs) - (.0481*Xc) + (.254*Ln) + (.0223*Temp)

(The R^2 value represents the proportion of the variation in the dependent variable which is explained by the independent variable(s).)

The correlation between actual cutout and anatomically predicted retail product has an R^2 of .94. This suggests that predictions of TRP based on anatomical measures are satisfactory. Table 1 and 2 show averages and summaries of various measurements for live, carcass, and cutout data. Trimmed retail product may be predicted for carcass data using the following formula:

TRP # = 4.8 + (0.58 * cold carc wt) + (1.39 * ribeye area) - (7.36 * adj fat) - (5.87 * body wall thick)

Table 1. Slaughter Cutout Data.

Trait	Average	Trait	Average	
Live Wt	129.25	Conformation Score	10.79	
Cold Carc Wt	69.11	Lean Color Score	3.20	
Ribeye Area	1.37	Trim Retail Product*	40.90#	61.55% Cold Carc
Adj Fat	.17'	BIA Pred Lean Avg	41.73#	61.92% Cold Carc
Body Wall Thickness	.76"	Anatomically Pred TRP	41.45#	61.78% Cold Carc
Kidney Fat	1.90 lbs	Volume (L^2/(Rs+Xc))TRP	41.78#	61.99% Cold Carc
USDA Yield Grade	2.28	Retail Product as % Live Wt	31.95%	
Marbling	3.95	Sum Value IMPS	$117.92	
Streaking	3.90	Sum Value TRP	$149.65	
Leg Score	10.94			

* Dependant Variable
Marb/Shnk - 3.00 - 3.99 = slight; 4.00 - 4.99 = small

Table 2. Wholesale Cutout Data.

Cut	# Untrim	% of Cut Wt	Trim Cut Wt	Trim WT % of Untrim
Shoulder	12.92	21.10	11.37	89.11
Rack	5.86	8.58	4.74	86.93
Loin	5.92	9.65	4.81	82.69
Leg	19.95	32.46	18.17	87.93
Breast, Flank	15.48	24.78	----	----

A set of 182 lambs with known sires have been processed and analyzed during the last two years. The lambs were evaluated by BIA immediately prior to slaughter. After a 24-hour chill, the carcasses were also evaluated by BIA using anatomical references for electrode placement similar to those used on the live animal. Relatively small numbers of lambs within each sire group has limited the evaluation to the Columbia breed at this time. Sire groups containing five or more observations are listed in Table 3. The data shows that there is a tremendous difference within the breed sires. The total retail product between the high and low sire is $31.99. The retail product that is used for calculating the TRP value is as follows:

$ = (trim shoulder wt*$2.30) + (trim rack*$4.32) + (trim loin*$3.49) + (breast, flank, etc.*$0.85*0.5)

$ prices are from retail stores in the Fargo-Moorhead area.
Leg price is "boneless," wt is "bone in," hence the multiplier of 0.9 to get boneless wt.
Breast, shank, plate, and flank yield approximately 0.5 of the wt as boneless stew/ground meat.

Table 3. Columbia Sire Average Summary.

Sire	Live Wt	Carc Wt	Eye	Fat	BW Th	Pred # Ln	Pred % Ln	Ana # Ln	Ana % Ln	Pred # Ln	TRP $
1	146.1	78.1	2.40	.20	0.80	46.7	60.5	46.4	60.7	42.2	166.2
2	124.2	65.8	2.30	.15	0.80	40.2	62.1	40.5	62.8	40.6	145.5
3	136.6	72.0	2.20	.20	0.80	44.0	62.4	42.8	60.6	43.4	155.7
4	123.0	60.0	2.30	.12	0.80	36.0	62.1	37.4	64.6	40.0	134.3
5	125.2	60.8	2.10	.18	0.80	38.0	64.6	37.7	63.5	40.3	135.5
6	128.8	67.5	2.10	.30	0.80	39.7	60.0	39.2	59.6	NA	144.9
7	142.7	71.7	2.60	.18	0.70	43.4	62.5	43.5	62.8	NA	160.2
8	126.9	69.0	2.30	.19	0.80	40.9	61.5	40.5	60.8	NA	146.0
9	132.3	66.7	2.10	.16	0.80	41.6	63.9	42.2	64.9	43.0	152.0
10	125.0	64.6	2.20	.11	0.70	37.9	60.9	41.2	66.1	40.9	148.4
11	126.2	67.2	2.20	.20	0.70	40.7	62.0	40.5	61.6	NA	145.2
12	126.0	67.2	2.10	.20	0.70	40.6	61.8	39.9	61.0	NA	140.2
13	126.2	67.2	2.20	.20	0.70	40.7	62.0	40.5	61.6	NA	145.2

Regression was run on this data set to develop a formula that could predict pounds of lean muscle mass on the live animal. Using this formula, with N = 182, R^2 was .80. The formula is as follows:

BIA lean L = -.2634 + (.3190*Liv Wt) + (.0504*Liv Rs) + (.1542*Liv Xc) - (.0169*Liv Ln)

Statistical analysis of this formula in breed and sire comparisons has been done and the verification of the accuracy of the lean pounds prediction formula has been completed with the 1996 Columbia Lean Lamb data set (N = 38). These lambs were used to establish the accuracy of the prediction formulas generated where the dependent variable was actual pounds of TRP. The generated anatomical predicted pounds of TRP had an R^2 of .82. The generated live predicted pounds of TRP had an R^2 of .64. Table 4 shows WFEPD values for the identified Columbia sires that were based on pounds of TRP per day of age.

Table 4. Columbia Sire WFEPD values.

Sire	$ TRP	Lamb Age/ Days	$/Day	WFEPD
1	166.25	259	.64	-0.030
2	145.50	196	.74	+0.012
3	155.73	273	.57	-0.060
4	134.25	179	.75	+0.016
5	135.50	308	.68	-0.012
6	144.96	209	.47	-0.096
7	160.17	210	.76	+0.020
8	152.02	194	.78	+0.029
9	148.42	195	.76	+0.020

CONCLUSIONS

The data accumulated in both portions of this experiment and analyzed through SAS analysis shows that pounds of TRP can be predicted using BIA measurements for the carcass (R^2 = .82) and, more importantly on the live animal (R^2 = .64). The accuracy of the live animal prediction formula can be utilized in the establishment of a within-flock expected progeny difference (WFEPD) value based on pounds of retail product. Using the calculated Within Flock Expected Progeny Difference, if a ram were mated to 40 ewes and produced 60 lambs, and these lambs were slaughtered at 203 days of age (the average from Table 4), the difference in retail value between the best and worst sire would be approximately $1,400 in retail value.

PROSPECTIVE

The Columbia selection portion of the lean lamb study is in its fourth year. Assignment of ewes to treatment groups (high lean, low lean, and control) was done in 1995. Ram lamb selection, based on BIA, was done at that time. Replacement ewe and ram selection from the 1996 and 1997 lamb crops were based on BIA trimmed retail product index and Columbia breed standards. All lambs were weighed and subjected to BIA analysis in May and the TRP index based on those readings were used to rank the lambs. Only Columbia type score 1 and 2 were considered for replacement. The top indexing lambs from the HL and the low indexing lambs from the LL were selected as replacements. The control group received replacements by random assignment. Lambs not assigned to a group were all processed through the NDSU Meats Laboratory where carcass evaluation was done and used for statistical analysis. The offspring from this study will continue to be utilized in the development and verification of a WFEPD for the identified breed group. The ultimate outcome is to produce an accurate formula which can be easily incorporated as a WFEPD value in the sheep industry. Efforts on value based marketing are accelerating, and our data clearly shows the benefit of sire evaluations as a tool to increase efficiency through genetic improvement in lean growth.

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MANAGEMENT STRATEGIES TO EFFECTIVELY CONTROL LEAFY SPURGE IN RANGELAND BY GRAZING SHEEP

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 usage 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. Birth rate and survivability of lambs from birth to weaning are critical factors impacting gross income and net profit for the sheep producer.

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 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 loss of the Federal Wool Incentive program will negatively impact the future of sheep producers in North Dakota. 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 Shepherd IMS enterprise analysis was developed to assist sheep producers evaluate the economics of their operation (Nudell, 1994). Sheepbud Shepherd IMS is presently being S.P.A. tested and will be 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 (TI) 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 will 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 an existent accelerated lambing flock of 500 ewes (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 1.4 lambings annually and presenting 1.5 lambs per lambing. This provides in excess of 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 (TI)

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 TI 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 Shepherd IMS financial analysis program to cross reference comparisons.

Duration

The data accumulated from five 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.)

1997 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 1997. Tables 1 and 2 give production information for the various ewe types and management systems lambing in the project. Tables 3 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 1997 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 MI 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					
	1995-1996		1997		1995-1996			1997		
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	23	23	38	38	27	27	27	42	42	42
EWES EXPOSED	60	59	38	39	54	58	55	32	34	33
EWES LAMBING	52	56	35	37	51	55	51	26	26	28
LAMBS BORN	89	91	62	65	85	86	63	32	33	28
LAMBS WEANED	72	77	53	45	58	57	51	24	30	28
LAMBS WEANED PER EWE EXPOSED	1.20	1.31	1.39	1.15	1.07	.98	.93	.75	.88	.85

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

Table 2. Reproductive performance of Montadale-Rambouillet cross ewes under five different rearing strategies.

	JANUARY LAMBING				MAY LAMBING					
	1995-1996		1997		1995-1996			1997		
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	23	23	38	38	27	27	27	42	42	42
EWES EXPOSED	56	53	49	41	53	53	50	36	33	40
EWES LAMBING	48	47	42	37	52	52	47	32	30	38
LAMBS BORN	67	67	66	58	66	68	53	38	47	42
LAMBS WEANED	55	56	56	42	50	52	47	31	39	41
LAMBS WEANED PER EWE EXPOSED	.98	1.06	1.24	1.02	.94	.98	.94	.86	1.18	1.03

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

Table 3. Performance of lambs born of Rambouillet ewes reared on five different strategies.

	JANUARY LAMBING				MAY LAMBING					
	1995-1996		1997		1995-1996			1997		
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)	46.02	48.30	45.43	48.19	29.57	32.93	39.13	34.04	36.30	41.75
WEAN AGE DAYS	66.11	64.29	72.70	73.95	48.22	48.10	47.10	49.58	51.06	50.30
WEAN WEIGHT CORRECTED TO 60 DAYS (lbs)	42.0	45.1	37.5	39.1	36.8	40.3	50.7	41.2	42.7	49.8
POUNDS LAMB WEANED PER EWE EXPOSED @ 60 DA	50.4	59.1	52.1	45.0	39.4	39.6	47.53	30.9	37.8	42.3

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

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

	JANUARY LAMBING				MAY LAMBING					
	1995-1996		1997		1995-1996			1997		
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)	47.54	50.24	43.14	50.71	29.06	34.15	42.74	37.5	38.3	35.5
WEAN AGE DAYS	61.74	67.37	70.94	74.74	47.48	49.82	49.68	37.0	53.2	46.0
WEAN WEIGHT CORRECTED TO 60 DAYS (lbs)	46.2	44.7	36.5	40.7	36.7	41.1	51.6	60.8	43.2	46.3
POUNDS LAMB WEANED PER EWE EXPOSED @ 60'DA	45.3	47.4	45.2	41.5	34.5	40.3	48.5	52.3	51.0	47.6

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
LAMBING TIME	JAN/SEPT	JAN/SEPT	JAN/SEPT
REARING TYPE	IN/OUT	IN/OUT	IN/OUT
EWE AGE @ LAMBING TIME MONTHS	16/24	16/24	16/24
TOTAL EWES	98	121	93
EWES LAMBING	63/59	89/67	78/61
DRY EWES (BOTH LAMBINGS)	14	8	6
LAMBS BORN	81/88	114/90	113/69
LAMBS WEANED	64/76	90/86	79/55
% REARED OF THOSE BORN	79/86	79/95	

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
LAMBING TIME	JAN/SEPT	JAN/SEPT	JAN/SEPT
WEAN WEIGHT (LBS)	39.29/42.91	44.7/32.68	41.62/41.62
WEAN AGE (DAYS)	64.35/65.22	62.9/56.18	66.74/63.63
WEAN WT CORRECTED TO 60 DAYS (LBS)	36.6/39.6	42.6/34.9	37.42/39.24
TOTAL LBS OF LAMB PRODUCED PER EWE @ 60 DAYS (LBS)	56.57	56.49	54.99

R = RAMBOUILLET
* =EXTREMELY WET CONDITIONS IN LOTS

Table 7. Merged data for the years 1995 - 1997 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	105	94	98	97	89	86	91	86	92	88
EWES LAMBING	90	84	87	93	84	82	85	77	81	79
LAMBS BORN	133	125	151	156	104	113	93	117	119	92
LAMBS BORN/ EWES EXPOSED	1.26	1.33	1.54	1.61	1.17	1.31	1.02	1.36	1.29	1.05
LAMBS WEANED	111	98	125	116	81	91	88	82	87	79
LAMBS WEANED / EWES EXPOSED	1.06	1.04	1.28	1.20	.91	1.06	.97	.85	.95	.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	194	186	89	184	189	88
EWES LAMBING	174	166	85	164	174	79
LAMBS BORN	237	238	95	268	275	92
LAMBS WEANED	161	150	88	207	209	79
LAMBS WEANED/ EWE EXPOSED	.83	.81	.99	1.13	1.11	.90

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

	LAMBING SYSTEMS		
	IN	OUT	PAST
EWES EXPOSED	378	378	179
EWES LAMBING	338	345	164
LAMBS BORN	505	508	187
LAMBS WEANED	399	406	167
LAMBS WEANED / EWE EXPOSED	1.06	1.07	.93

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	395	353	179
EWES LAMBING	354	324	164
LAMBS BORN	575	453	187
LAMBS WEANED	450	341	167
LAMBS WEANED / EWE EXPOSED	1.14	.97	.93

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	465	462
EWE LAMBING	425	417
LAMBS BORN	570	635
LAMBS WEANED	469	495
LAMBS WEANED/ EWE EXPOSED	1.01	1.07

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.

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A PRELIMINARY LOOK AT THE ECONOMIC RESULTS
OF THE LAMBING SYSTEMS STUDY.

Dan Nudell and Tim Faller

Data from the first three years of the lambing systems study was compiled and analyzed with the Sheepbud computer program. The results are interesting and challenge conventional thinking about maximizing economic return from a sheep flock.

Table 1 summarizes the results of the first look at the economics of the various systems. Results shown are averages of the three years results compiled and then entered into the budget program as a single years results. For example ewe numbers were smaller in 1995, ewes were added to the trial in 1996. In 1997 ewe numbers begin to decline due to attrition. The number of ewes listed in Table 1 is simple average number of exposed ewes for the first three years of work.

Table 1. Three year average economic results, HREC, 1995-1997.

	Jan Conf	**Jan Out**	**May Conf**	**May Out**	**May Past**
Ewes[1]	68	64	58	59	59
Lambs[2]	79	73	54	59	56
Wean Weight[3]	40.6	43	42.9	41.8	49.9
Gross Return[4]	$57.00	$59.00	$50.00	$51.00	$60.00
Feed Cost[5]	$47.57	$47.51	$47.50	$47.47	$36.65
Other Variable	$10.37	$9.51	$8.90	$8.53	$4.57
Fixed Costs	$6.52	$6.69	$6.99	$4.74	$2.43
Breakeven[6]	$123.98	$118.90	$140.52	$130.14	$81.96
Net Per Ewe[7]	$(13.62)	$(11.08)	$(20.08)	$(15.50)	$10.81

[1]This is the three year average number of ewes in the trial.
[2]This is the three year average of lambs born in each trial.
[3]This is the three year average weaning weight.
[4]This is the single year calculated result using average production.(lambs @$1/#, wool @$.95/#)
[5]This is the average feed disappearance for all three years at 1997 prices.
[6]Breakeven calculated to cover all costs except owners labor, management and equity.
[7]Net before paying owners labor, management and equity costs.

There are several interesting results listed in the table that merit further discussion. First look at the average weaning weights listed. Lambs reared in January were creep fed, all others received no creep feed. The addition of creep feed did not appear to have a positive effect on the weaning weights of the lambs in the January system. Creep feed may have had an impact on lamb survivability in the January groups. The cost of creep feed averaged $6 per lamb. The six to nine pound advantage shown by the pasture group came at a very low cost.

Total feed cost were very similar for all groups with the exception of the large cost reduction observed in the pasture group. This feed cost savings of near $11 was probably the largest contributor to the end results obtained.

Another difference contributing to the net return results was the reduction in other variable costs and fixed costs observed in the pasture lambing group. These two savings are mostly driven by the large difference in building expense associated with the pasture lambing system. The confinement groups require 20 square feet per ewe of expensive building, the outside groups require 12 square feet of less expensive building per ewe. The pasture group uses tree shelter belts for weather protection. It is interesting to note that these results include the winter of 1996-97, one of the worst winters on record.

We also observed a dramatic reduction in labor requirements for the May pasture group. Consider that no lambs are jugged, there is little or no manure to haul and winter feeding consists of simply dropping small bales off the back of a flatbed pickup. The net return from this system is even more attractive when considered on a per hour of labor and management basis.

Caution:

These results are preliminary. They do not include replacement costs and income from ewe culling. They do not take into account the performance of lambs entering the feedlot. Some expenses, such as total veterinary and medical expenses are estimated in this analysis and will be refined. Also note that the haylage ration used for the confinement and outside groups suffered from quality problems in the May feeding period. This may have adversely affected the results for non-pasture May lambing groups. The results do merit further study and discussion of lambing systems in the west river region of the Dakotas.

Field Pea as a feedstuff for growing lambs.

W. W. Poland[1] and T. C. Faller[2]

Introduction

Grain producers are beginning to recognize the advantages of adding field pea (*Pisum sativum*) into their small grain rotations (Endres, 1996). Field pea, while yielding similarly to wheat, has been shown to improve long-term soil quality, increase soil nitrogen content, and provide a break in the cycle of many organisms that can cause problems in wheat production (e.g. orange wheat blossom midge, scab). In part due to these agronomic benefits, acreage seeded to field pea has steadily increased in North Dakota. As the production of field pea increases in the state, producers are looking for alternative markets for their grain.

The chemical composition of field pea (Table 1) suggests that it has an excellent potential to be used as a livestock feed. A brief summary of Canadian research (Hickling, 1994) indicates that field pea can be used as a major source of supplemental protein for dairy cattle. Poland and Landblom (1996) concluded that field pea is a suitable substitute for barley and soybean oil meal when replacement is made on a equivalent protein basis in growing calf diets. Thus, a lamb feeding trial was designed to evaluate the feeding potential of field pea in growing lamb diets. The study involved substituting all or a portion of the barley and soybean oil meal in a control diet with graded levels of field pea.

Materials and Methods

Two-hundred-forty lambs (wethers and ewes) were used to investigate the feeding potential of field pea in the diets of growing lambs. Lambs (72.3 ± 10.0 lbs initial body weight) were allotted by weight and sex into 8 finishing pens on April 16, 1997. Four dietary treatments were then assigned to pens (2 pens/treatment). A 81% concentrate, self-fed control diet (0%Pea) containing barley , soybean oil meal, alfalfa hay, straw and vitamin and mineral supplements was established (Table 2). Ammonium chloride was also included to prevent urinary calculi (NRC, 1985). The control diet was formulated to meet or exceed the nutritional needs of an early-weaned lamb possessing a moderate to rapid growth potential (NRC, 1985). Three other diets (Table 2) were constructed where field pea replaced one-third (33%Pea), two-thirds (66%Pea) or all (100%Pea) of the soybean oil meal in the control diet. A proportional amount of barley was also displaced by field pea so that diets would be isonitrogenous. Lambs were fed for 90 days. Live weights were recorded at the beginning and conclusion of the study.

Nine lambs died during the course of the trial. Death loss is reported as the average number of lambs per pen within a treatment that died expressed as a percentage of the total of number of lambs in that pen. Calculations of death loss and lamb feeding days (total number of days individual lambs were fed) are based upon all lambs starting the trial. Subsequently, data

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from those lambs that died was deleted from the data set before preforming further statistical analyses. Data were analyzed as a split-plot design, where the whole plot was treated as a completely random design. Dietary treatment was the only whole plot factor and pen of lambs represented the experimental unit. Lamb sex was considered the split-plot factor. The sex of 15 lambs was not recorded in the original data set. These lambs were coded with a separate sex code. Means for lambs of unknown sex are not reported since proportion of wethers and ewes in this sex class within a pen was unknown. No interactions were present between sex (wether or ewe) and level of field pea in the diet.

Results

Feedlot performance is summarized in table 3 and 4. There were no differences due the inclusion of field pea (Table 3) on the percentage of lambs that died during the course of the trial (average = 3.75%) or on the total number of lamb feeding days (average = 88.3 days per lamb). Feeding field pea in a high concentrate diet did not statistically improve final live weight ($P = .88$), total gain ($P = .68$), average daily gain ($P = .68$) or average daily feed intake ($P = .54$). Feed efficiency ($P = .78$) was also not affected by the feeding of field pea.

Wether lambs (Table 4) were heavier than female lambs at the beginning ($P < .001$) and the end ($P < .001$) of the trial. Total weight gain ($P < .02$) and average daily gain ($P < .02$) also favored wether lambs. Feed efficiency ($P < .05$) was improved in wether, over ewe, lambs. However since daily feed intake was assumed to be the same for all lambs in a pen (sexes combined), this difference in feed efficiency is computationally a difference in average daily gain.

Discussion

The results of this study are similar to those previously reported (Poland and Landblom, 1996), where field pea was fed in barley-based, high concentrate (70%) diets to growing calves. In that experiment, average daily gain and feed efficiency were not affected by feeding field pea. However in a second experiment (Poland and Landblom, 1996), calf performance and feed efficiency were improved by the inclusion of field pea into a lower concentrate (30%) diet. Research in South Dakota (C. Birkelo, SDSU; personal communication) included field pea in a corn-based, high concentrate (90%) finishing diet for cattle. While average daily gain was not affected, feed efficiency was improved (5.1 vs 4.8 feed/gain) when field pea replaced corn and soybean oil meal.

Conclusion

Field pea appears to be an excellent substitute for barley and soybean oil meal for growing lambs and calves. More research is needed to completely characterize the nutritional benefits of using field pea as feedstuff for all types of sheep and cattle.

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Table 1. Chemical composition of field pea[a] (Hickling, 1994).

Item	Average
Crude protein	26.0
Ether extract (fat)	1.4
Acid detergent fiber (ADF)	9.1
Neutral detergent fiber (NDF)	19.8
Starch	60.0
Ash	3.7

[a] Composition expressed on a dry matter basis.

Table 2. Diet composition and nutrient analysis of growing lamb diets containing field pea.

	Level of Field Pea			
	0%	33%	66%	100%
Feedstuffs:				
Barley	72.6	66.6	60.5	54.5
Soybean oil meal	8.4	5.6	2.8	0.0
Pea	0.0	8.8	17.7	26.5
Alfalfa hay	11.8	11.8	11.8	11.8
Straw	4.4	4.4	4.4	4.4
Limestone	1.8	1.8	1.8	1.8
TM salt	0.5	0.5	0.5	0.5
Ammonium chloride	0.5	0.5	0.5	0.5
Vitamin supplement	0.05	0.05	0.05	0.05
Formulated analysis[a]:				
DM, %	88.8			
TDN, %DM	78.0			
ME, Mcal/lb DM	1.28			
CP, %DM	16.0			
Ca, %DM	.91			
P, %DM	.36			

[a] Analysis was calculated using book values for individual feed ingredients.

Table 3. Effects of feeding field pea on feedlot performance of growing lambs.

Item	Level of Field Pea 0%	33%	66%	100%	SE
Number[a], per pen					
Initial	30	30	30	30	-.-
Dead	8.3	3.3	0.0	3.3	-.-
Animal days	2601.5	2649.5	2700.0	2644.0	49.98
Weights[b], lb/hd					
Initial	75.3	71.0	72.1	72.0	0.93
Final	104.7	107.3	109.7	111.3	6.51
Total gain	29.4	36.2	37.6	39.2	6.57
Daily gain[b], lb/hd	0.33	0.40	0.42	0.44	0.067
Daily feed intake[b], lb/hd	3.57	3.72	3.70	3.66	0.048
Efficiency[b]:					
Gain/feed	0.092	0.109	0.113	0.119	0.0150
Feed/gain	10.9	9.2	8.8	8.4	-.-

[a] These data are from lambs that started the trial.
[b] These data are for lambs that finished the trial.

Table 4. Effects of lamb sex on feedlot performance of growing lambs.

Item	Males	Females	SE
Weights[a], lb/hd			
Initial[b]	75.3	69.9	0.96
Final[b]	115.2	105.4	1.83
Total gain[c]	39.9	35.5	1.30
Daily gain[ac], lb/hd	0.44	0.39	0.014
Daily feed intake[cd], lb/hd	3.66	3.66	-.-
Efficiency[a]:			
Gain/feed[c]	0.121	0.108	.0039
Feed/gain	8.25	9.28	-.-

[a] These data are for lambs that finished the trial.
[b,c] Sexes differ (P<.01 and .05, respectively).
[d] Daily feed intake was assumed equal for all lambs in a pen.

THE UTILIZATION OF NAKED OATS (HULLESS OATS) IN GROWING RATIONS OF EARLY WEANED LAMBS

Roger Haugen and Wes Limesand
NDSU Experiment Station, Fargo, 1998

INTRODUCTION

Alternative crops are on the rise in the region and one of those crops is naked oats (hulless oats). Naked oats has some very desirable characteristics including high digestibility, high protein and low fiber. Because of these, the possibilities of feeding naked oats to livestock has sparked interest in research trials. One such feeding possibility is in lamb growing diets.

PROCEDURE

Thirty fall born lambs (Sept-Oct of 1996) were divided into 3 pens (10 lambs /pen) on December 9, 1996 at an average weight of 61 pounds. Included in the study were purebred Hampshire, Suffolk, Columbias plus crossbred lambs. Each pen had 4 males and 6 females.

One pen received a diet with 0% naked oats, the second pen received a diet containing 20% naked oats on a dry matter basis, and the third pen received a diet containing 40% naked oats on a dry mater basis. Other ingredients in the three diets were corn, soybean meal, alfalfameal, and minerals. Table 1 lists the three diet compositions on an as fed basis. Diets were tested for protein and averaged 17.3% on a dry matter basis. All diets were pelletted and self-fed.

Data collected included weights at each weigh period (every three weeks) plus feed utilization. The lambs remained on test for 63 days. Evaluations included average daily gain, feed consumption, and feed conversion.

The experiment was repeated with 1997 spring born lambs. Sixty spring born lambs (January - March) were divided into 6 pens. Each treatment (0%, 20% and 40% naked oats) describe above was applied to two pens. Lambs were put on the experiment May 5,1997 at an average weight of 57.4 pounds. Included were purebred Hampshire, Suffolk, Columbias plus crossbred lambs. Each pen had 4 males and 6 females.

Both the fall and spring lambs were weaned at approximately 60 days of age.

Table 1. Diet Compositions - As Fed Basis

Ingredients	0%Naked Oats	20%Naked Oats	40%Naked Oats
Corn	67.0	53.0	39.0
Soybean oil meal	14.0	10.5	7.0
Naked Oats		17.5	35.0
Alfalfa meal	13.0	13.0	13.0
Molasses	4.5	4.5	4.5
Limestone	1.0	1.0	1.0
Supplement[a]	0.5	0.5	0.5

[a] Trace mineral, vitamin mix

RESULTS AND DISCUSSION

The results of the fall born study are presented in Tables 2 thru 4. No significant differences were found in average daily gain, daily feed intake or feed efficiency among the three diets. The 30 lambs gained almost a pound a day (0.93) with a daily feed intake over the 63 days at 3.58 pounds per day. Feed efficiency for the 30 lambs was 3.84 pounds of feed per pound of gain for the 63 days.

Table 2. 1996 Fall Born Lambs - Average Daily Gain

Item	0%Naked Oats	20%Naked Oats	40%Naked Oats
1st 3 weeks	1.05	0.90	0.95
2nd 3 weeks	0.94	0.90	0.95
3rd 3 weeks	0.92	0.92	0.85
Total - 63 days	**0.97**	**0.91**	**0.92**

Table 3. 1996 Fall Born Lambs - Daily Feed Intake

Item	0%Naked Oats	20%Naked Oats	40%Naked Oats
1st 3 weeks	3.40	3.19	2.97
2nd 3 weeks	3.70	3.50	3.65
3rd 3 weeks	3.84	3.98	3.98
Total - 63 days	**3.64**	**3.56**	**3.54**

Table 4. 1996 Fall Born Lambs - Feed Efficiency

Item	0%Naked Oats	20%Naked Oats	40%Naked Oats
1st 3 weeks	3.25	3.54	3.12
2nd 3 weeks	3.93	3.91	3.84
3rd 3 weeks	4.15	4.31	4.67
Total - 63 days	**3.75**	**3.92**	**3.85**

The spring born results are presented in Tables 5 thru 7. As in the fall study, no significant differences were found among the three diets. The 60 lambs gained 0.76 pound a day and ate 2.97 pounds of feed per day. Feed efficiency for the 60 lambs was 3.89 pounds of feed per pound of gain for the 63 days. There was a trend in feed efficiency which favored the 0% naked oats (3.68) over the 20% naked oats (3.98) and the 40% naked oats (4.04).

Table 5. 1997 Spring Born Lambs - Average Daily Gain

Item	0%Naked Oats	20%Naked Oats	40%Naked Oats
1st 3 weeks	0.77	0.79	0.73
2nd 3 weeks	0.74	0.71	0.71
3rd 3 weeks	0.85	0.78	0.79
Total - 63 days	**0.79**	**0.76**	**0.74**

Table 6. 1997 Spring Born Lambs - Daily Feed Intake

Item	0%Naked Oats	20%Naked Oats	40%Naked Oats
1st 3 weeks	2.53	2.68	2.68
2nd 3 weeks	2.93	3.05	2.88
3rd 3 weeks	3.23	3.28	3.43
Total - 63 days	**2.90**	**3.01**	**3.00**

Table 7. 1997 Spring Born Lambs - Feed Efficiency

Item	0%Naked Oats	20%Naked Oats	40%Naked Oats
1st 3 weeks	3.27	3.41	3.66
2nd 3 weeks	3.61	3.83	3.85
3rd 3 weeks	3.80	4.23	4.37
Total - 63 days	**3.68**	**3.98**	**4.04**

The results of these two trials indicate that naked oats can be utilized in growing rations for early weaned lambs without any significant loss of performance. The determing factor for incorporating naked oats into lamb diets should be cost of the grains being considered. In addition, the diets used in these two trials were pelletted which will add additional cost to the diets.

THE USE OF SHEEP ON LEAFY SPURGE INFESTED RANGELAND IN A MULTI-SPECIES APPROACH

by

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Introduction

Leafy spurge (*Euphorbia esula* L.) is North Dakota's most destructive noxious weed, invading about one million acres of North Dakota, primarily rangeland (North Dakota Dept. of Agriculture 1996). Chemicals continue to be the primary method of control and attempt to eradicate leafy spurge (Lym et al. 1995), however, it is not economically feasible to control large infestations (Bangsund et al. 1996). Many areas infested with leafy spurge are environmentally sensitive, including areas amongst trees, along rivers and streams, or on lands with a high water table. Most chemicals which provide effective control of leafy spurge cannot be applied to these sensitive areas due to high potential to damage desirable plants and contaminate ground water.

Biological control using grazing has become a more acceptable tool in the last ten years. Helgeson and Thompson (1939), and Helgeson and Longwell (1942) showed that sheep do use leafy spurge and provide some control. However, no published reports have documented the potential use of sheep in a multi-species approach with cattle to improve grass and grass-like utilization, increase plant richness, and control leafy spurge on leafy spurge infested rangeland.

The objectives of this ten-year study are: 1) to determine if grazing leafy spurge infested rangeland with cattle and sheep together will improve grazing efficiency and livestock performance compared to a single class grazing program, and 2) to determine if multi-species grazing with cattle and sheep on leafy spurge infested rangeland will improve plant species richness and reduce leafy spurge density compared to single class grazing.

Data presented within this article are preliminary results including two years of data from a ten-year research project.

Study Area and Procedures

The multi-species grazing project was conducted on sections 31 and 32, T139N, R81W of Morton county, on a 643 acre tract of native rangeland owned by the North Dakota State Correctional Center in south central North Dakota, approximately 2.5 miles southwest of Mandan, and on the north half of section 9, T138N, R81W of Morton county on a 257 acre tract of native rangeland operated by the Northern Great Plains Research Laboratory, approximately 2 miles south of Mandan. Approximately 25 percent of each tract of land is infested with leafy spurge. The two tracts of land are located within 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).

The multi-species grazing project was separated into two trial. Trial #1 was used to study the effects of two different grazing management treatments, twice-over rotational grazing (TOR) versus seasonlong grazing (SLG), to control leafy spurge using a multi-species approach. Trial #2 was used to study multi-species grazing (MSG) versus single class grazing (SCG) on leafy spurge infested rangeland.

Twice-over rotational grazing treatment (TOR) consisted of 603 acres of native range, with a carrying capacity of 0.74 AUMs/acre (446 AUMs). The seasonlong grazing treatment (SL) consisted of 237 acres of native range, with a carrying capacity of 0.71 AUMs/acre (168 AUMs). The TOR was grazed by 96 animal units of cattle (85-1200lb cows with calves) and 33 animal units of sheep (200 mature dry ewes), or 645 AUMs of grazing. The SL was grazed by 37 animal units of cattle (49-705lb yearling steers) and 13 animal units of sheep (78 mature dry ewes), or 250 AUMs of grazing. Stocking rates for both treatments were 0.97 AUMS/acre. Sheep started grazing on May 15 when leafy spurge was ready for grazing (4 to 6 inches) and cattle started June 1 when cool season grass species reach grazing readiness (3 to 3.5 leaf stage). Species of livestock were removed from treatments on October 15 or when 50 to 60% utilization of grass and grass-like plant species was reached.

The MSG versus SCG trial consisted of three replicated 20 acre plots on native range. Each 20-acre plot was subdivided into four five acre quadrats, with each quadrat randomly treated with cattle only (CO), sheep only (SO), cattle and sheep (CS), or nonuse (NU) treatments. Cattle only treatment was grazed by two steers, SO grazed by ten sheep, and CS grazed by one steer and five sheep. Stocking rates were 1.4, 1.5, and 1.5 AUMs/acre for the CO, SO, and CS, respectively. Stocking rates for this trial were designed for four months of grazing for cattle and four and half months grazing for sheep. Livestock were removed from this trial once 50 to 60% utilization of grass and grass-like species was achieved. Sheep grazing began on May 15 and cattle grazing started on June 1.

Leafy spurge density counts for Trial #1 were collected within six replicated 32 by 16 foot exclosure subdivided into two 16 by 16 foot plots. Grazed and ungrazed treatments were randomly selected between the two plots. Each plot was then stratified into 12 inch^2 quadrats. Ten 12 inch^2 quadrats were randomly selected to conduct leafy spurge density counts. Three exclosures were located within the TOR and three within SL. Leafy spurge density counts on Trial #2 were obtained using a permanent 109 yard transect and counts collected every five and half feeet using a 12 inch^2 quadrat. Transects were selected based on leafy spurge location within the treatments to assure full length of transect comprised leafy spurge.

Forage production and degree of use of leafy spurge, grass and gras-like, shrub, and other forbs were determined on Trial #1 using the pair-plot clipping technique (Milner and Hughes 1968). Trial #2 forage production of grass and grass-like, forbs, shrubs, and leafy spurge was determined by clipping the nonuse treatment when vegetative species reach peak production in late July (Whitman et al. 1952). Nonuse was stratified into seven and half by seven and half yard plots. Twenty-five quadrats were randomly selected and clipped within each NU using a 24 $inch^2$ frame. Degree of use of leafy spurge, grass and grass-like, forbs, and shrubs was determined for each treatment at the end of the grazing season by stratifying each treatment into seven and half by seven and half yard quadrats using a 24 $inch^2$ frame.

Livestock performance and production was collected for both cattle and sheep by determining average daily gains (ADG). Both classes of livestock were weighed prior to pasture turnout and at the end of the grazing season.

Leafy spurge stem density and percent change from 1996 to 1997 and among treatments were tested for significance using the multi-response permutation procedure (Biondini et al. 1988). Herbage production and degree of use was tested for significance between treatments and years using analysis of variance. Analysis of variance was also used to determine significant changes in average daily gains between treatments and years.

Results and Discussion

Twice-over Rotational Grazing Versus Seasonlong Grazing

No significant changes (P>0.05) were found in leafy spurge stem density in either the TOR or SL from 1996 to 1997 (Table 1). However, when comparing the two treatments, leafy spurge stem density was reduced (P<0.05) on the SL compared to the increase on the TOR (Table 2). Percent degree of use of grass and grasslike, and leafy spurge increased from 1996 to 1997 in both treatments (Table 3).

Average daily gains (ADG) were significantly different (P<0.05) for all classes of livestock, except calf average daily gains and sheep average daily gains in SL, from 1996 to 1997. A difference (P<0.05) in ADG between the TOR and SL sheep was found for both years (Table 4). Sheep ADG on the twice-over rotational treatment was higher (P<0.05) than SL in 1996, however, sheep ADG on the SL was higher (P<0.05) than TOR in 1997.

Mutli-Species Grazing Versus Single Species Grazing

Leafy spurge stem density did not change (P>0.05) in the CO, SO, CS, and NU from 1996 to 1997 (Table 5). However, comparing among treatments in leafy spurge density change, SO treatment leafy spurge density decreased (P<0.05) compared to an increase on the CO and NU treatments and there were no differences between SO and CS in leafy spurge density change (Table 6). Cattle only had greater percent increase (P<0.05) than CS treatment and there were no differences (P>0.05) between CS and NU (Table 6). There were no changes (P>0.05) in herbage production for grass and grass-like, forbs, shrubs, and leafy spurge from 1996 and 1997. Degree of use of grass and grass-like and leafy spurge increased (P<0.05) in all treatments from 1996 to 1997.

No differences (P>0.05) were found in steer ADG between years on the CO and CS treatments. However, in 1997 ADG of sheep in the SO were lower (P<0.05) than 1996. No differences (P>0.05) in sheep ADG were seen among treatments in 1996 and 1997 (Table 7).

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Table 1. Average number of Leafy spurge stems per 12 $inch^2$ frame on the twice-over rotational grazing (TOR) and seasonlong grazing (SL) treatments from 1996 to 1997.

Treatment	1996 Average	1997 Average	P-value
SL			
Grazed	14.4	12.5	0.84
Ungrazed	14.7	14.9	0.75
TOR			
Grazed	13.2	15.9	0.51
Ungrazed	8.6	10.8	0.45

Table 2. Leafy spurge stem density percent change for twice-over rotational grazing (TOR) and seasonlong grazing (SL) treatments from 1996 to 1997.

Treatment	Percent change
SL	
Grazed	-13.2^{ax}
Ungrazed	$+1.2^{a}$
TOR	
Grazed	$+20.5^{by}$
Ungrazed	$+31.1^{b}$

(a denotes SL only, b denotes TOR only, and xy denotes treatment effect.)

Table 3. Degree of use (%) for grass and grass-like, leafy spurge, and total herbage on non leafy spurge (native) and leafy spurge infested sites (spurge) on the twice-over rotational grazing treatment (TOR) versus seasonlong grazing treatment (SL) for 1996 and 1997.

Site	Grass and Grass-like	Leafy spurge	Total
SL			
Native 96	21%	-	15%
Spurge 96	1%	47%	16%
Native 97	32%	-	36%
Spurge 97	33%	53%	41%
TOR			
Native 96	34%	-	32%
Spurge 96	2%	40%	20%
Native 97	37%	10%	38%
Spurge 97	39%	62%	48%

Table 4. Average daily gains (lbs/day) for individual classes of livestock on twice-over rotational grazing (TOR) versus seasonlong grazing (SL) for 1996 and 1997.

Treatment	1996 ADG	Standard error	1997 ADG	Standard error	P-value
SL					
Steers	2.00	0.04	1.80	0.03	0.001
Sheep	0.23	0.03	0.28	0.01	0.071
TOR					
Cows	0.78	0.05	1.00	0.05	0.001
Calves	2.30	0.03	2.30	0.03	0.797
Sheep	0.32	0.01	0.25	0.01	0.001

Table 5. Average number of leafy spurge stems per 12 inch^2 frame on multi-species grazing versus single species grazing study from 1996 to 1997.

Treatment	1996 Average	1997 Average	P-value
Nonuse	9.8	11.4	0.626
Cattle only	9.8	12.0	0.731
Sheep only	10.4	6.7	0.725
Cattle and Sheep	11.6	12.3	0.815

Table 6. Leafy spurge stem density percent change for multi-species grazing versus single species grazing study from 1996 to 1997.

Treatment	Percent change
Nonuse	$+16.1^{bc*}$
Cattle only	$+22.7^{c}$
Sheep only	-36.2^{a}
Cattle and Sheep	$+5.5^{b*}$

* Denotes a significant difference at a P<0.10 between the cattle and sheep treatment and the nonuse.

Table 7. Average daily gains for individual classes of livestock on multi-species grazing versus single species grazing study for 1996 and 1997.

Treatment	1996 ADG	Standard error	1997 ADG	Standard error	P-value
Cattle only	1.80	0.16	1.60	0.13	0.475
Sheep only	0.16	0.02	0.07	0.02	0.001
Cattle and Sheep					
Steer	1.50	0.32	1.10	0.16	0.307
Sheep	0.16	0.02	0.09	0.03	0.056

FEASIBILITY OF OPERATING A LAMB SLAUGHTER PLANT IN NORTH DAKOTA

Dan Nudell and Tim Petry[1]

INTRODUCTION

The production and sale of livestock and livestock products are important sources of income for North Dakota agricultural producers. Cash receipts from livestock and products typically amount to 20 to 30 percent of North Dakota farm income. In some counties, cash receipts from livestock are quite important and amount to three-fourths of total farm income (NASS, 1997).

There were 135,000 sheep and lambs on 1000 North Dakota farms and ranches on January 1, 1997. Sales of sheep and lambs generated approximately $6,978,000 in 1996 with sales of wool generating about $676,000 (NASS, 1997).

The North Dakota livestock slaughtering and processing industry is composed primarily of relatively small facilities that serve local communities. A medium-sized (by industry standards) cow slaughter and processing facility, a medium-sized hog slaughter and processing plant, and a bison slaughter and processing facility do exist. A group of cattle producers is promoting a cooperatively owned medium-sized market cattle slaughter and processing plant which could be located in North Dakota. Slaughtering and processing lambs occurs in several small plants in North Dakota amounting to less than 500 head per year.

Rural economic development has emerged as a high priority public policy issue in North Dakota. Policymakers have set goals to increase value-added livestock enterprises in the state to increase economic activity. Each dollar received for livestock in North Dakota generates approximately $4.49 in increased economic activity due to the multiplier effect, so expanding livestock production is an economic development endeavor with high potential.

The lack of a major lamb slaughtering facility in or near North Dakota means that many lambs must be transported several hundred miles for marketing. Declining sheep numbers nationwide and increased concentration in lamb processing have resulted in only a few large lamb slaughter plants. These large plants are not necessarily responsive to the unique needs of niche markets which are developing for lamb.

A group of North Dakota lamb producers identified several niche markets for high-quality North Dakota lambs. The potential availability of an existing federally inspected livestock slaughter and meat processing facility in Steele County heightened their interest in determining the feasibility of a cooperatively owned lamb slaughter and processing facility. The cooperative would likely be patterned after existing and proposed livestock slaughter cooperatives, whereby cooperative members would own shares to supply lambs to the plant on a year-round basis.

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The proposed plant would slaughter and process 20,000 lambs per year. Although this plant is small by industry standards, there are several advantages for a plant of this size. The plant would process lambs for small niche markets with unique requirements that large plants cannot satisfy. Generally , these markets are willing to pay higher prices and are more interested in quality, specifications, and service rather than quantity. Furthermore, the plant would not be in direct competition with larger major packers because of the unique market that would be served. A steady dependable market for lambs would be available in eastern North Dakota, which would help to stabilize an industry which has been declining. Several new jobs would result.

In April 1996, Valley Wool Growers Cooperative applied to the Agricultural Products Utilization Commission in North Dakota for a grant to cover the cost of a feasibility study of the proposed plant in Hope. Funding was granted, and this report is the result of that work.

The analysis was conducted in several sections corresponding to critical factors which affect feasibility of the plant. If analysis shows any of these factors to be unsatisfactory, the plant would not be feasible and the feasibility analysis could stop at that point. The critical factors analyzed by sector include federal inspection requirements, the potential for an adequate supply of lambs, the potential for a viable niche market, plant investment and operating costs, and the expected returns.

THE WHOLESOME MEAT ACT

Livestock slaughter plants operate under meat inspection regulations administered by the United States Department of Agriculture, Food Safety and Inspection Service (USDA, FSIS). Regulation began in 1891 when a comprehensive federal meat inspection law was passed. The 1891 legislation provided for inspecting the animal prior to slaughter and the meat after slaughter.

The 1891 legislation was extended in 1906 to include sanitation standards for slaughtering and processing plants trading in interstate commerce. This legislation was the basis of all meat inspection until the passage of the Wholesome Meat Act of 1967, which extended the requirements for inspection to plants that only sold meat within the state of operation.

The 1967 legislation gave individual states until 1969 to establish state inspection of processing plants that were not previously federally inspected. North Dakota passed a state inspection bill but did not allocate funds to initiate the program. Consequently, in 1970, federal inspection was initiated in North Dakota.

The 1967 Wholesome Meat Act has been modified several times. The regulations, designed to insure a safe and wholesome supply of meat, govern the operation of all slaughter plants which retail or wholesale meat products. Some exemptions to the act were made for small local plants. Custom-exempt plants may slaughter and process meat for the livestock owner and are inspected only quarterly. The meat cannot be sold to other customers. Retail exempt plants, such as grocery stores, may cut, process, and retail meat that has been purchased from a federally inspected plant.

The USDA is implementing a new series of regulations for meat slaughter plants and processors called HACCP, which stands for Hazards Analysis Critical Control Points. The intent of the regulation is to identify potential problem areas in food safety and implement standard plant practices to insure a wholesome meat supply. The regulation has a staggered implementation scheme with the largest plants being required to meet the new guidelines first. By 1999, all plants must meet the new guidelines. The proposed plant would be required to meet the new regulation by 1999.

The HACCP regulation will require each plant to develop a plan to identify the critical control points for meat safety critical points and develop specific action plans to insure food safety. These plans may include employee monitoring of certain processes, enhanced record keeping or even laboratory testing of products and process.

HACCP is estimated to require up to two (2) additional full-time equivalents in payroll when fully operational and approved by USDA. Since these employees will have an inspection/supervisory capacity and, consequently, will be near the top of the pay scale at the Hope plant, this will have a substantial impact on the plant's operating costs.

The proposed plant will market all or nearly all of its product to wholesale and retail customers. None of the exemptions provided in the Wholesome Meat Act for custom-exempt and retail-exempt plants will provide any relief from the regulations of the act. Compliance with the requirements of federal inspection are expensive, but are mandated by law. Furthermore, the liability risk of selling an unsafe product is extremely high. The cost of meeting the requirements of the Wholesome Meat Act and the HACCP regulations will significantly impact the cost of doing business in the proposed slaughter plant.

Dr. Robert Anderson, supervising veterinary medical officer, FSIS, USDA, toured the existing plant with the authors and sheep producer members of the proposed lamb packing plant cooperative. He identified potential problem areas in the existing facility, and concluded that the plant should be renovated to a "like new" status before it would be approved for reopening under federal inspection. The proposed cooperative would need to submit a request for federal inspection, including blueprints and all anticipated building and equipment requirements for approval.

SUMMARY

Since federal inspection is mandated by law, the USDA is obligated to provide inspection to a plant that meets their specifications. Therefore, if the plant was renovated to a "like new" status and approved, federal inspection requirements would not prevent the plant from being operational.

NORTH DAKOTA LAMB SUPPLY

A major assumption of this study is that the cooperative will be successful in recruiting sufficient lamb producer members to supply 80 lambs each processing day throughout the year. The supply of lambs to operate a slaughter plant is one of the critical factors investors must verify prior to investing in the facility. In the tight margin industry of meat packing, the inability to operate facilities at full capacity can have a serious negative effect on the plant's profitability. A large portion of the financial obligation of the plant is in fixed costs: the physical structure of the building and equipment. While variable costs, such as utilities and labor, can be reduced during periods of lamb shortages, the cost of the capital investment does not change during periods of reduced use. Ensuring a steady supply of lambs is critical for success.

The total supply of lambs in North Dakota is sufficient to supply a plant of this size with all the product needed to run at full capacity. In 1996, North Dakota sheep producers marketed 80,000 lambs from 77,000 ewes (USDA, 1997). The inventory of ewes in 1997 rose to 91,000, so more than 90,000 head of lambs may be marketed in 1997, depending on the number of ewe lambs retained for flock expansion. Also, Minnesota and South Dakota producers will be invited to join the cooperative which will expand the availability of lambs.

The geographic distribution of lamb production in North Dakota would be a concern for the plant. USDA data for 1997 indicate that 22 percent of the North Dakota sheep inventory is in the eastern one-third of the state, 31 percent is in the central one-third and 47 percent is in the western one-third. Therefore, recruiting cooperative members from western North Dakota would be important, or members in eastern North Dakota would need to purchase and feed additional feeder lambs to supply the plant's needs.

Two supply related concerns need to be addressed: the seasonality in lamb production and the practice of selling feeder lambs instead of slaughter weight lambs in North Dakota.

Due to the reproductive biology of sheep, lamb production has been characterized by seasonal production patterns. The weekly U.S. federally inspected lamb slaughter for 1996 ranged from a high of 102,500 head at the end of March to a low of 52,800 in the first week of July. Higher slaughter occurs before the spring religious holidays and is lower during the mid-summer between the spring and fall lamb crops. Weekly sales data for North Dakota are not available, but data from West Fargo Stockyards indicate that in only 5 weeks of the year did the market receive enough lambs to meet the needs of the plant and could meet 75 % of the need in only 12 weeks. In addition the range of supply was 0 to over 800 head per week. In 16 weeks, the available supply was less than 50 head.

Since the plant has a maximum capacity inherent in its design, shortfalls in production cannot be made up in a following period without adding extra shifts. A rural plant is not expected to have available trained labor that can fill extra shifts on short notice. Weeks where full production is not achieved will adversely affect the profitability of the plant.

The technology exists today to provide a more stable year-round supply of lambs. Traditional lambing time has been in the spring. Sheep are seasonal breeders and, if left to their own devices, would always lamb in the spring. Technologies are available using hormones, light or the ewe's natural responses to lengthen the time she is reproductively active. All these methods increase the amount of management input needed by the sheep flock and have not been widely accepted in the industry.

Researchers at North Dakota State University at Hettinger have had good success in getting ewes to lamb in August, September, and October, using the ewes' response to rams and selection to choose replacement females from fall lambing ewes. The lambing and conception rates are not as high as spring lambing, but are high enough to be feasible.

South Dakota State University has done extensive work with light control and has used hormone control to extend the lambing season. Their work confirms the ability to extend lambing to non-traditional times. Extending lambing into the fall is more labor intensive than spring lambing.

The operators of the plant will have to overcome traditional production practices and competition for resources during non-traditional times of lamb production. Other farm enterprises may compete for available resources in non-traditional lambing flocks.

Based on official USDA saleable receipts at the West Fargo Stockyards in eastern North Dakota and lambs marketed by producers enrolled in the North Dakota Sheep Development Project in western North Dakota, it was estimated that less than 40 percent of the lambs marketed in the state were slaughter weight. The remaining 60 percent were feeder lambs weighing from 50 to 110 pounds. The cooperative would need high quality slaughter lambs with a consistent weight and grade. An educational program would be necessary to inform members of the additional feeding requirements necessary to meet the weight and quality goals of the cooperative.

It will be very important that the plant manager monitor the progress of the lambs committed by members to assure production would remain on schedule. In the event that members could not meet quality and quantity commitments of the contract, lambs may have to be purchased from livestock markets. Five markets are within a 100-mile radius of Hope, with West Fargo Stockyards being the largest seller of lambs. Purchasing lambs at the necessary weights and grades during the summer at these markets may be difficult.

Existing slaughter plants are offering or exploring the option of offering contracts to producers to ensure their supply. The lamb industry has been experiencing good prices and a tight supply. The supply side is not expected to change. A continuing tight supply of lambs would indicate that existing buyers probably will compete strongly for the available supply. Reaction to a new market entrant from existing slaughter lamb buyers at markets is a possibility that must be considered.

SUMMARY

Sheep numbers in North Dakota and the region coupled with new technology in year-round lamb production indicate that enough lambs could be available to meet the needs of the plant. However, recruiting sufficient members to supply the plant on a daily basis will be difficult. The Northern

Plains Premium Beef effort to recruit members is an example of the difficulty a new livestock cooperative may experience. On the other hand, the North American Bison Cooperative is an example of a successful effort.

VIABILITY OF THE NICHE MARKET

The national market for carcass lamb has averaged less than $2 per pound. In the 1990s, the price ranged on an annual basis from $1.17 to $1.77 a pound (see Table 1). 1997 year-to-date prices have averaged $1.83 a pound. This study used a projected price of $2 per carcass pound, a premium of near 9 percent over 1997 prices and near 23 percent over the average price during the 1994 to 1996 period.

The premium price was chosen because the cooperative plans to market specialty wholesale cuts that meet the unique specifications of quality conscious buyers. High value markets for lamb products exist in affluent geographic areas influenced by ethnic and religious demand. These consumers typically demand specialty products and services not provided by major packers, and are willing to pay premium prices.

Certified Fresh American Lamb, a brand name developed by the Sheep Industry Development Council, meets high quality specifications and typically sells for a premium over non-branded lamb. For example, the USDA carcass lamb report dated February 14, 1997, quoted Choice and Prime, Yield Grade 1-4, 55-65 lb., less than carlot (LCL) volume, CAF East Coast, lamb carcasses at $188.50 to $191.50 per hundredweight (cwt.). The same specifications of Certified Fresh American Lamb were quoted at $214/cwt.

Table 1. Lamb Carcass Price History, Choice-Prime, East Coast, 55-65 lb, 1990-1997.

	Time Period				
Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Annual
	$/cwt.				
1990	125.10	122.96	121.71	116.12	121.47
1991	111.51	123.83	121.65	117.33	117.33
1992	124.99	142.28	129.32	130.05	131.66
1993	157.24	143.25	133.59	141.78	143.97
1994	134.08	135.90	167.45	153.05	147.62
1995	148.00	167.21	177.75	160.92	163.47
1996	168.25	187.81	186.33	168.02	177.56
1997	186.87	186.90	175.35	NA	183.04 YTD

Source: USDA, Agricultural Marketing Service.

Marketers are selling lamb to consumers at premium prices. Many of these sellers are direct marketing. They are also operating at a level below 400 per week and are located in major urban areas where the potential customer base is larger than North Dakota's.

Producers of the cooperative have identified several confidential niche markets for high quality North Dakota produced lambs. Some examples include marketing to ethnic and religious groups in more urban markets and production of hothouse lambs[2] for that market.

SUMMARY

There is a niche market for the high quality, specialty product this plant would produce. In addition, a premium price for the product can be expected because it meets the specifications of unique consumer groups.

PROPOSED PLANT LOCATION

Hope, North Dakota, is located in southern Steele County in eastern North Dakota. The city is located approximately 35 miles northeast of Valley City, North Dakota. Hope has access to the federal interstate highway system via state highway 32 or 38. The city had a 1990 census population of 281 people. A municipal electric system and a sewer and lagoon system are in place and have the capacity to handle effluent from the proposed plant. Propane and fuel oil are available, but there is not a natural gas supplier.

Hope is the center of 9 percent of the N.D. lamb industry with approximately 8000 lambs available within the east central region. Five livestock auction markets are within 100 miles of Hope.

The Hope city government favors the proposed project and has agreed to award incentives to encourage reopening the plant. The city has guaranteed electrical and water rates for five years with no increase. In addition, they are offering a five-year property tax abatement, pending county approval.

There are several concerns to the proposed location in Hope. Its location away from an interstate highway may add some transportation difficulties. In addition, it may not be as easy to access air transportation, overnight parcel delivery and other transportation options as in a more urban setting.

The plant in Hope is located on the main street of this small community abutting a grocery store on one side and a single family home on the other. There is little room for expansion and only limited room for holding pens, semi-trailer parking and loading/unloading facilities. The building's close proximity to residential areas could be a potential problem for neighborhood complaints about noise, odors, and pests. The highly visible location makes the plant an easy target for complaints.

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[2]A lamb born and raised out of the normal season and marketed at six to ten weeks of age.

The existing structure is available for a reasonable price. However, the building and equipment need extensive renovation to meet federal meat inspection standards.

The city of Hope has offered several inducements to establish the plant in Hope. The community supports the venture and would receive a positive economic impact if the plant were reopened. Balancing this support is the small size of the town. There is a small labor pool to draw from and only limited amenities in Hope to attract new workers to the plant.

SUMMARY

While the proposed location is not ideal, it does meet the minimum requirements of the project and has strong local support.

PLANT INVESTMENT

The estimated purchase price for the existing building and equipment was $22,000 (Erickson). The cost of renovating and adding on to the building to meet the standards needed to obtain federal inspection was estimated at $246,000 (Triple E Construction). Renovations would include a new roof; adding additional floor space; resurfacing existing floor space; changing the layout of the existing plant; and completely refurbishing all walls, electrical fixtures and plumbing. The purchase price and renovation would cost $268,000.

Some equipment was included in the purchase price of the original building; however, the study budgeted for new equipment at $1,200,000 (Koch Supply). Included was new refrigeration equipment, an entirely new set of killing and processing equipment, sausage-making equipment and a smokehouse. Trade sources contacted recommended complete replacement of the equipment presently in place in the existing structure.

Total building and equipment investment was estimated at $1,468,000, but does not include any charges for infrastructure changes, such as road work or water and sewer line upgrades. These costs, if any, were projected to be paid with a grant from the regional development council (Lake Agassiz Regional Council). Projected costs for offal disposal facilities were estimated at $10,000 for 10 acres of land, $20,000 for a front-end loader and $2000 for fencing and access.

The cost of constructing a new structure was also investigated. Construction costs for a new building were estimated at $250,000 plus additional expense for land acquisition. The cost of renovating the existing plant or constructing a new facility were nearly equal and were treated the same in the rest of the analysis.

Total investment in fixed costs was estimated at $1,500,000 plus up to $100,000 in infrastructure improvements. In addition, nearly $500,000 in operating capital would be needed for the project. This project would require $2,000,000 in funds to begin operation.

SUMMARY

Investment costs were higher than originally expected due to the extensive refurbishing necessary to meet federal inspection and increased capacity requirements. While this raises concerns about the ability of the proposed cooperative to raise necessary investment capital, the total investment does not determine success or failure of the project.

ESTIMATED LAMB SLAUGHTER PLANT BUDGET

The largest single variable operating cost category estimated for the proposed plant was the cost of purchasing lambs to slaughter. Lamb purchase expenses from members were estimated, using 130 pounds live weight and a live price of 90 cents per pound for animals delivered to the plant. At full capacity the lamb purchase costs were estimated at $2,340,000 per year. This figure could vary widely if lambs were purchased on the open market. Live lamb prices can be volatile and follow seasonal price patterns.

The second largest expense category is salary and wage requirements. Five employment categories needed for the plant are management, office staff, maintenance, production and food safety. Table 2 provides a breakdown of salary expenses at three levels of plant operation.

The plant was budgeted for one management position. This person would be expected to monitor performance, judge quality and buy lambs; supervise the production facility; oversee the sales and accounting office functions; supervise the maintenance of the plant and its equipment; oversee the operation of the offal disposal operation and be the only salesman for the lamb meat and by-products produced. The manager's job was budgeted at $40,000 per year with a 25 percent allowance for fringe benefits. Salary and fringe benefits at $50,000 per year may be unrealistically low. The 1997 survey of wages in the meat processing industry (Nunes, 1997) shows a median base salary of $75,000 for plant managers/general managers. While this survey was for larger plants than the proposed plant in Hope it is reflective of the competition for the quality of manager needed to handle the diverse needs of this plant.

Table 2. Proposed Slaughter Plant Salaries and Fringe Benefits, ND, 1997.

		Plant Capacity		
		100%	75%	50%
Position	Salary[1]	Salary & Fringe	Salary & Fringe	Salary & Fringe
	----------------------	---------------------- $	----------------------	----------------------
Manager	1 @ 40,000	50,000	50,000	50,000
Office	1 @ 10,000	12,500	9,375	6,250
Maintenance	1 @ 15,000	18,750	14,063	9,375
Production	5 @ 20,000	125,000	93,750	62,500
HACCP	1 @ 22,000	27,500	27,500	27,500

[1]Salary is cash only; final cost includes fringe benefits at 25% of base wage for all workers.

The proposed budget allowed $10,000 for a part-time office worker. At the same level of benefits this was an annual expense of $12,500 for office labor. The office worker would function as the receptionist and bookkeeper, process payroll, generate the billings and answer the phone.

One full-time maintenance person was budgeted at a slightly higher rate than the office person. This employee would be responsible for maintenance of the buildings, grounds, and equipment; and would have responsibility for offal disposal and maintenance of the offal disposal site. Most importantly, this person would be responsible for plant cleaning on a daily basis.

Five production workers were assumed to be required, based on the 1976 survey of slaughter plants in North Dakota. The average output per worker in that survey was used to determine the amount of production labor needed for a plant of this size. Assuming 80 lambs per day each worker would need to completely process 2 head per hour to meet production goals. The average wage for butchers in North Dakota in 1996 was $19,900 per year(N.D. Labor Dept). An estimated $20,000 per year with the same level of benefits as all other employees was budgeted. Production employees accounted for $125,000 in annual payroll.

The federal veterinarian estimated that the additional payroll needs to meet the requirements of HACCP could add up to two additional full-time employees. One person dedicated to HACCP compliance was budgeted. The manager, maintenance person and office staff would perform also some of the tasks. The HACCP person was budgeted at $22,000 plus benefits, due to the semi-supervisory role in insuring compliance with the requirements of the HACCP program.

Investment capital was budgeted to come from three sources including a low interest loan from the regional development council, a loan from commercial sources and members' equity. Public infrastructure investment was projected to come from grant sources. Investment sources and annual payment schedule at various use levels are shown in Table 3.

Table 3. Proposed Slaughter Plant Investment Sources and Repayment Schedule, ND, 1997.

Source	Plant Capacity and Annual Scheduled Repayment		
	100%	75%	50%
	----------$----------		
$100,000 Loan	6,721	6,721	6,721
$800,000 Loan	93,963	93,963	93,963
$600,000 Member Equity	0	0	0
$1,500,00 Total	100,684	100,684	100,684

Total capital investment requirement was estimated to be $1,500,000. A 40 percent equity position is a common requirement, so up to $900,000 could be borrowed capital. Sources of borrowed capital would include $100,000 from the regional development council at 3 percent interest with a $6721 annual payment for 20 years and $800,000 from commercial sources at 10 percent interest for 20 years. The budgeted annual payment was $93,962.89. Mortgage loans are fixed costs with constant annual payments at all levels of plant operation.

The final source of funds for investment was member equity capital budgeted at $600,000. No repayment was assumed, but a return on investment will be computed. Profits will either be distributed to the investors as dividends or retained by the cooperative and called retained earnings for capital expenditures. Bylaws adopted by the cooperative will designate methods for dividend disbursement and uses for retained earnings.

Depreciation is a major expense category for the plant. The building, valued at $268,000, was depreciated over 20 years using the straight line method. Building depreciation was budgeted at $13,400 per year for the life of the plant. (Table 4)

Equipment, including all new refrigeration, a smokehouse, and new slaughtering and processing equipment, was valued at $1,200,000 and was depreciated over ten years using the straight line method. Budgeted expense for equipment depreciation was $120,000 per year. Both building and equipment depreciation is constant regardless of the percent of plant capacity used. Depreciation expense is documented in Table 4.

In addition to physical plant investment, the plant would require operating capital estimated at $468,400. The major draws on operating capital are live animal purchases and payroll obligations. The operating budget for the plant assumes that the turnaround time on product, i.e. the time between when the expense is incurred and when the payment is received for product, is 60 days. Other studies have used 30 or 45 days for an operating budget. Industry sources indicate that funds for less than 60 days may be insufficient capital for the successful operation of the plant. The operating budget was derived by dividing total expenses for the year by 12 to determine a monthly expense. Monthly expenses were doubled to compute 60 days of operating capital.

The two most significant variable cost items were lamb purchase and labor costs. At projected full capacity, the plant would purchase 1667 lambs a month. The 60-day lamb purchase expense was just under $390,000[3]. Monthly salary needs were near $19,000. Operating capital needs for salaries would be nearly $38,000. These two expense items alone required working capital of $428,000 to operate 60 days. Together with the other variable expenses, the working capital needs of the plant were estimated at $486,400. The cost of maintaining this pool of capital was estimated at $48,640 per year.

Insurance for property, liability, directors, and workers compensation was budgeted at $33,803 per year. Insurance premiums are constant at all capacity levels and were obtained from a major insurer of commercial property in North Dakota. A breakdown of the insurance expense categories is provided in Table 4. Workers compensation insurance rates for production workers at near $16 dollars per $100 of wages resulted in the total annual bill for workers compensation at over $18,000.

Repairs and maintenance were budgeted at 1 percent of value for the building and 2 percent of value for the equipment. The building repairs are assumed to remain constant at all levels of use. Table 4 records repairs and maintenance costs at various levels of use. Equipment repairs and maintenance were prorated with level of capacity usage in the plant. Equipment repairs were budgeted at $24,000 per annum at full capacity dropping to $18,000 at 50 percent capacity. The rate for reduced capacity use repairs was 1.75 percent of value at 75 percent capacity and 1.5 percent of value at 50 percent capacity. The assumption was that reduced capacity will reduce

[3]Assuming 130-pound lambs at $0.90 per pound.

the amount of wear and tear on machinery and equipment. The reduction in wear and tear was not proportional to the reduction in plant use since some equipment, such as refrigeration, would operate at nearly the same levels regardless of the plant's usage.

Table 4. Proposed Slaughter Plant, Depreciation, Repairs and Insurance Expenses, ND, 1997.

		Plant Capacity		
		100%	75%	50%
Depreciation		----------$----------		
	Building	13,400	13,400	13,400
	Equipment	120,000	120,000	120,000
Insurance				
	Property[1]	6,300	6,300	6,300
	Liability[2]	5,120	5,120	5,120
	Directors[3]	4,250	4,250	4,250
	Workers Comp	18,133	18,133	18,133
Repairs				
	Building	2,680	2,680	2,680
	Equipment	24,000	21,000	18,000

The budget for general travel, dues, and conventions was estimated from a survey of slaughter plants in North Dakota where travel and associated costs ranged from $0.00019 to $0.00025 per pound of live animal sold. Travel and dues for the proposed plant were estimated at $0.00046 per pound. While budgeted at nearly twice the rate of the survey, the total amount was only sufficient to allow travel to one national sales meeting per year.

General office expense was budgeted at $750 per month. While at first glance this may appear excessive, the cost of photocopiers, fax machines, computers, and the service contracts and supplies needed to maintain them have risen dramatically. For example, the service contract at the Hettinger Research and Extension Center for the copy machine alone was $1300 in 1996.

Advertising was budgeted at $1200 per year. This is higher than figures in the survey of slaughter plants, but this survey included many plants whose market was local and whose advertising needs were small. Twelve hundred dollars may be a conservative estimate of the advertising needs of this plant.

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[1]Includes building, equipment, and $300,000 of inventory.

[2]Liability insurance estimate also includes employee theft coverage. Coverage is for $5 million liability and $100,000 employee theft.

[3]Coverage is $1 million.

No property tax was budgeted for the first five years, because the city offered a property tax exemption for that period. After five years this would need to be added to the budget. The amount of tax obligation at the end of the exemption period was difficult to estimate.

Water use in the plant was estimated from Utility Usage in Small Slaughter Plants (Brasington, 1978). Plant water use was estimated at .36 gal per pound of live weight for processing and 1.36 gal per square foot of building per day for cleanup. The plant expects to process 2,600,000 pounds of live animal causing an annual water use need of 936,000 gallons. The building is approximately 3800 square feet in size. Projecting cleaning for 250 days per year in that size building gives a water use of 1,301,520 gallons. Total water needs were slightly greater than 2.2 million gallons per year. Based on water rates at Hope, the annual water charge was $4620 when operating at full capacity. Water usage would be slightly reduced at lower operating capacity; however, the budget held the charge steady at all use levels since estimating the reduction in use would be difficult.

Utility usage was also estimated from the same study as water usage. Energy use was estimated at 965,000 BTU per 1000 pounds of live weight slaughtered per year. The plant expects to slaughter 2,600,000 pounds at full capacity. An annual use of near 2,500,000,000 BTU would be electricity combined with propane, natural gas or fuel oil. Twenty-five percent electricity and 75 percent propane levels were selected. The plant would need just over 700,000 kwh of electricity and slightly more than 26,000 gallons of propane annually. Municipal electric rates for Hope of $0.037 kwh and the summer fill price of $0.60 per gallon for propane were used to estimate $6500 annually for electricity and $11,700 for propane. These amounts may be reduced at lower capacity uses; however, it is difficult to estimate the energy reduction at lower slaughter rates.

Laundry is a necessary expense in a slaughter plant. Plant workers need large volumes of clean smocks, aprons, hats and other protective clothing. Laundry expenses were estimated to be $1600 based on a survey of small meat processing plants. At reduced slaughter rates, laundry is reduced proportionately. The demands of HACCP may make this expense item even higher.

Slaughter and processing supplies are a surprisingly large expense. Based on the survey a plant this size would need slightly over $9500 in supplies. HACCP will also increase supply costs by an estimated $4,500. Also, HACCP required laboratory analysis will add costs, estimated at near $12,000 per year (Meat and Poultry, May 1997). This brings the total annual supply cost to $26,000. These costs were reduced proportionately in the budgets for reduced slaughter rates.

Miscellaneous charges were based on the survey and estimated at $1600 per year. They were reduced proportionately in the reduced slaughter rate budgets. Delivery charges were not included in the budgets for the proposed plant. All sales were assumed FOB Hope. This may be an optimistic assumption especially, for by-product sales.

Offal disposal was assumed to be by composting. The investment needed to set up a site and purchase equipment was included in investment costs. The maintenance employee was expected to provide the labor. Variable expense for offal disposal was expected to be for the purchase of straw for bulking and fuel for the equipment. Total disposal of offal was calculated at 650 tons per year. Assuming straw is added at 2 times the rate of offal and can be purchased delivered for $25 a ton, the straw bill was estimated at $32,500. Fuel for unloading, delivery and stacking was estimated to be 1000 gallons per year. Variable costs for offal disposal totaled $33,500 per year and were adjusted proportionately as slaughter rates are reduced.

SUMMARY

Before lamb purchase variable costs were estimated at slightly over $650,000 per year, and at full capacity the lamb purchase costs were $2,340,000 per year. Total annual plant operating costs were near $3 million. At reduced slaughter rates, the lamb purchase expense dropped; however, many of the other costs did not decline.

INCOME

Income was estimated at $2.8 million per year. This included $2.6 million of meat sales and $200,000 from pelt sales. Meat was projected to be sold at $2 a carcass pound, which was a premium over 1997 lamb market carcass prices. Pelts were projected to sell at $10 each. This was under the 1997 market price but is probably reflective of the distribution in quality of pelts that can be expected at the plant, as well as the low volume being offered for sale.

There was no allowance for other by-product sales or sales of compost, which may be a potential income source. The low volume available makes predicting the potential return difficult. Sales from this category should be considered a bonus to this plant. A summary of all expense and income items are detailed in Table 5. A five-year projected cash flow was generated in Table 6. The analysis assumes that the plant operates at 75 percent capacity the first year of operation and then attains 100 percent capacity in year two and on. Profit or loss from the previous year is carried into the next year in this table.

SUMMARY

Estimated operating expenses for the plant exceeded projected income by more than $200,000. Initial estimates of expenses were deliberately made at minimal values to determine if the plant had a chance to operate profitably. Several categories of expenses could realistically exceed initial estimates. However, since initial expenses already exceeded expected income, further refinement and documentation of expenses was not necessary.

Table 5. Proposed Slaughter Plant Expenses, Revenue and Profit, ND, 1997.

	Plant Capacity		
	100%	75%	50%
	--------------------------$--------------------------		
Depreciation	133,400	133,400	133,400
Insurance	33,803	33,803	33,803
Repairs	26,680	23,680	20,680
P and I	100,684	100,684	100,684
Operating	48,640	48,640	48,640
Salaries	233,750	194,688	155,625
Travel, Dues, Etc	1,200	1,200	1,200
Office	9,000	9,000	9,000
Advertising	1,200	1,200	1,200
Property Tax	0	0	0
Water	4,620	4,620	4,620
Electricity	6,500	6,500	6,500
Fuel	11,700	11,700	11,700
Laundry	1,600	1,200	800
Slaughter Supp	26,000	19,500	13,000
Misc.	1,600	1,200	800
Delivery	0	0	0
Offal	33,500	25,125	16,750
Subtotal	673,877	616,140	558,402
Lamb Purchase	2,340,000	1,755,000	1,170,000
TOTAL	3,013,877	2,371,140	1,728,402
Lamb Sales	2,600,000	1,950,000	1,300,000
Pelt sales	200,000	150,000	100,000
By-Product Sal	0	0	0
Subtotal	2,800,000	2,100,000	1,400,000
Profit	-213,877	-271,140	-328,402

A five year cash flow projection is presented in Table 6. Projections assume that the plant operates at 75 percent of maximum capacity in the first year of operation and then achieves 100 percent capacity in the following four years.

Table 6. Projected Slaughter Plant five Year Cash Flow Projection, ND, 1998-2002.

	Year 1 @75%	Year 2 @ 100%	Year 3 @ 100%	Year 4 @ 100%	Year 5 @ 100%
			$		
Depreciation[1]	133,400	133,400	133,400	133,400	133,400
Insurance[2]	33,803	33,803	33,803	33,803	33,803
Repairs[3]	23,680	26,680	26,680	26,680	26,680
P & I Payments[4]	100,684	100,684	100,684	100,684	100,684
Operating	48,640	48,640	48,640	48,640	48,640
Salaries	194,688	233,750	233,750	233,750	233,750
General[5]	11,400	11,400	11,400	11,400	11,400
Utilities[6]	22,820	22,820	22,820	22,820	22,820
Laundry	1,200	1,600	1,600	1,600	1,600
Supplies	19,500	26,000	26,000	26,000	26,000
Misc	1,200	1,600	1,600	1,600	1,600
Offal	25,125	33,500	33,500	33,500	33,500
Subtotal[7]	616,140	673,877	673,877	673,877	673,877
Carry Over[8]		-271,140	-485,017	-698,894	-912,771
Lamb Purchase	1,755,000	2,340,000	2,340,000	2,340,000	2,340,000
Total Exp.[9]	2,371,140	3,285,017	3,498,894	3,712,771	3,926,648
Lamb Sales	1,950,000	2,600,000	2,600,000	2,600,000	2,600,000
Pelt Sales	150,000	200,000	200,000	200,000	200,000
Total Sales	2,100,000	2,800,000	2,800,000	2,800,000	2,800,000
Profit/Loss	-$271,140	-$485,017	-$698,894	-$912,771	-$1,126,648

ECONOMIC PROFITABILITY

An economic profitability analysis to determine an internal rate of return for the proposed plant and a potential return to member equity was not computed because initial cost and return assumptions resulted in a net loss. However an opportunity cost of equity capital was computed to use in subsequent analyses to identify alternatives which may allow the plant to be feasible.

The original assumption was that the investors in the proposed cooperative would provide $600,000 in equity capital. The opportunity cost of that capital to the investors is equal to the return the members could receive from an alternative investment with similar risk. One argument may be that lamb producer investors may be willing to accept a lower return from their investment in the proposed plant because they would be guaranteed a local market for lambs at a pre-determined price. An alternative argument is that producers would need a higher return on investment because the proposed plant may be riskier that alternative investment opportunities.

[1]Includes building and equipment

[2]Property, liability, theft and workers comp.

[3]Building and equipment.

[4]Includes all loans, but no provision for member equity repayment.

[5]Includes general travel, dues, convention expense, general office expense and advertising.

[6]Includes water, electricity and fuel.

[7]All variable expenses except lamb purchase.

[8]Previous operating years profit or loss carried into currant year.

[9]All expenses including lamb purchase.

A wide variety of investment alternatives can be used for comparison including stocks, bonds, certificates of deposit, mutual funds, and farmland; as well as a number of existing and potential producer-owned cooperatives that require an investment in equity capital. Twenty-year U.S. Treasury Bonds, which may be considered a relatively safe investment, are yielding about 7 percent interest. Shorter term certificates of deposit are yielding about 5 percent , while some stocks and mutual funds are generating close to a 10 percent return. Producer investors may expect a return of from 5 to 10 percent on equity, which means the project would need to generate an additional $30,000 to $60,000 per year to entice producers to invest.

Each individual investor would have a different minimum rate of return that would be acceptable. An average of 7.5 percent or $45,000 was chosen as an example of an opportunity cost of equity capital for use in subsequent analyses.

MAXIMUM BREAK-EVEN INVESTMENT

Previous projections indicated that the total fixed and variable costs would exceed total revenue. Consequently, it was decided to determine what level of costs would allow the proposed plant to break-even. Variable costs vary directly with production and may have been underestimated in some cases. Therefore, it would be difficult to reduce the variable cost category.

Fixed costs are "sunk" costs that include investment in plant and equipment, insurance, etc. These costs do not vary with production, but do affect profitability because of their magnitude.

Two possible solutions for fixed costs that are too high are to either 1) increase volume to lower the per unit fixed costs or 2) reduce the fixed cost expenditure. Since increased volume is probably not a viable option for the proposed plant, the potential for reducing fixed investment was examined. The question is what can be paid for the plant and equipment to break-even.

A budget for operating a slaughter plant at 20,000 lambs a year in North Dakota is shown in Table 7. The analysis works backwards from the previously developed budgets. Starting with the total expected income of $2,800,000 at a production level of 20,000 lambs, the lamb purchase expense of $2,340,000 was subtracted. This provides the gross margin of $460,000 available to pay all other costs. From this gross margin, all other variable costs amounting to $406,813 were subtracted. The balance of $53,187 was the amount that is available to pay for fixed expenses and return on investment, assuming that all other expense items do not change in a plant with less investment.

Table 7. Proposed Plant Maximum Investment to Break-Even, ND, 1997.

	$	
Total Sales		2,800,000
Lamb Purchase	2,340,000	
Gross Margin		460,000
Workers Comp.	18,133	
Insurance[1]	9,370	
Operating Interest	48,640	
Salaries	233,750	
Travel, Dues, Etc	1,200	
Office	9,000	
Advertising	1,200	
Water	4,620	
Electricity	6,500	
Propane	11,700	
Laundry	1,600	
Supplies	26,000	
Misc.	1,600	
Offal Disposal	33,500	
Total Other Variable	406,813	
Margin After Variable Exp.[2]		53,187
$100,000 Loan[3]	6,721	
$122,000 Loan[4]	14,329	
40% Member Equity[5]	0	
Insurance[6]	1,575	
Repairs and Maintainance	5,550	
Facility Depreciation	12,500	
Equipment Depreciation	12,000	
Profit/Loss.		512

Using the same assumptions as the original budget in Table 3, an investment was calculated that would be near break-even returns. The assumptions were 1) that the first source of funding would

[1]Liability and Directors Insurance.

[2]This is the amount available to pay for facilities, provide a return for investors and return a profit to the plant.

[3]This assumes the first source of borrowed funds would be the same low interest loan from the regional development council that was used in the original projection.

[4]This assumes the second source of borrowed funds is a commercial loan at 10% for 20 years.

[5]No provision is made for return to members equity in this analysis.

[6]Property insurance.

be a $100,000 loan at 3 percent interest for 20 years from the regional council, 2) that members would provide 40 percent equity, and 3) that the balance of the 60 percent that is borrowed would be a 20-year loan at 10 percent interest. Since either a renovated or new building would cost about $250,000 after renovation, that figure was used for facility cost. Repairs and maintenance were calculated at 1.5 percent of the entire investment. Depreciation was figured as straight-line for 20 years on the building and 10 years on the equipment.

Calculation of an equipment purchase price that would allow the plant to break-even was made. Results indicated that an equipment purchase price of $120,000 would allow the plant to achieve near break even results. To break-even and to pay a return to member equity, the plant would need to purchase equipment for less than the $120,000 calculated here.

However, a word of caution is necessary. The projection was for break-even results, which allow no room for error. Slight variations in costs or returns put the plant in a negative cash flow with little chance for recovery. A slowdown in sales, a price drop in the lamb meat market, a small increase in one of the variable costs, or even a short closing due to bad weather or equipment failure could change the profit potential from break-even to a loss.

In addition, the break-even equipment purchase price of $120,000 did not provide for a return on member equity. When a return on member's equity is calculated, the break-even equipment purchase price would be further reduced. Furthermore, lenders are likely to be reluctant to finance a project that is projected to at best break even.

Used equipment purchased at a small percentage of new price may turn out to be like the purchase of the building; renovation costs necessary to meet inspection standards may be equal to the purchase price for new equipment. There may be sources of used equipment, because used equipment has been used successfully in other plants. However, the cost of finding equipment and refurbishing it so that it meets the necessary standards may be high.

The assumption that all other costs will stay the same with used equipment is open to debate. If used equipment is purchased, it is fair to assume that downtime will increase due to a heavier equipment failure rate, and equipment costs would increase. It is also fair to assume that equipment meeting the exact specifications may not be available, which may lead to a less efficient plant and higher labor costs.

Finding an existing, but relatively new, plant with equipment that can be purchased within the break-even budget may be a possible solution to making this project happen. The dilemma is finding one with the necessary equipment in this geographic region.

SUMMARY

A reduced investment cost may make the proposed plant feasible. However, finding good used equipment or an alternative site with appropriate building and equipment may be difficult.

PROFIT SENSITIVITY TO CHANGE IN INPUT COSTS

There are many sales and expense categories for a slaughter plant manager to monitor. It is useful to know which categories have the greatest potential to change the profit potential as they change. This allows the manager of an operating plant to focus attention on the most critical factors for success. Knowing these factors also allows potential investors in a proposed plant to assess the potential impact of a change in the estimated operating or investment budget on the projected profit potential. Sensitivities to change in the individual income and expense categories were calculated for the proposed plant and are presented in Table 8.

Table 8. Profit Sensitivity in Proposed Slaughter Plant to Changes in Income or Expenses, ND, 1997.

	Percent Change in Net Profit Caused by 1% Change in Category
	------------------------%--------------------
Sales	12.07
Lamb Purchase	-10.08
Salaries	-1.01
Depreciation	-0.57
Investment Payment	-0.43
Operating Interest	-0.21
Insurance	-0.15
Offal Disposal	-0.14
Repairs and Maintenance	-0.12
Slaughter Supplies	-0.11
Fuel	-0.05
Office	-0.03
Electricity	-0.02
Water	-0.02

Table 8 illustrates the substantial effect on profits that changes in sales revenue or lamb purchase price have on the plant's projected profit. Other categories have far less potential to change profit. Thus management should allocate more effort in cost control of live animal purchases and efforts in revenue enhancement than in control of other cost categories.

For example, if the sales revenue is increased by 1 percent, the plant's projected profit is expected to rise by near 12 percent. Since a relatively optimistic price of $2 per carcass pound was assumed for the lamb meat, it may be unrealistic to assume that category could be increased appreciably. Therefore, an analysis of alternative lamb purchase prices which would enable the proposed plant to break-even was made.

The first computation, based on the original assumptions in Table 5, was to determine what price the plant could pay for lambs to break-even. The $213,877 projected loss at 100 percent capacity was deducted from the $2,340,000 total lamb purchase cost. Results indicated that about an eight cents per pound reduction in the lamb purchase price to $0.8177 would allow the plant to break-even. The $0.8177 price does not include a return to member's equity. Including an additional $45,000 in the budget to provide a return to the equity capital invested in the plant reduces the break-even price of lamb purchases to $0.8004. The impact of changing lamb purchase prices is shown in Table 9.

Table 9. Proposed Slaughter Plant Projected Profitability at Various Lamb Purchase Prices, ND, 1997.

	Lamb Purchase Prices ($/lb.)			
	----------$----------			
	0.9000	0.8177	0.8004	0.7358
Total Revenue	2,800,000	2,800,000	2,800,000	2,800,000
Total Costs	3,013,877	2,800,000	2,755,000	2,582,207
Cash Return	-213,877	0	45,000	217,793
Equity Cost	45,000	45,000	45,000	45,000
Economic Profit	-258,877	-45,000	0	168,000
Economic Profit With 25% Cost Increase[1]	-426,877	-213,000	-168,000	0

[1]This would raise plant operating costs by approximately $168,000.

Table 9 also demonstrates the effect of increasing costs on the plant's ability to pay for lamb purchases. In the original estimated budget, several categories have potential to increase the plant's cost of operation. For example, no allocation was made for property taxes or delivery in the original budget. Furthermore, the estimate for offal disposal was made using the assumption that composting would be a feasible solution. The potential exists for costs to exceed the original estimates. Thus, Table 9 shows the effect of a 25 percent increase in plant operating costs on lamb purchase price. A lamb purchase price of $0.7358 per pound would cover a 25 percent increase in costs and a return on member equity.

The proposed plant's profits are sensitive to the market price for lamb carcasses, the primary product produced. Projections were made using $2 per carcass pound for lamb, which is a premium over the wholesale trade price for lamb. If the plant was unable to achieve this price for carcasses, the price paid for live animals would need to be adjusted. The impact of lower carcass sales prices on the break-even purchase price of lambs is documented in Table 10.

Table 10. Impact of Lower Carcass Prices on Break-Even Lamb Purchase Prices, ND, 1997.

	Carcass selling prices ($/lb.)			
	$2.00	$1.90	$1.80	$1.70
	$			
Total revenue	2,800,000	2,670,000	2,540,000	2,410,000
Operating Costs[1]	673,877	673,877	673,877	673,877
Gross Margin	2,126,123	1,996,123	1,866,123	1,736,123
Equity Costs	45,000	45,000	45,000	45,000
Live Purchase[2]	2,081,123	1,951,123	1,821,123	1,691,123
Break-even Price[3]	0.8004	0.7504	0.7004	0.6504

[1]Costs before lamb purchase expense.

[2]Total amount available for live lamb purchase to break-even.

[3]Live lamb price per pound to break-even at various carcass selling prices.

SUMMARY AND CONCLUSIONS

A group of North Dakota lamb producers who are members of Valley Wool Growers Association identified several niche markets for high-quality North Dakota lambs. The potential availability of a closed, but formerly federally inspected, livestock slaughter and meat processing facility in Steele County heightened their interest in determining the feasibility of a cooperatively owned lamb slaughter and processing facility. The cooperative would be patterned after existing and proposed slaughter cooperatives, whereby cooperative members would own shares to supply lambs to the plant on a year-round basis.

Valley Wool Growers Association applied to the Agricultural Products Utilization Commission in North Dakota for a grant to cover the cost of a feasibility study of the proposed plant in Hope. Funding was granted, and the research was conducted by researchers at the Hettinger Research and Extension Center and the Institute of Natural Resources and Economic Development in the Department of Agricultural Economics at North Dakota State University.

The analysis was conducted in several sections corresponding to critical factors which affect feasibility of the plant. The critical factors analyzed included federal inspection requirements, the potential of an adequate supply of lambs, the potential for a viable niche market, plant investment and operating costs, expected return, alternative lamb purchase prices, alternative lamb carcass sales prices, and several investment and expense scenarios.

The supervising veterinary medical officer for USDA, FSIS toured the existing plant and concluded that the plant should be renovated to a "like new" status before it would be approved for reopening under federal inspection. Since federal inspection is mandated by law, the USDA is obligated to provide inspection to a plant that meets specifications. Therefore, if the plant was renovated to a "like new" status and approved, federal inspection requirements would not prevent the plant from being operational.

Sheep numbers in North Dakota and the region, coupled with new technology in year-round lamb production, indicate that enough lambs could be available to meet the needs of the plant. However, recruiting sufficient members to supply the plant on a daily basis may be difficult. The cooperative would need high quality slaughter lambs with a consistent weight and grade. An educational program would be necessary to inform members of the additional feeding requirements necessary to meet the weight and quality goals of the cooperative.

Producers in the proposed cooperative identified several confidential niche markets for high quality North Dakota produced lambs. Some examples include marketing to ethnic and religious groups in more urban markets and production of hothouse lambs for that market. There is a niche market for the high quality specialty product this plant would produce. In addition, a premium price for the product can be expected because it meets the specifications of unique consumer groups.

The building and equipment investment was projected to be $1,468,000 which was higher than originally expected due to the extensive refurbishing necessary to meet federal inspection and increased capacity requirements. Plant operating expenses at full capacity were projected to be $3,013,877 per year which included $673,877 in operating expenses and $2,340,000 for lamb purchase. Income from lamb meat sales and pelts was estimated at $2,800,000 per year.

The assumptions of purchasing lambs for $0.90 per pound and selling the meat for $2.00 per carcass pound resulted in an annual negative margin of $213,877 at full capacity.

An economic profitability analysis to determine an internal rate of return for the proposed plant and a potential return to member equity was not computed because initial cost and return assumptions resulted in a net loss. However, an opportunity cost of equity capital of $45,000 was computed to use in analysis of alternatives which may allow the plant to operate profitably.

An analysis of equipment investment costs concluded that only $120,000 minus the cost of equity capital could be spent to allow the plant to break-even. Since used equipment may be difficult to obtain,. an analysis of alternative lamb purchase prices was conducted. Results indicated that a lamb purchase price of $0.8004 per pound would be necessary to cover all original cost assumptions and provide a return to member investor equity. A 25 percent increase in non-lamb purchase costs would further reduce the lamb purchase price to $0.7358 per pound.

RECOMMENDATIONS

The original idea for lamb producers to purchase the existing slaughter and processing facility in Hope, North Dakota, expand and remodel it to slaughter and process 20,000 lambs annually, refurbish it to meet federal inspection specifications, pay the producer members $0.90 per pound for lambs, and sell the meat for $2.00 per carcass pound was projected to operate at a loss.

Therefore, other scenarios were investigated which would enable the plant to operate profitably. The maximum price that could be paid for lambs to pay all investment and operating costs, including a 7.5 percent return to member equity, was $0.8004 per pound. A 25 percent increase in projected costs would reduce the purchase price to $0.7358 per pound, or a reduction in the lamb carcass sales price to $1.80 per pound would reduce the lamb purchase price to $0.7004.

The range in probable prices that could be paid for lambs is $0.70 to $0.80 with a likely price of $0.75. The proposers of the cooperative will need to decide if prices in this range would be sufficient to lure enough member investors to provide the 20,000 lambs necessary to operate the plant.

The idea to add value to locally produced lambs and provide product to a niche market is a good one. It should not be lost even if the viable purchase prices are considered too low to generate sufficient interest. Other alternatives could be considered and include the following:

1) A viable niche market for high quality, specialty lamb products does exist; so producers may want to pursue slaughtering lambs on a custom basis in an existing slaughter facility. This would eliminate the initial investment costs in buildings and equipment and enable producers to concentrate on producing and marketing a high quality product. It would allow starting on a smaller scale with fewer lambs per year. The authors highly recommend this alternative.

2) Producers may pursue alternative packing plant sites which may be for sale. However, the likelihood of finding a suitable building with adequate equipment in the immediate geographic area for under $400,000 may be small.

3) Other lamb producer groups in Minnesota, Wyoming and the Dakotas have also expressed an interest in building or purchasing a lamb slaughter facility. Producers may want to coordinate activities with one or all of these groups to see if a larger, regional plant would be feasible. Valley Wool Growers Association may even want to take leadership in attempting to bring all these groups together to discuss alternatives for a regional lamb slaughter, processing, and marketing project. The authors also recommend this alternative.

4) Stringent federal inspection specifications along with the new HACCP requirements cause relatively high per unit costs for small slaughter plants. There are several other livestock producer groups (ratite, elk, deer, goat, specialty beef, etc.) who may like to have access to slaughter and

processing facilities. Rural economic development funds may be available to assist producer groups in building a multi-species "incubator" type of slaughter facility in which groups could share in the costs and scheduling of the plant. It could be billed as a demonstration project for possible adoption in other geographic areas if it is viable. Furthermore, small slaughter plant operators may need to seek some sort of regulatory relief, particularly with HACCP, from Congress in order to remain a viable industry.

North Dakota State University looks forward to further assisting lamb producers in whichever alternative they decide to pursue.

NEED FOR FURTHER RESEARCH

The 1979 survey of small slaughter plants information is still the best source of costs and capacities in small slaughter plants. However, this study is dated. A repeat of the survey would provide valuable current information to the many groups looking to expand livestock slaughter in the Northern Plains.

A growing concern for all slaughter plants is the disposal of non-saleable offal products. A research and demonstration project of composting red meat offal products would allow a more accurate picture of the potential of this technology and its costs and returns.

Critical Success Factors For Profitable Sheep Production

Dan Nudell, Harlan Hughes and Tim Faller

Many factors affect profitability of farm enterprises. These factors are either things the manager can control, the management decisions he makes, or things that are out of his control, for example weather or imports of competing product. The effect on profit of each of these factors can range from large to small. There is a limited amount of time that a manager can spend on any given farm enterprise. Since there is almost a limitless number of potential factors that a manager can measure and use in decision making, the first step a prudent manager should take is to decide what factors are in his control, and then decide which factors in his control will have the greatest impact on the profitability in this enterprise. If a manager can focus his management skills on the most critical factors affecting the profitability of the enterprise his management time can be expended in measuring, analyzing and making decisions from the resulting information in the best possible and most efficient manner.

Management decisions can be thought of as the bridge between where the enterprise is and where the manager wishes it to be, in other words his goal. This goal often may be the maximum profit from the enterprise under consideration. The present state of the enterprise, where I am, is often more difficult to define. Some type of records are necessary to determine the state of the enterprise that decisions are being made for. If a producer knows where the enterprise is and has a defined goal, then the next step is to make management decisions, to build a bridge so to speak, that will allow the enterprise to move towards the goal. This is where knowing the critical success factors is important. Having this knowledge allows the producer to focus his or her attention on the things that have the greatest effect on progress towards the goal.

This research identifies the critical success factors for profitable sheep production. Information from producers in the North Dakota Sheep Development Project was analyzed to identify the management parameters that had the largest effect on the profitability of the enterprise. Some surprising results emerged. Many of the factors we commonly accept as crucial to profit in the sheep business did not survive a hard look at their true contribution to profitability. The analysis instead shows producers that there are other management decision points that bear more close scrutiny than the traditional measures of lambing rate and death loss.

The identified critical success factors are 1) having a low unit cost of production, 2) having enough size to be efficient, 3) adding value to the base production of the flock and 4) a mathematical measurement of year-around management level. At first glance these four factors seem fairly simple and hardly worth a research project. Lets exam them in more detail.

Unit cost of production is a ratio of all production from the flock and all costs associated with the flock. It is a powerful number embodying all activities of the flock in one measurement. Not surprisingly the study showed that profits were enhanced by having a low unit cost of production. The next measurement is having enough size to be efficient. This was measured as the gross dollar output of the flock. Again, not surprisingly the larger volume flocks tended to be more profitable. Adding value to the flocks basic production, defined as feeding lambs to weights heavier than traditional weaning weights was identified as a positive influence on profitability. Finally a measure of management level throughout the entire production year, defined as a relationship between flock size and lambing season length was identified as important to profit.

Lets discuss these factors individually. Unit cost of production (UCOP) is a measure of the average cost of producing one unit of final product. Said another way it is the total cost incurred by the flock divided by the total hundredweights of lamb equivalent sold. Since UCOP is a measure of all things it is very powerful as a measurement tool, but less useful as a day to day management measure. Looking at the factors that management can affect that have the most influence on UCOP may be more useful. UCOP can be represented mathematically with the equation

$$\text{UCOP} = \text{Intercept} + \text{FEED COST} - \text{WEAN WEIGHTS} - \text{POST WEANING WEIGHT GAIN} + \text{POST WEANING WEIGHT GAIN}^2$$

This equation tells us that UCOP is most affected by three factors that we control. They are feed cost, total weaning weight and the total amount of post weaning weight gain in lambs. As you look at the equation you can see that adding feed cost to the operation raises the average unit cost of production, increasing the weaning weight decreases average cost of production and adding post weaning gain, at least up to a certain point, lowers average cost of production. The second value added term is in the equation as a squared term and has an opposite sign to the non-squared term. This indicates that as lambs become too heavy the total cost of production rises.

The measure of size of efficiency used in this study was flock gross revenue(GROSS). Adding revenue was positive for flock profit. Two factors had the greatest effect on gross revenue, they are the amount of post-weaning lamb weight gain and the management measure. Represented mathematically the equation for gross revenue is

$$\text{GROSS} = \text{Intercept} + \text{POST WEANING WEIGHT GAIN} - \text{A MANAGEMENT MEASUREMENT}$$

This equation tells us that increasing the amount of weight we add to our lambs after weaning is positive for gross revenue and also positive for net revenue, and that tightening management practices during the year is a positive influence on gross revenue.(the management measurement is recorded as a negative number, thus an increase in the level of management means that the management number becomes smaller which in turn increases the Gross return)

The third critical success factor is the management parameter. This is defined as the lambing season length minus the number of ewes in the flock. Thus a negative number means that there is at least one ewe lambing every day of the lambing season. A positive number means that there are days in the lambing season where no ewes lamb. A positive number tells us that there are days when the shepherd expends labor checking on ewes and receives no return for that labor. What the management measurement really tells us is the level of attention the ewes receive at other times of the year. Having a concise lambing season implies that all the best management practices were followed during the entire production year to ensure that ewes were ready and able to breed in the shortest time frame.

The management measure can be explained with a two variable equation.

MANAGEMENT = Intercept - MONTH OF BIRTH - TOTAL PRODUCTION

Where month is the number of the month (Jan = 1, Feb = 2, etc.) the first lamb is born in and total production is a measure of the flocks total productivity recorded as market lamb equivalents. As the month of lambing moves later in the year the management response becomes smaller. This is probably a biological response from hitting their ewes peak breeding season. As total production rises the management measurement also decreases. This is probably a reflection of better managers having higher production and higher producers being better managers.

Finally the profit equation tells us that profits are enhanced by feeding lambs past weaning weights. Typically many North Dakota lambs have been fed to finish weights elsewhere, this data would indicate that we are missing an opportunity to capture additional profit by not finishing lambs in state. The factors affecting feeding lambs can be explained with a three variable equation:

POST WEANING WEIGHT GAIN = Intercept - DEATH LOSS - WEANING WEIGHT + TOTAL FLOCK PRODUCTION

The equation tells us that as death loss rises producers tend to sell lambs at a lower weights. This is logical since a producer who has already suffered high death loss pre-weaning may be reluctant to risk owning his lambs for a feeding period. As weaning weights rise the ability to add weight to the weaned lambs declines due to the upper limit set on acceptable lamb weights. An finally as total flock production rises so does the amount of weight gain on feeder lambs. Producers who are producing all commodities from the flock at high levels probably have the skills and confidence to finish lambs.

Table 1. Sensitivity of profit to a 1 percent factor change.

	ELASTICITY	**PROFIT CHANGE AT WITH 1 PERCENT CHANGE IN FACTOR**
UCOP	1.36	$25.09
GROSS	1.08	$19.93
FEED COST	0.73	($13.42)
POST WEAN WEIGHT GAIN	0.66	$12.18
TOTAL PRODUCTION	0.52	$9.64
WEANING WEIGHTS	0.39	$7.18
MANAGEMENT	0.19	$3.41
MONTH	0.16	($2.95)
DEATH LOSS	0.05	($0.89)

If we look at all these factors together we can measure the effect each on has on net profit and rank them according to that effect. Economists call this effect elasticity. It is a measure of the magnitude of change we see in an output related to a small change in some other factor. Focusing on the factors that have the largest magnitude effect on the outcome we wish to change is the most efficient way to achieve our goal. This ranking is documented in Table 1. From Table 1 we can tell that a one percent change in unit cost of production changes the flock's net profit results by over 1.3 percent. By contrast a 1 percent change in pre-weaning death loss changes net profit by only 0.05 percent. An astute producer will expend more effort on the management factors that have larger effects on net profit.

Summary:

This research shows that the traditionally accepted measurement of success in the sheep industry, lambing rate, is not the best indicator of profit potential for the flock. Producers instead need to focus more energy on the cost side of the operation. Of the five factors with the largest elasticity response to profit, two are cost driven, Unit cost of production and feed cost. The remaining three of the five factors with the largest elasticity are related to size of the operation. Gross returns, post-weaning lamb feeding and total flock output all enhance profitability as size and output increase.

In contrast pre-weaning death loss has little effect on net profit and the lambing rate effect on profit is not significant. This is contrary to conventional belief in the sheep industry and merits further discussion.

Use of a synthetic progestogen in combination with a superovulatory treatment for induction of synchronized estrus in seasonally anovular ewes.

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NDSU Main Experiment Station, Fargo, 1998

Introduction

Production of animals for meat is a multi-billion dollar industry in the U.S. alone. Income from sale of animals, feed consumed by animals, and meat consumed in the U.S. was, conservatively, $235 billion in 1994 (Agricultural Statistics, 1995-96), which does not include the economic impact of the food industry and its employees. Because maintenance of reproductively sound females is the primary expense for livestock producers, reproductive failure remains one of the most limiting and costly factors facing the livestock industry (Trenkle and Willham, 1977; Ferrell and Jenkins, 1985). Thus, improvements in reproductive efficiency would have a major impact on the profitability of animal agriculture. Beyond that, with the continued explosive growth of the world's population, which shows no signs of slowing any time soon, the ability to efficiently produce animal protein, especially from low-quality forages, should be and is a major driving force for agricultural research (NRC, 1989; Mann, 1997). Thus, understanding the mechanisms controlling reproductive efficiency of farm animals has important socioeconomic implications for North Dakota, the nation, and the world.

The **goal** of this research program is to develop an effective procedure for production and storage of fertile eggs from ewes during anestrus (i.e., out-of-season), when they normally are not cycling and their ovaries are quiescent. The **specific objective** of this experiment was to evaluate the use of norgestomet (a synthetic progestogen) in combination with a superovulatory treatment regimen (FSH) for the production of fertile eggs from seasonally anestrus ewes. A future objective of this line of research is to develop improved procedures for cryopreservation and transfer of sheep embryos.

Sheep are seasonal breeders, and normally exhibit ovarian function and estrous cycles during late summer and fall. Conversely, they exhibit anestrus and ovarian quiescence normally during the winter and early spring. Synthetic progestogens have been used successfully for estrus synchronization in the cycling ewe (Hinds et. at. 1961; Tilton et. al., 1966, 1967). Synthetic progestogens also have been shown to stimulate estrus behavior and ovarian activity in seasonally anestrous ewes (Haugen et al., 1997; Safranski et al., 1992; Jabbar et al., 1994). In all of these studies, however, a substantial number of ewes do not respond to progestogen treatment alone during seasonal anestrous.

However, it has been shown that a variety of gonadotropin treatments can augment the ovarian response to progestogen treatment during the anestrous period (Safranski et al., 1992; Jabbar et al., 1994). Over the past 10 years, we have developed an extremely successful technique for inducing multiple ovulations (superovulation) in cyclic ewes (Jablonka-Shariff et al., 1994, 1996). We therefore **hypothesized** that progestogen treatment in combination with our technique for inducing superovulation in ewes would provide an effective means to produce large numbers of fertile eggs from seasonally anestrous ewes.

With successful techniques for induction of out-of-season superovulation, our laboratory will begin to focus on embryo collection, culture, cryopreservation, and transfer procedures for optimizing the use of genetically superior ewes during a time when they are naturally unproductive. This technology should prove to be extremely useful to the sheep industry as a whole.

Materials and Methods

Twenty seasonally anestrous non-lactating ewes of various ages were randomly assigned to progestogen (Synchro-Mate-B [SMB], Merial Limited, Athens, GA) alone (SMB treatment, n=10 ewes) or progestogen in combination with an FSH superovulation regimen (SMB/FSH treatment, n=10 ewes). One-half of an SMB implant (½ of cow implant) was implanted into the left ear of each ewe and left in place for 10 days as described by Jabbar et al. (1994). At the end of SMB treatment, SMB implants were removed through a small incision made in the skin at the distal end of the implant. Beginning on the morning of removal of SMB implants, ewes received twice daily (morning and evening) intramuscular injections of saline (salt water) or FSH (FSH-P, a pituitary extract; Sioux Biochemical, Sioux Center, IA) for three days as follows; Day 1, 5 mg/injection; Day 2, 4 mg/injection; Day 3, 3 mg/injection (total dose = 24 mg).

Rams were introduced to ewes at the time of the first saline or FSH-P injection and remained with the ewes for a total of 25 days. Rams were brisket painted daily to aid in estrous detection. On Days 7-9 after the synchronized estrus, all ewes were subjected to a laparoscopic exam to determine ovulation rates.

Results

Table 1 shows the estrus response of ewes to the SMB or SMB/FSH treatments. Nine of 10 ewes in each treatment group expressed out-of-season estrus in response to the SMB treatment alone. Furthermore, estrus in all ewes was synchronized, with estrus occurring between 1 and 3 days after removal of the SMB implant. However, ewes receiving the superovulation treatment (SMB/FSH) exhibited estrus an average of one day earlier ($P<0.01$) than ewes receiving SMB alone (see Table 1, below).

Table 1. Estrus responses to Synchro-Mate-B and superovulation treatment in seasonally anestrous ewes.

Treatment	No. of ewes	No. ewes synchronized*	Days to estrus after SMB removal	Range in no. days to estrus
SMB	10	9	2.2 ± 0.2	1.5 - 3.0
SMB/FSH	10	9	1.2 ± 0.1	1.0 - 2.0

*Ewes in estrus within 72 hours of SMB removal.

Ovulation rates differed significantly ($P<0.01$) between the two treatments, with those ewes receiving the superovulation treatment (SMB/FSH) exhibiting 8.2 more ovulations than ewes receiving SMB alone (see Table 2). All ewes receiving the superovulation treatment were superovulated, indicating that in this study, the superovulation treatment was 100% effective. The range in ovulation rates was reasonable for use in an embryo transfer program. Only one ewe in the superovulation treatment exhibited only 3 ovulations, whereas all other ewes had 5 or more ovulations (Table 2).

Table 2. Ovarian responses to Synchro-Mate-B and superovulation treatment in seasonally anestrous ewes.

Treatment	No. of ewes	No. ewes superovulated*	Ovulation rate (no. CL)	Range in no. of ovulations
SMB	10	2[a]	1.7 ± 0.4	1-4
SMB/FSH	10	10[b]	9.9 ± 1.5	3-17

*Ewes with more than 2 ovulations.
[a]One ewe exhibited 3 ovulations, one ewe exhibited 4 ovulations
[b]One ewe was not detected in estrus by the ram but exhibited 6 ovulations in response to SMB/FSH treatment.

Discussion

Superovulation is considered critical for the long-term success of embryo collection and transfer programs because: 1) donor animals are usually genetically superior; and 2) the procedure is costly. Thus, to ensure that embryo transfer is cost-efficient, maximizing the number of embryos obtained from each donor is important. Superovulation protocols currently in use in the animal industry, however, are less than optimal.

Although most ewes respond to superovulatory regimens, embryo recovery rates vary between approximately 30 to 60% (Jabbour and Evans, 1991; Rexroad and Powell, 1991; Ryan et al., 1991; Evans et al., 1994). In addition, a lower embryo recovery rate is observed when ewes are superovulated and inseminated during the anestrous period (i.e., winter and early spring) compared with the normal breeding season (late summer and fall), perhaps due to the formation of sub-functional corpora lutea from the superovulated follicles (Hunter, 1991; Ryan et al., 1991). Moreover, these superovulatory regimens involve use of combinations of several hormones, including progesterone, gonadotropin-releasing hormone, pregnant mare serum gonadotropin, follicle-stimulating hormone, and(or) prostaglandin F2a (Hunter, 1991; Jabbour and Evans, 1991; Rexroad and Powell, 1991; Ryan et al., 1991; Evans et al., 1994), and thus are difficult to administer and costly.

Data from the present study not only confirms earlier reports that the use of synthetic progestogens are useful in stimulating ewes to ovulate out-of-season, but also demonstrates that the use of a simple, effective superovulation regimen developed by our laboratory for normally cycling ewes is effective for inducing superovulation in seasonally anestrous ewes (Grazul-Bilska et al., 1991; Jablonka-Shariff et al., 1994; Doraiswamy et al., 1997). This superovulation regimen resulted in 13.2 ± 0.9 ovulations in 85 ewes superovulated during the breeding season over five years (Jablonka-Shariff et al., 1994), which is slightly higher than the 9.9 ovulations observed in the present study. The differences observed from our previous work compared to the present study is likely due to the fact ewes in the present study were induced to ovulate out-of-season.

The results of this study will lead to improved methods for obtaining large numbers of high quality embryos in sheep for use in embryo transfer programs and also will provide for increased flexibility and efficiency of reproductive management for sheep producers. Future studies in our program will be carried out to compare the quality of eggs and/or embryos obtained from superovulated cyclic and seasonally anestrous ewes. Eggs from these ewes will be fertilized in vitro, and the rates of fertilization, development, and survival after cryopreservation will be evaluated. In addition, we also will examine the effectiveness of cryopreservation techniques for the long-term storage of sheep embryos. Future directions in our program also will include transfer of embryos after in vitro (in the laboratory) or in vivo (natural) fertilization.

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Application of Modern Biotechnologies in Sheep Production

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In the last 10-20 years, new biotechnologies have been developed that are on the verge of revolutionizing animal production (Wallace, 1994; Hansel and Godke, 1992; Wilmut et al., 1992). These biotechnologies involve primarily the application of tools derived from molecular genetics, as well as assisted reproductive technologies, to the improvement of animal production (Hansel and Godke, 1992; Wilmut et al., 1992 Nicholas, 1996). These modern biotechnologies include:

1. Use of molecular markers, such as microsatellite markers with sequence tagged sites (STS), as powerful gene mapping tools;
2. Use of STS to map genetic loci for quantitative traits (milk production, fleece weight, growth rate, metabolic efficiency, etc.), which are termed quantitative trait loci (QTL);
3. Use of QTL in animal breeding programs, which is termed marker-assisted selection;
4. Use of QTL and other molecular markers to map and identify the genes for specific traits or defects, which is termed positional cloning;
5. Genetic diagnosis using specific molecular probes to identify individuals, including adults and embryos, that carry a specific gene;
6. Introduction of specific genes, or gene transfer, into individuals to correct a genetic defect or obtain a specific biological product.

The recent development of techniques for production, culture, storage, and transfer of embryos is critical for the application of several of these powerful new molecular tools (Niemann, 1991; Hansel and Godke, 1992; Nicholas, 1996). For example, modern embryo technologies have enabled the development of methods to transfer desired single genes or, alternatively, the entire genome from a desirable individual, to embryos. This latter technique involves the cloning, or duplication, of entire individuals that are genetically identical. Both of these techniques have been made feasible by the development of nuclear transfer, wherein an entire nucleus containing the desired gene or genome is transferred to an early, single-cell, embryo that previously has had its own nucleus removed (Schnieke et al., 1997; Wilmut et al., 1997). In addition, rapid advances in techniques to manipulate embyros in the laboratory has enabled genetic screening of embryos for genetic defects or quantitative traits using molecular markers.

To enable the application of these modern biotechnologies to the specific needs of North Dakota animal producers, the Animal & Range Sciences (A&RS) Department has recently appointed a new Assistant Professor of Animal Embryology, Dr. Anna T. Grazul-Bilska. Dr. Grazul-Bilska has a strong background in cellular and molecular biology. Her appointment as an Animal Embryologist will enable the Department to continue its commitment to addressing the needs of the livestock industry in North Dakota, by allowing us to adapt the modern biotechnologies to producer needs. In addition, appointment of Dr. Grazul-Bilska to the A&RS faculty will enhance all of the animal research programs in the Department, including Animal Physiology, Nutrition, Genetics, and Meat Science, as well as at the Research and Extension Centers throughout the state, because she will give us ready access to technologies such as gene transfer, genetic analysis of pre-implantation embryos, embryo collection, storage, and transfer, etc.

Dr. Grazul-Bilska will develop a research program emphasizing applied as well as fundamental aspects of animal embryology, with a focus on embryo culture and manipulation in domestic livestock species. In addition, she will provide leadership in animal embryology resear and teaching efforts, and will engage in collaborative, interdisciplinary research that will enhance NDSU's animal science research efforts. Initially, Dr. Grazul-Bilska's research program will focus on evaluation of the quality of oocytes and embyros obtained from superovulated and non-superovulated animals under different hormonal and nutritional treatment regiments (Grazul-Bilska et al., 1991); and she also will initiate research to evaluate the importance of cell-to-cell communication in embryo growth and development. In addition, a portion of Dr. Grazul-Bilska' research program initially will focus on sheep embryology because of existing expertise in the A&RS department in manipulation of reproductive processes in sheep (see article in this report b Redmer et al.), and because sheep provide a relatively cheap source of embryos for studies that potentially will benefit the entire livestock industry. Dr. Grazul-Bilska's future research efforts will emphasize collaborations with other biotechnologists and molecular geneticists to ensure tha North Dakota's livestock industry has access to expertise in the latest biotechnologies that will impact animal production.

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Montadale Regeneration Project

Wes Limesand, Bert Moore, Paul Berg, and Millie Brown

In a history-making move, the Board of Directors of the Montadale Sheep Breeders Association unanimously approved the Montadale Regeneration Project in their annual meeting held June 19, 1997, in Springfield, Illinois.

The Regeneration Project will involve returning to the roots of the Montadale breed . . . crossing Cheviot rams on Columbia ewes. The purpose of this project is to increase the genetic base while keeping the current breed standards. In addition to increasing the availability of quality breeding stock and allowing the breed to expand, the project promises to generate new interest in the Montadale breed. No other modern sheep breed has taken such an up-front approach.

Objectives

1. To go back to the roots of the Montadale breed to create another strain of Montadales to increase out-cross potential within the breed.

2. To increase availability of quality breeding stock in order to allow the breed to expand while keeping the current breed standards.

3. To generate new interest in the Montadale breed.

Rationale

Although most purebred sheep producers hate to admit it, the reality exists that most breeds of sheep are not pure at this time. In the interest of gaining a competitive advantage, certain breeders have introduced other breeds into their breed.

Montadale represent one of the youngest purebred breeds in the modern sheep industry. Montadale breeders prided themselves for years on their integrity and the pureness of the breed. There is concern with that integrity today. It is quite certain that at least four different introductions of additional Columbia blood into the breed has occurred in the last twenty years. The future of the Montadale breed should not be left to undocumented experimentation.

To date, no sheep breed has chosen to be up-front and public about a major step to increase the gene pool of their breed by going back to their roots and creating more of the breed from the roots up. The Montadale Regeneration Project is a planned process to expand the base of the breed which is controlled and traceable.

During the fiftieth anniversary celebration in 1996, the national Board of Directors adoptec a campaign of "4000 in 2000!" The goal was to begin a campaign to take the next steps to move Montadales beyond the 3000-3400 registration total that they have been stuck a for most of the last fifteen to twenty years.

Achievement of the goal of "4000 in 2000" seemed simple enough. If every breeder registered just two more ewe lambs each year, the problem would be solved. The probler exists, however, in finding the necessary numbers of ewes to provide the additional 1000 lambs for registration, maintain the quality of the registered progeny and thus achieve the numbers goal. Creation of a program to expand the number of ewes available to produce these numbers of progeny seemed more reasonable and attainable.

Participants in the program are encouraged to use only larger Columbias so as not to loos(the present size and scale of the Montadale breed. These breeders are also encouraged t(use no less than eight Columbia ewes of similar breeding to facilitate consistency in the project.

Requirements

1. An Application of Intent to Participate which must be approved by three national directors.

2. One of the Directors must have physically inspected the Cheviot ram and the Columbia ewes.

3. Registration certificates, three-generation extended pedigrees produced by the respective breed association, and readable nose prints of the Cheviot ram and the Columbia ewes must be submitted with the application.

4. Registration certificates of progeny created under the Regeneration Project will have special codes to designate the crosses. Readable nose-prints must be submitted wi application for registry of these progeny.

    A. Ewe lambs and ram lambs from the Cheviot x Columbia will be registered with the Montadale Association with a "C" code.

    B. "C" code F-1 ewe lambs will then be bred to a Montadale ram. Their offspring will be designated with an "M" code.

    C. When "M" code rams or ewes are bred to a purebred Montadale, their offsprin(will have no special designations. Said offspring must meet the Montadale breed standards for registry.

D. A few "C" code F-1 ram lambs from the Cheviot x Columbia cross will be allowed to be registered and may be bred back to Columbia ewes. These ram lambs must first be inspected by one national director. Only ewe lambs from the "C" code F-1, ram x Columbia may be registered and they will be designated with an "X" code. An "X" code ewe bred to a Montadale ram will produce "M" code offspring which in turn is crossed with a purebred Montadale.

5. Nose prints of all lambs which will be registered with code designations must be submitted at time of registry.

6. This project is open to not only Montadale breeders, but to other interested breeders who are willing to follow the Association's guidelines.

7. If animals are leased, a lease agreement must accompany the application.

8. Applicants must pay an application fee of $25, as well as Senior Annual Dues to the Montadale Association and all application registration and transfer fees.

9. The Montadale Association requests that all judges strictly follow the current Breed Standards.

An application for Intent to Participate may be obtained by contacting the M.S.B.A. Office, P.O. Box 603, Plainfield, IN 46168; phone or fax 317-839-6198.

NDSU Involvement

North Dakota State University personnel were approached as a source of Columbias to be used in this regeneration project. Twenty mixed age Columbia ewes were assigned to the project. A Border Cheviot ram was selected by the Montadale Board of Directors and Breed Secretary. Results of these matings born in January 1998 look promising. Lambs have demonstrated excellent vigor and alertness. They also exhibit very acceptable Montadale breed type with open faces, dark noses and dark hooves.

Performance will be measured on all these lambs. It is hoped that they can contribute as an important part of the regeneration project which the Montadale breed has boldly endorsed.

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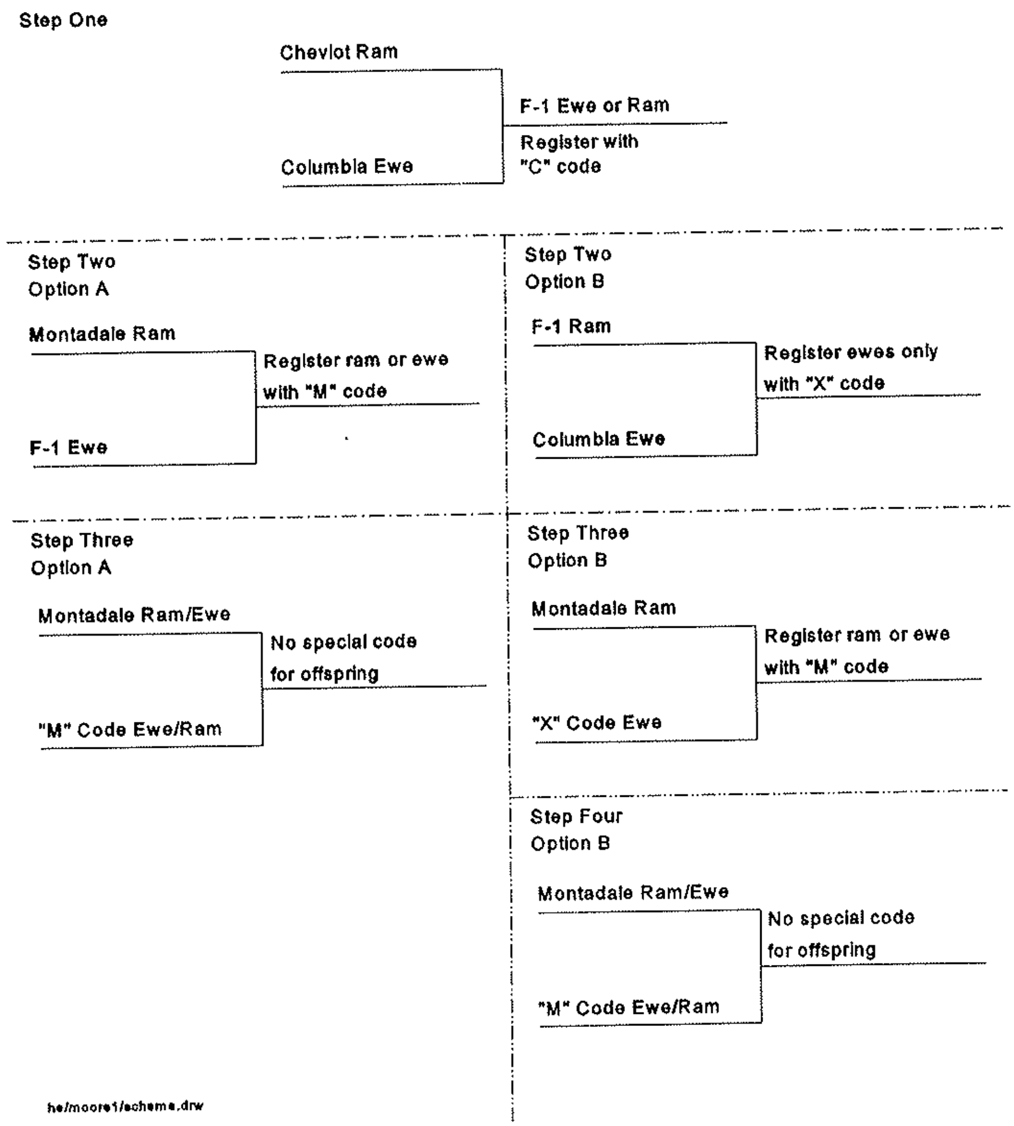
MATING SCHEME FOR STEPS IN REGENERATION PROJECT



The Test for Spider Lamb Syndrome Gene in Sheep

Bert Moore, Wes Limesand and Paul Berg

Background

Spider lamb syndrome is a heritable congenital abnormality caused by a recessive gene that produces a range of skeletal deformities in lambs. The problem, which seemed to have been first observed in the early 1970's, became a topic of serious concern to breeders in the early and middle 1980's. Many of the most popular bloodlines in the Suffolk and Hampshire breeds seemingly carried this damaging gene. Sheep which had tracings in their pedigrees to suspected carriers of this gene were said to possess "grey" pedigrees, whereas those sheep which had no apparent incidence of carriers in their pedigrees were designated as "white pedigreed" sheep.

After the incidence of "spider" lambs in both Suffolk and Hampshire flocks at North Dakota State University, the decision was made to eliminate "grey" pedigreed sheep from these flocks. This could be done with a high degree of confidence because all sheep could be traced in their female lines to original purchases when these flocks were established. Suffolks traced to many purchases made in western Canada in 1945 and some of the Hampshires could be traced to purchases made as early as 1914. Very few flocks in the U.S. could trace their lines of ancestry to their beginnings in this fashion.

Funded in part by a grant from the National Suffolk Sheep Association, NDSU helped establish the mode of inheritance and the diagnostic procedures for determination of spider lamb syndrome. An outgrowth of these procedures was the establishment of a "test flock" of known spider producing ewes. These ewes were maintained and mated to rams which were introduced into the flock. Occurrence of sixteen "normal" lambs from these matings gave a 99% + probability that the ram was free of the spider gene. Incidentally, one ram which by pedigree analysis was believed to be "white" pedigree did sire spider lambs from these test ewes. This ram had also been mated to a number of ewes in the main flock. All his progeny were slaughtered and not allowed to go out as breeding stock. This was a fortunate occurrence, because otherwise the progeny might have unknowingly spread the incidence of the spider gene.

NDSU Involvement

Because of NDSU's active involvement in the spider syndrome problem and dedication to production of genetically sound sheep, it was natural to continue association in efforts to identify the spider gene by DNA analysis. Development of the DNA test was researched by Dr. Michael Bishop, ABS Global, DeForest, Wisconsin; Dr. Jon Beever, University of Illinois; and Dr. Nola Crockett, Utah State University. Substantial numbers of blood samples were supplied to these researchers for analysis in developing the test. Samples from the main flock were used to form the baseline of the non-carriers. Samples from the "test" flocks of known spider producers were analyzed and characterized as the known carrier group.

Test Matings

Test matings of Southdown rams were also done with the NDSU "test" ewes. This provided additional information which Dr. Michael Bishop used in his work on the test. Genotypes of lambs would then be analyzed along with the genotypes of their parents.

Results of these matings were as follows:

Lamb No.	Genotype
7417	NS
7418	NS
7419	NN
7420	NS
7421	SS
7425	NN
7426	NS
7428	NS
7429	NN
7430	NN
7431	NN
7432	NN
7433	NS

NN = Normal/Normal
NS = Carrier
SS = Spider Lamb

The lamb 7421 had all the visual symptoms of a spider lamb and this diagnosis was confirmed by Dr. George A. Schamber of the NDSU Veterinary Diagnostic Laboratory.

The development of a DNA test was accomplished and released in June, 1997. Dr. Jon Beever sampled 325 head of sheep which were exhibited at the North American International Livestock Exposition of the Suffolk, Hampshire, Shropshire, Southdown and Oxford breeds. His analysis reported that 28% of those sheep sampled were identified as "carriers" of the spider gene. This illustrates that the incidence of the gene is still rather widespread and a source of concern to sheep breeders. The development of this test, however, improves considerably upon the time and expense required to maintain test flocks and make test matings to check for the gene's occurrence. Also, the test makes it possible for many more breeders to have the confidence that they are using breeding stoc which is free of the spider gene.

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Natural Resources Conservation Service
Plant Materials Center
Bismarck, North Dakota

Project No.: 38A339X Hettinger, North Dakota

Project Title:

Field evaluation of cool-season grasses for pasture, range, wildlife habitat, and protection of surface and ground water.

Cooperators:

USDA, Natural Resources Conservation Service (NRCS) in cooperation with the North Dakota State University (NDSU), Hettinger Research and Extension Center (HREC); Adams County Soil Conservation District (ACSCD); and Mr. Joseph Clement, private landowner.

Location:

Legal Description; SE1/4 sec. 24, T. 129, R. 96, Adams County, North Dakota. Approximately 2 miles south of Hettinger.

Objective:

The objective of this study is to evaluate the performance and adaptation of native and introduced cool-season grass species and varieties for use in pastures, range, wildlife habitat, and water quality projects in southwestern North Dakota and surrounding regions of South Dakota, Montana, and Wyoming.

Site Information:

One hundred and one different varieties or experimental lines were seeded in 6 ft. x 25 ft. plots on April 6, 1992. Plots were replicated three times. 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 generally planted at 20-25 seeds/ft^2. Soil at the site is a Vebar-Flasher fine sandy loam, which is typically low in organic matter and available water capacity.

Evaluation Methods:

Plant performance data has been collected by the Plant Materials Center (PMC) for six years. Evaluation parameters include: emergence, weed competition, stand density, stand rating, plant height, disease resistance, seed production, vigor, and forage production. Forage production has been determined since 1993 and will continue through 1997.

Forage quality (nutrient content) is another essential element in evaluating plant performance. A study was initiated in 1995 by the Adams County Soil Conservation District to address this parameter. North Dakota State University Extension Service has taken the lead in organizing sample collection and analyses. Samples of 25 selected entries to be analyzed were clipped at various intervals throughout the growing seasons of 1995, 1996, and 1997 by personnel from NDSU, NRCS, the District, and volunteers.

Summary:

Plots had a good start in 1992. Moisture conditions in 1992 and 1993 produced dense stands and abundant forage. Droughty conditions in 1994 reduced forage yields considerably. There was a slight increase in production in 1995 compared to 1994. Production overall in 1996 was the lowest of any evaluation year. Weeds have been chemically controlled at the site each year, and residue has been managed with a spring burn. Severe infestation of wheatgrasses from the surrounding CRP land forced the PMC to abandon replication three and gather data from the array in 1996 and 1997. Forage production in 1997 was similar or lower than for 1996. Dry growing conditions have contributed to declining yields.

PROJECT: 38A339X Hettinger, North Dakota

PROJECT TITLE: Field evaluation of cool season grasses for pasture, rangeland, wildlife habitat, and protection of surface and groundwater.

Table HE-2: Plant performance 1992-1997. Seeding Date: April 6, 1992.

SPECIES/ENTRY/NO.	(1) EMERG. 92	WEED(2) COMP. 92	93	STAND(3) DENSITY 92	93	STAND(4) RATING 94	95	96	97	PLANT(5) HEIGHT 93	95	96	(6) DISEASE 93	SEED(7) PRODUCTION 93	94	96	(8) VIGOR 95	96	97	FORAGE YIELD (lb/ac) (9) 1993	1994	1995	1996(10)	1997
FAIRWAY WHEATGRASS																								
1. Parkway	2	2	2	53	75	3	3	2	3	28	21	22	2	2	6	8	4	3	4	2260A	838B	985B	664CD	539D
2. Kirk	3	3	2	52	68	3	3	3	2	31	29	25	2	1	4	5	3	2	4	2961A	1235B	1395B	690CD	767CD
3. SD-77	4	3	2	39	64	2	2	3	2	30	27	21	2	1	4	7	2	4	3	3187A	1632AB	1843AB	747CD	1064ABC
4. Ephraim	3	4	2	40	59	3	4	3	3	26	25	21	2	3	5	7	4	4	5	1957A	1346AB	1435B	955BCD***	662CD
5. Ruff	4	3	2	48	69	3	3	2	2	29	25	17	2	2	5	8	2	3	4	2864A	1198B	1322B	673CD	896BCD
6. NEAC1	4	2	3	46	56	3	2	3	2	24	21	19	2	2	4	7	2	3	4	1962A	1079B	1478B	557D	900BCD
7. NEAC2	4	2	2	48	66	3	2	3	2	29	25	19	2	2	5	7	2	4	4	3454A	1377AB	1950AB	838BCD	1397A
CRESTED WHEATGRASS																								
8. Summit	3	3	2	45	62	3	4	3	2	30	31	29	2	2	3	4	2	2	3	2777A	2207A	2478A	1503AB	1095ABC
9. Nordan	4	4	3	41	66	3	3	3	2	31	33	21	2	2	3	6	3	3	3	3382A	1609AB	1466B	1757A***	1382AB
10. NEAD1	3	4	2	45	72	3	3	3	2	31	29	27	2	2	4	4	4	3	3	2458A	1017B	1106B	1310ABC	1281AB
FAIRWAY x CRESTED CROSS																								
11. Hycrest	3	3	2	42	68	3	3	3	3	32	28	29	2	1	4	4	2	3	3	2688A	1330AB	1363B	1072ABCD***	1151ABC
12. Hycrest #2	3	3	1	40	61	3	4	3	2	28	27	29	2	2	3	5	3	2	4	2475A	1586AB	1602AB	1099ABCD	1141ABC

(1) Emergence and stand uniformity seven weeks after seeding, 5/21/92. Rating: 1=excellent, 5=fair, 9=no emergence.

(2) Weed competition, 7/21/92 and 8/17/93. Rating: 1=none, 5=moderate, 9=severe.

(3) Density estimate; percent of full rows in sample frames, 100% equals full frame, 7/21/92.

(4) Stand within plot, 8/16/94, 8/30/95, 7/31/96, 7/30/97. Rating: 1=excellent, 5=fair, 9=poor.

(5) Plant height average in inches, 8/17/93, 8/30/95, 7/31/96.

(6) Disease problems (primarily stem and leaf rust), 8/17/93. Rating: 1=none, 5=moderate, 9=severe.

(7) Seed production potential, using number of culms as an indicator, 8/17/93, 8/16/94, 7/31/96. Rating: 1=excellent, 5=fair, 9=poor.

(8) Vigor (overall plant health), 8/30/95, 7/31/96, 7/30/97. Rating: 1=excellent, 5=fair, 9=poor.

(9) Forage yield measured as lb/ac oven dry matter, 8/17/93, 8/16/94, 8/30/95, 7/31/96, 7/30/97. Comparison of means is by Student-Newman-Keul's Multiple Range Test (1993) and Duncan's New Multiple Range Test (1994, 1995, 1996, 1997), means with same letter for each species grouping (separated by line) are not significantly different (P=.05).

(10) In 1996 and 1997, the array and replications 1 and 2 were harvested for forage production (rep 3 not harvested due to severe contamination).

* Entries preceeded by an asterisk are not replicated, forage production data was not collected.

** Only replications 1 and 2 analyzed, no harvest in replication 3 due to severe contamination.

SPECIES/ENTRY/NO.	(1) EMERG. 92	WEED(2) COMP. 92	93	STAND(3) DENSITY 92	93	STAND(4) RATING 94	95	96	97	PLANT(5) HEIGHT 93	95	96	(6) DISEASE 93	SEED(7) PRODUCTION 93	94	96	(8) VIGOR 95	96	97	FORAGE YIELD (lb/ac) (9) 1993	1994	1995	1996(10)	1997
SIBERIAN WHEATGRASS																								
13. P-27	5	5	3	38	51	3	4	4	3	33	32	26	2	1	5	5	4	3	3	2860A	1340AB	1893AB	1326ABC	1469A
INTERMEDIATE WHEATGRASS																								
14. Chief	3	5	2	52	60	1	2	2	2	42	38	32	2	1	5	5	1	3	2	4040A	2050A	3008A	1975A	1579A
15. Clarke	3	3	2	60	75	2	2	3	2	42	33	38	2	2	5	6	2	4	2	4806A	1811A	2748A	2160A	1619A
16. Reliant	2	1	1	58	77	1	2	2	2	44	35	33	2	1	5	6	3	3	3	4330A	2135A	2805A	2049A***	1314A
17. Oahe	2	2	1	56	61	2	2	3	2	42	35	28	2	2	6	7	3	3	3	3919A	1593A	2829A	1565A***	1476A
18. SD-54	2	1	1	47	66	2	2	2	2	44	38	32	2	2	4	6	2	3	3	5526A	2184A	2665A	2039A	1361A
19. *Tegmar	1	1	1	88	48	-	-	-	-	31	--	--	2	2	-	-	-	-	-	----	----	----	----	----
20. *Greenar	-	-	1	--	58	-	-	-	-	37	--	--	2	2	-	-	-	-	-	----	----	----	----	----
21. Slate	1	2	1	64	70	2	1	2	2	43	38	29	2	2	4	7	3	3	3	3510A	1829A	2469A	1424A	1285A
22. NETI1	3	4	2	64	64	2	1	3	2	45	40	29	2	1	5	7	2	3	3	3897A	2390A	3163A	1472A	1439A
23. NETI2	2	2	1	60	70	2	2	2	2	43	39	31	2	2	4	6	1	3	3	4081A	2197A	3228A	1486A	1235A
24. NETI3	2	2	2	58	60	1	1	2	2	44	41	28	2	1	3	6	1	3	3	4619A	2615A	3213A	1854A	1517A
25. NE50C3	3	3	2	48	70	1	2	2	1	42	42	31	2	2	3	7	2	3	3	4213A	3014A	3392A	1770A	1466A
26. NECASPIAN3	2	3	1	62	60	1	2	2	2	47	39	34	2	1	3	6	2	3	3	4592A	2506A	3585A	1573A	1196A
27. *Amur	-	1	1	41	40	-	-	-	-	43	--	--	2	2	-	-	-	-	-	----	----	----	----	----
PUBESCENT WHEATGRASS																								
28. Greenleaf	3	3	2	56	67	2	1	3	2	44	37	27	2	2	7	8	2	3	4	3978A	2220A	2665A	1563A	1258A
29. MDN-759	3	2	1	55	64	2	3	4	2	42	35	26	2	2	5	7	3	5	4	3583A	2001A	2630A	2034A***	1132A
30. Manska	2	2	1	44	63	1	2	3	2	41	33	30	2	2	4	8	2	4	4	4300A	2693A	3704A	1526A***	1354A
31. *Topar	-	1	1	58	52	-	-	-	-	31	--	--	2	2	-	-	-	-	-	----	----	----	----	----
32. *Luna	-	1	1	60	50	-	-	-	-	39	--	--	2	2	-	-	-	-	-	----	----	----	----	----
TALL WHEATGRASS																								
33. Orbit	3	5	2	49	61	2	2	3	3	48	52	32	2	2	4	5	2	3	4	4397A	2151A	2371A	1245A	673A
34. Alkar	3	5	2	40	66	3	4	4	2	46	47	33	2	2	4	5	3	2	4	4664A	2162A	2530A	1717A***	839A
35. Platte	3	4	1	54	63	2	2	3	2	51	45	34	2	2	3	6	2	4	3	3536A	1894A	2652A	953A	752A
36. *Jose	-	1	1	82	70	-	-	-	-	53	--	--	2	2	-	-	-	-	-	----	----	----	----	---
37. *Largo	-	2	1	46	51	-	-	-	-	53	--	--	2	2	-	-	-	-	-	----	----	----	----	---

PROJECT: 38A339X Hettinger, North Dakota

SPECIES/ENTRY/NO.	(1) EMERG. 92	WEED(2) COMP. 92	93	STAND(3) DENSITY 92	93	STAND(4) RATING 94	95	96	97	PLANT(5) HEIGHT 93	95	96	(6) DISEASE 93	SEED(7) PRODUCTION 93	94	96	(8) VIGOR 95	96	97	FORAGE YIELD (lb/ac) (9) 1993	1994	1995	1996(10)	1997
QUACKGRASS																								
38. RS Hoffman	3	3	1	48	63	1	1	4	4	38	26	22	2	3	8	6	3	4	4	3454A	1327A	984	969A	827A
BLUEBUNCH x QUACK CROSS																								
77. RS-1 Hybrid N	3	4	2	40	67	2	2	2	3	44	27	28	2	2	7	6	3	2	3	3768A	1588A	1762A	1357A	1325A
78. RS-1 Hybrid R	3	3	2	53	64	2	2	4	2	38	26	26	2	3	7	5	4	3	3	3434A	1864A	1782A	1662A***	1364A
SMOOTH BROMEGRASS																								
39. Magna	3	3	1	40	77	1	1	3	2	35	37	24	2	2	5	6	2	4	3	3999A	1883AB	1751ABC	824AB	817ABC
40. S-7133	3	4	2	37	66	3	3	3	4	34	33	24	2	4	7	6	3	4	5	2826A	1234ABC	709C	731AB	462CD***
41. Manchar	3	3	2	42	76	1	4	3	3	32	33	27	2	2	4	5	4	4	4	2888A	1389ABC	1040BC	776AB	707ABCD
42. Rebound	4	3	1	44	80	1	3	2	2	31	35	32	2	3	8	7	3	3	4	2684A	1388ABC	1248ABC	1241AB***	1010AB
43. Cottonwood	5	3	1	38	80	1	2	2	2	33	37	26	2	3	6	6	2	4	4	3190A	2016A	1888AB	1192AB***	831ABC
44. Lincoln	3	2	2	44	76	2	2	2	2	30	31	31	2	3	7	7	3	4	5	3033A	1782AB	2206A	1137AB	1156A
SMOOTH x MEADOW CROSS																								
45. S-9183	4	3	2	38	64	4	3	3	3	34	32	29	2	3	6	6	3	3	5	2843A	849C	827BC	476B	495BCD
MEADOW BROMEGRASS																								
46. Fleet	2	2	1	53	76	1	1	3	2	34	18	23	2	4	8	8	2	4	5	3668A	785C	957BC	523AB	222D
47. Paddock	3	2	1	54	73	2	2	2	2	32	15	17	2	6	8	8	3	3	5	3139A	841C	1215ABC	519AB	305CD
48. Regar	3	4	1	33	74	2	2	3	2	29	19	14	2	7	9	8	2	4	6	2855A	1045BC	1203ABC	1272A***	266D
ORCHARDGRASS																								
49. *Paiute	-	3	2	76	41	-	-	-	-	26	--	--	2	8	-	-	-	-	-	----	----	----	----	---

SPECIES/ENTRY/NO.	(1) EMERG. 92	WEED(2) COMP. 92	93	STAND(3) DENSITY 92	93	STAND(4) RATING 94	95	96	97	PLANT(5) HEIGHT 93	95	96	(6) DISEASE 93	SEED(7) PRODUCTION 93	94	96	(8) VIGOR 95	96	97	FORAGE YIELD (lb/ac) (9) 1993	1994	1995	1996(10)	1997
RUSSIAN WILDRYE																								
50. Mayak	5	4	3	40	57	3	3	3	4	40	19	17	2	4	9	8	4	5	5	2105A	282A	520A	193B	139A
51. Swift	5	5	2	26	53	3	3	3	3	40	23	14	2	5	9	7	3	4	5	2439A	738A	599A	432AB	351A
52. Cabree	4	3	2	36	63	4	5	4	4	37	13	13	2	3	9	8	4	4	5	2255A	449A	455A	258B	217A
53. Vinall	3	4	3	27	62	4	3	3	4	41	13	17	2	3	9	8	4	4	5	2101A	429A	566A	191B	169A
54. Mankota	6	5	3	41	56	4	4	3	3	42	25	24	2	3	8	7	4	4	5	2327A	504A	714A	516AB***	289A
55. MDN-1831	6	6	2	31	49	4	4	3	4	40	13	10	2	3	8	7	4	4	5	2356A	548A	516A	457AB	325A
56. Bozoisky Select	5	4	2	40	56		3	4	4	46	25	22	2	2	8	8	3	5	5	2513A	620A	809A	776A***	389A
57. PI-272136	4	2	2	29	56	3	4	4	4	43	13	14	2	4	8	7	4	4	5	2112A	339A	331A	273B	386A
58. Syn A NL	5	6	2	29	52	5	4	3	4	42	21	25	2	3	8	7	3	3	6	2571A	680A	922A	306B	450A
MAMMOTH WILDRYE																								
59. ND-691	3	4	2	18	45	4	4	3	4	35	22	23	2	8	7	8	3	4	4	3301A	1433AB	2145A**	1216A	1139A
60. PI-478832	3	4	2	30	50	2	4	3	3	38	27	33	2	7	7	5	3	2	3	4234A	2088A	3055A**	1992A	1540A
61. Volga	4	4	3	20	42	4	5	4	5	38	26	33	2	7	7	6	4	4	5	2779A	1609AB	2256A**	1576A***	994A
EUROPEAN DUNEGRASS																								
62. ND-2100	7	7	8	6	19	7	8	6	8	20	14	22	1	9	9	7	7	4	5	1048B	540B	501B**	0	<100****
ALTAI WILDRYE																								
63. Prairieland	3	3	2	40	66	1	3	4	4	38	23	29	2	8	8	6	3	3	4	3137A	1555A	1535A**	2104A***	1308B
64. Pearl	3	4	2	33	66	3	4	3	6	38	20	29	2	7	7	7	4	2	5	3104A	1171A	1253A**	870B	945BC
65. Eejay	3	5	3	31	62	2	2	4	3	38	27	31	2	8	8	8	2	3	4	3507A	1643A	1648A**	1568AB	2072A
BEARDLESS WILDRYE																								
71. Shoshone	5	6	3	9	60	1	1	4	5	27	17	21	2	8	9	8	1	4	5	2223B	1098A	1762A**	1247AB***	588C
DAHURIAN WILDRYE																								
66. Arthur	2	2	2	58	71	2	3	5	8	46	31	31	2	1	2	4	3	4	6	4049	955	1143	607***	<100****

PROJECT: 38A339X Hettinger, North Dakota

SPECIES/ENTRY/NO.	(1) EMERG. 92	WEED(2) COMP. 92	93	STAND(3) DENSITY 92	93	STAND(4) RATING 94	95	96	97	PLANT(5) HEIGHT 93	95	96	(6) DISEASE 93	SEED(7) PRODUCTION 93	94	96	(8) VIGOR 95	96	97	FORAGE YIELD (lb/ac) (9) 1993	1994	1995	1996(10)	1997
BASIN WILDRYE																								
67. M-718	6	5	4	9	33	5	5	5	5	43	43	41	7	8	7	7	3	4	5	2196A	1758A	2724A	2008AB	1270A
68. PI-478831	3	2	2	32	72	4	3	3	4	40	33	41	7	7	7	6	3	3	5	1498A	1624A	1706A	1535B	1117A
69. Magnar	4	6	2	26	57	3	5	4	4	44	36	43	4	6	6	6	3	2	3	2431A	2112A	1674A	2766A***	1747A
CANADA WILDRYE																								
70. *Mandan	-	2	1	59	51	-	-	-	-	41	--	--	2	1	-	-	-	-	-	----	----	----	----	----
BEARDLESS BLUEBUNCH																								
72. *Whitmar	-	3	3	69	59	-	-	-	-	26	--	--	2	5	-	-	-	-	-	----	----	----	----	----
BLUEBUNCH WHEATGRASS																								
73. PI-232127	1	3	2	45	58	2	3	2	2	27	27	24	3	7	7	6	3	2	5	1933A	995A	1530A	1300A	1311A
74. PI-232128	2	4	2	32	50	2	3	3	2	28	17	22	2	7	8	7	3	3	4	2262A	1212A	1216A	1108A	1356A
75. Goldar	1	4	2	57	79	2	2	2	2	27	14	18	2	7	8	7	3	3	5	2332A	941A	1487A	1412A***	1184A
76. Secar	1	3	2	61	80	3	3	2	2	28	28	23	3	6	8	7	4	3	4	1975A	1294A	1318A	1360A	1026A
SHEEP FESCUE																								
79. *Covar	-	4	7	9	22	-	-	-	-	20	--	--	1	3	-	-	-	-	-	----	----	----	----	----
HARD FESCUE																								
80. *Durar	-	3	5	16	38	-	-	-	-	28	--	--	1	2	-	-	-	-	-	----	----	----	----	----
INDIAN RICEGRASS																								
81. Mandan 57-2	5	6	5	26	37	7	8	7	6	24	18	25	2	3	2	4	7	3	5	2160A	323A	0	137A	<100****
82. Nezpar	5	4	4	19	49	6	6	7	9	28	27	16	2	2	4	6	5	4	?	1960A	403A	0	282A	<100****
83. *Paloma	-	6	8	24	24	-	-	-	-	20	--	--	2	3	-	-	-	-	-	----	----	----	----	----

CANBY BLUEGRASS

SPECIES/ENTRY/NO.	(1) EMERG.	WEED(2) COMP.		STAND(3) DENSITY		STAND(4) RATING				PLANT(5) HEIGHT			(6) DISEASE	SEED(7) PRODUCTION			(8) VIGOR			FORAGE YIELD (lb/ac) (9)				
	92	92	93	92	93	94	95	96	97	93	95	96	93	93	94	96	95	96	97	1993	1994	1995	1996(10)	1997
GREEN NEEDLEGRASS																								
85. Lodorm	4	6	2	45	67	2	4	3	3	36	35	28	2	2	2	3	2	3	4	3322A	1331A	1308A	973A***	643A
86. SD-93	3	4	2	23	56	4	4	3	3	35	33	28	2	3	3	3	2	2	3	2196A	1035A	1113A	908A	902A
GREEN NEEDLEGRASS x RICEGRASS CROSS																								
87. *Mandan	-	6	6	24	54	-	-	-	-	31	--	--	2	3	-	-	-	-	-	----	----	----	----	----
STREAMBANK WHEATGRASS																								
88. *Sodar	-	6	5	54	73	-	-	-	-	26	--	--	5	5	-	-	-	-	-	----	----	----	----	----
THICKSPIKE WHEATGRASS																								
89. Elbee	2	3	2	48	71	2	2	3	3	28	9	21	2	3	8	6	4	5	5	2046B	412B	547A	238A	247A
90. Critana	4	4	2	43	68	2	2	2	3	26	13	21	4	4	8	7	3	4	5	2480A	711A	1223B	1135A***	319A
WESTERN WHEATGRASS																								
91. Walsh	4	4	2	50	74	1	1	2	2	24	25	17	2	7	8	8	3	4	5	2253A	983B	1871B	840A	666A
92. Rodan	3	4	1	53	79	1	1	3	2	26	22	24	2	6	8	7	2	3	3	3780A	2205AB	2440B	1446A***	1466A
93. *Rosana	-	6	3	54	57	-	-	-	-	22	--	--	2	6	-	-	-	-	-	----	----	----	----	----
94. Flintlock	3	4	2	36	54	1	1	2	2	31	29	25	2	6	8	7	1	3	3	3575A	2730A	4263A	1905A	1014A
95. *Barton	-	6	3	24	50	-	-	-	-	26	--	--	2	5	-	-	-	-	-	----	----	----	----	----
96. *Arriba	-	6	3	53	49	-	-	-	-	30	--	--	2	4	-	-	-	-	-	----	----	----	----	----
SLENDER WHEATGRASS																								
97. Revenue	3	2	2	71	64	2	3	4	5	39	35	31	2	1	1	3	2	3	3	4146A	2011A	2063A	1262A***	728A
98. Adanac	2	2	2	69	62	2	2	3	5	37	33	26	3	1	1	3	2	3	5	2559B	1143A	1057B	860AB	586A
99. Pryor	4	3	2	35	50	4	4	4	4	33	33	22	3	2	2	4	3	3	4	2082B	1367A	1046B	677B	599A
100. *San Luis	-	6	3	36	59	-	-	-	-	35	--	--	3	1	-	-	-	-	-	----	----	----	---	---
101. Primar	2	2	2	40	62	3	2	4	5	36	33	22	2	2	2	4	2	3	4	2831B	1185A	1469AB	711B	721A

SECTION II
MANAGEMENT SECTION

TIMOTHY C. FALLER
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HETTINGER RESEARCH EXTENSION CENTER

MR. ROGER HAUGEN
EXTENSION LIVESTOCK SPECIALIST
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39TH ANNUAL SHEEP DAY

HETTINGER RESEARCH EXTENSION CENTER
HETTINGER, NORTH DAKOTA

FEBRUARY 11, 1998

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.

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.

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 afte 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 a possible.

7. Be sure both teats are functioning and lambs nurse as soon a 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 wel (one to three days).

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

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

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

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

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.

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 assemblie have been found to be excellent for starting lambs.

* Lambs may require some assistance the first day or two to teac 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. Mil replacers should be mixed with warm water for best results an then cooled down. Lambs fed cold milk grow well with les problems from scours and other digestive disturbance. Cold mil keeps better too.

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

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

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

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

* 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.

SHEEPBARNS AND EQUIPMENT PLANS

Timothy C. Faller
Hettinger Research Extension Center
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NOTE: These and other plans are available through county agents or from Extension Agricultural Engineering, NDSU, Fargo, ND. The drawings show construction details and include a materials list for estimating. Due to changes in lumber sizes, lumber grades, plywood quality, and other developments in building materials, some adjustments are required for older plans. (Present charge is shown or $1.00 per sheet.)

CORRALS AND BARNS

Plan No.	Plan Title	Sheets
MW 72050	Pole Utility Buildings	$2.00
MW 72505	Slatted Floor, 40'x72', Feeder Lamb Barn	3.00
MW 72506	240 Ewe and Lambing Barn, 40'x104'	3.00
MW 72507	500 Ewe and Lamb Feeding Barn, 74'x256'	3.00
MW 72508	12' x 16' Portable Lamb Feeding Shed	2.00
MW 72509	40 Ewe and Lambing Barn, 24x32'	2.00
ND Plan	Confinement Sheep Barn & Hay Storage (at Hettinger)	1.00
Reprint #759	Practical Sheep Housing for North Dakota	No Charge
USDA 6096	Shearing Shed & Corral Arrangement	1
USDA 6236	Portable Handling Corral for Sheep (Metal Wood)	1
AE-683	Sheep Barn Layout	No Charge
AED-13	Insulation and Heat Loss	No Charge
AED-19	Slip Resistant Concrete Floors	No Charge
AED-25	Earth Tube Heat Exchange System Planning	No Charge
MWPS-3	Sheep Housing and Equipment Handbook (This 90 page booklet was revised in 1994. It includes barn and layout planning plus plans for fences and sheep equipment.)	10.00
MWPS-9	Designs for Glued Trusses	5.00

FEED HANDLING & FEEDERS

USDA 5917	Fencing, Feeding, and Creep Panels	1
Reprint #409	Chopped Hay Feeder for Sheep	No Charge
Reprint	16 ft. Collapsible Fenceline Feedbunk for Sheep	No Charge
ND 872-1-1	Stationary Roughage Self Feeder for 70 Ewes or 160 Lambs	No Charge
ND 872-1-2	Portable Roughage Self Feeder for 40 Ewes or 80 Lambs	No Charge

Plan No.	Plan Title	Sheets
MW 73110	24 ft. wide Clearspan Pole Frame Hay Shed	$ 3.00
MW 73111	36 ft. wide Clearspan Pole Frame Hay Shed	3.00
MW 73112	48 ft. wide Clearspan Pole Frame Hay Shed	3.00
MW 73113	32 ft. & 48 ft. Wide Pole-Frame Hay Shed (Interior Poles)	3.00
MW 73210	Moveable Grain Storage Walls, 6' to 12' High	2.00
MW 73217	20, 45, 170, and 340 Bu. Hoppered Grain Bins	3.00
MW 73220	48 ft. Wide Pole Frame Grain Storage	2.00
MW 73250	Grain Storage Buildings, 600, 1000, 1200, 1500 or 2000 Bu.	3.00
MW 73293	Grain-Feed Handling Center, Work Tower Across Drive	4.00
MW 73294	Grain-Feed Handling Center, Work Tower Beside Drive	4.00
PA	10 Ton Hoppered Feed Bin	No Charge
PA	4 Compartment Bin for Feed Mill	No Charge
ED-15	Horizontal Bunker Silos, Concrete Tilt-up	No Charge
SDA 6090	5500 Bushel Wooden Grain Bin	2
WPS-13	Planning Grain-Feed Handling Handbook	5.00