B[illegible] Research Report and Meeting Proceedings 1990 - 91

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THANK YOU

THE DEPARTMENT OF ANIMAL SCIENCES GRATEFULLY ACKNOWLEDGES THE ASSISTANCE OF THE FOLLOWING COMPANIES AND PEOPLE IN OUR BEEF PROGRAM:

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R & J Ranch, Briggs, TX
SANOFI Animal Health, Overland Park, KS
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THE DEPARTMENT OF ANIMAL SCIENCES
UNIVERSITY OF ILLINOIS

Dennis R. Campion, Head of Department

On behalf of the faculty, staff and students involved in beef cattle research, teaching and extension, I am pleased to introduce the 1990 Beef Cattle Research Report.

This past year has been an exciting and very active year for the Department and the beef cattle program. Construction of the new wings on the Animal Sciences Laboratory will be completed April, 1991. Then renovation of the existing building will be initiated with completion scheduled for December, 1992. The adjacent Plant and Animal Biotechnology Laboratory will be ready January, 1990. Several faculty members will be housed in this Laboratory while ASL is being renovated. Modern animal facilities are featured in PABL which will allow progress to be made in the area of molecular genetics and immunology.

With the hiring of a very capable support staff and the stocking of the Orr Animal Research Center, our beef cattle research program is now fully integrated and operational. Dr. Dan Faulkner continues to be the leader in coordinating the Campus and Center beef cattle operations.

An outstanding faculty which includes Doctors Berger, Fahey, Faulkner, Merchen and Parrett is devoted to beef cattle research. The team is also composed of other collaborating investigators and many graduate students and support personnel. This group is to be commended for their excellent research, teaching and public service activities in the beef cattle area. Their interest in the industry as well as in our beef cattle-oriented students is evidenced by the excellent ways in which they have successfully integrated state-of-the-art teaching with creative and original research, both basic and applied. The "team effort" is geared toward helping our Illinois beef cattle industry be among the best and most innovative in the country. Professors in the areas of rumen microbiology, reproductive physiology and meat science have also made significant contributions to our beef cattle research program.

UNIVERSITY OF ILLINOIS PUREBRED ANGUS HERD

D. F. Parrett, D. B. Faulkner and C. L. Willms

The University of Illinois maintains 60 spring calving purebred Angus cattle. In addition, ten to fifteen replacement heifers are retained each year. The cattle are used in research and teaching. Teaching uses include, beef production, livestock judging and evaluation courses, and special learning classes for undergraduate student research projects. The students gain experience in performance record keeping, animal selection, hands-on laboratory experience, heat-detection, calving and general beef cow herd management.

Most of the research conducted using the cattle is related to applied nutrition and new management techniques. Recent work has concentrated on previous androgenization effects of beef calves, limited creep feeding, various estrous synchronization techniques for beef cows and gene mapping of purebred lines of cattle.

Many clinics, workshops and judging activities also make use of the purebred cattle. The herd also serves as a catalyst for interaction between the Department of Animal Science staff members and the Illinois purebred cattle industry. Performance tested bulls are sold each year through the Illinois Performance Tested Bull Sale. Bulls are also raised and used as herd sires for the commercial cow herds at the Dixon Springs and Orr Research Centers. By raising our own herd sires, we can provide predictable performance and uniformity in the cattle raised for research trials. Of particular importance is the development of a calving ease herd within the Angus herd. These cattle are bred specifically for low birth weight EPD's. This group will become an increasingly important segment of our targeted purebred production program. EPD's (expected progeny differences) are used extensively in designing the breeding programs, with a goal of optimum performance for our environment (table 1).

Many breeders have supported our Angus program and we appreciate their efforts to enhance our program. The University of Illinois Angus cattle have been well accepted in recent years, having the top indexing bull in 1988 and second top indexing yearling bull in 1989 at the Illinois Beef Performance Tested Bull Sale. Also, in the last two Illinois Angus Futurities, the University has consigned one of the top-selling bred females, having the champion heifer in 1988.

TABLE 1. SIRES USED TO PRODUCE THE 1991 CALF CROP

	Expected Progeny Differences			
Sire	Birth	Weanling	Milk	Yearling
Hoff Hi Spade SC491	4.0	50.5	14.3	83.2
R & J Extra 493	3.4	41.5	9.4	70.6
R & J Maxima	4.9	37.6	16.4	53.1
Brost Dan Patch	7.0	51.6	12.8	86.0
Fairfield Dark Star	6.3	52.4	18.8	82.5
SS Rito 0715 OH3	-4.5	20.3	6.2	32.5
R & J Milky Way	.2	44.5	16.3	61.8

EFFECTS OF SYNOVEX-S[a] ALONE OR IN COMBINATION WITH FINAPLIX-S[b] ON PERFORMANCE AND CARCASS CHARACTERISTICS IN FINISHING STEERS

D. D. Buskirk, D. B. Faulkner and L. L. Berger and C. L. Willms

SUMMARY

Two feedlot trials were conducted to evaluate the effects of implanting at the initiation of the finishing phase and reimplanting at 56-d with Synovex-S alone and in combination with Finaplix-S on feedlot performance and carcass traits. There were no significant (P>.07) interactions between initial implant and reimplant on either performance or carcass characteristics. In trial 1, no significant (P>.05) differences were observed between initial implant or reimplant treatments in any of the parameters examined. In trial 2, initially implanting with Synovex alone increased (P<.05) intake, daily gain, yield grade, and dressing percent, compared to non-implanted animals. Steers initially implanted with Synovex alone had increased (P<.05) hot carcass weight and fat thickness compared to non-implanted or Synovex + Finaplix implanted steers. All other carcass measures were similar (P>.05) among all treatments. Reimplanting had no statistically significant effect (P>.05) on any of the parameters examined.

INTRODUCTION

Finaplix-S is a newly approved implant for feedlot steers which contains 140mg of trenbolone acetate. Since Synovex-S contains different anabolic agents (20mg estradiol benzoate and 200mg progesterone), it has been hypothesized that Finaplix-S and Synovex-S may be additive in enhancing feedlot performance. The objective of these two trials was to examine possible additive effects of these implants on growth and carcass characteristics in feedlot steers at two locations.

PROCEDURE

Trial 1. Seventy-two crossbred steers (719 lb) were blocked by weight then randomly assigned to treatments arranged in a 2 x 3 factorial design for a 126-d finishing trial. Factors were initial implant (Synovex-S or Synovex-S + Finaplix-S) and 56-d reimplant (No implant, Synovex-S or Synovex-S + Finaplix-S). Steers were adjusted to a high concentrate diet using a series of three rations fed 4 days each (Table 1).

Cattle were weighed on days 0, 30, 56 and 126 of the feeding period. Feed was held at a constant level below ad libitum for 2 days before the final unshrunk weight was taken. Steers were slaughtered after 126-d on feed and carcass data was recorded.

Trial 2. One hundred forty-one crossbred steers (671 lb) were randomly assigned to treatments arranged in a 3 x 3 factorial design for a 109-d finishing trial. Factors were initial implant (No implant, Synovex-S or Synovex-S + Finaplix-S) and 56-d reimplant (No implant, Synovex-S or Synovex-S + Finaplix-S). Steers

[a]Registered trademark of Syntex Agribusiness, Inc.
[b]Registered trademark of Roussel Uclaf.

were adjusted to a high concentrate diet using a series of two rations (Table 2). Cattle were weighed on days 0, 56 and 109 of the feeding period. The steers were shrunk for beginning and final weights. Steers were slaughtered after 109-d on feed and carcass data was recorded.

Statistical analysis for both trials were conducted using the GLM procedure of SAS. Performance and carcass data were analyzed using pen as the experimental unit. Treatment mean differences were separated using the F-test for least significant difference.

RESULTS

Trial 1. There were no significant (P>.07) interactions between initial implant and reimplant on either feedlot performance or carcass characteristics.

There were no significant (P>.05) differences between initial implant or reimplant treatments in any of the performance or carcass traits evaluated (Table 3 and 4). Ribeye area tended (P=.09) to be greater for the initial implant of Synovex + Finaplix compared to Synovex alone.

Trial 2. There were no significant (P>.14) interactions between initial implant and reimplant on either feedlot performance or carcass characteristics.

Initially implanting Synovex increased (P<.05) intake, daily gain, yield grade, and dressing percent compared to steers receiving no implant (Table 5). Initial implants of Synovex increased (P<.05) daily gain by 10 percent over non-implanted steers. Increased intake and daily gain caused by Synovex were proportional resulting in similar (P>.20) feed/gain ratios to the other treatments. The initial implant of Synovex alone increased (P<.05) both hot carcass weight and fat thickness compared to no implant or Synovex + Finaplix treated steers. All other carcass measures were similar (P>.05) among treatments.

Reimplanting had no statistically significant effect (P>.05) on any of the parameters examined (Table 6). Initially implanting with Synovex alone increased (P<.05) fat thickness by .09 in. compared to no implant, however, reimplanting with Synovex tended (P<.07) to decrease fat thickness by .05 in. compared to steers not reimplanted. Reimplanting with Synovex alone also tended (P<.08) to improve yield grade over animals not receiving an implant at 56-d. Although percent Choice is numerically higher for Synovex + Finaplix than either Synovex or no reimplant these differences are not statistically different (P>.18 and P>.09 respectively).

In conclusion, implanting Synovex-S alone at the initiation of the finishing phase, increased intake, daily gain, fat thickness, yield grade, hot carcass weight and dressing percent compared to non-implanted steers. Finaplix-S exhibited minimal additive effects when implanted with Synovex-S on feedlot performance and carcass characteristics. Reimplanting at 56-d had no significant effect in these trials.

TABLE 1. COMPOSITION OF DIETS FOR (Trial 1)

Ingredient	1	2	3	4
	-------------% Dry matter basis-------------			
Corn Silage	--	40	25	10
Corn	15	47	62	77
Corn Gluten	30	--	--	--
Ammoniated Corn Cobs	25	--	--	--
Soybean Hulls	25	--	--	--
Molasses	5	3	3	3
Supplement	--	10	10	10
Supplement Composition:				
Corn	45.2			
Soybean Meal	30.1			
Urea	5.0			
Calcium carbonate	10.0			
Potassium chloride	5.5			
Trace mineralized salt	3.0			
Bovatec premix[a]	0.8			
Vitamin-mineral premix[b]	0.4			

[a]Soybean meal carrier with 12.98g Bovatec®/lb premix.
[b]Guaranteed analysis: 4,540,000 IU/lb vitamin A and 567,000 IU/lb vitamin D_3.

TABLE 2. COMPOSITION OF DIETS FOR (Trial 2)

Ingredient	1	2	3
	--------% Dry matter basis--------		
Ground shelled corn	53	63	74.25
Hay	38	28	19
Soybean meal	7	7	4
Urea	--	--	0.25
Dicalcium phosphate	0.5	0.5	0.5
Limestone	0.75	0.75	1
Trace mineralized salt	0.5	0.5	0.5
Potassium chloride	--	--	0.5
Bicarbonate	0.25	0.25	--

TABLE 3. EFFECT OF INITIAL IMPLANT ON ANIMAL PERFORMANCE AND CARCASS TRAITS (Trial 1)

	Synovex	Synovex + Finaplix	SE
Intake, lb/d	23.4	23.3	.36
Daily gain, lb	3.93	3.98	.08
Feed/Gain	5.96	5.85	.11
Hot Carcass wt., lb	745	743	7.5
Fat Thickness, in.	0.57	0.56	.02
KPH %	2.03	2.00	.08
Ribeye Area, sq. in.	12.91	13.36	.15
Yield Grade	3.08	2.88	.08
Marbling Score[a]	13.06	13.31	.60
Quality grade[b]	9.39	9.44	.28
Percent Choice	55.6	52.8	10.1
Dressing %	61.0	61.0	.24

[a]High slight = 12, low small = 13, average small = 14, etc.
[b]High Select = 9, low Choice = 10, average Choice = 11, etc.

TABLE 4. EFFECT OF REIMPLANT ON ANIMAL PERFORMANCE AND CARCASS TRAITS (Trial 1)

	None	Synovex	Synovex + Finaplix	SE
Intake, lb/d	23.4	23.6	23.0	.44
Daily gain, lb	3.92	3.97	3.98	.10
Feed/Gain	5.97	5.95	5.80	.14
Hot Carcass wt., lb	742	753	736	9.2
Fat Thickness, in.	0.59	0.56	0.55	.03
KPH%	1.90	2.06	2.08	.10
Ribeye Area, sq. in.	12.91	13.35	13.14	.18
Yield Grade	3.0	2.95	2.91	.10
Marbling Score[a]	13.63	13.25	12.67	.74
Quality grade[b]	9.50	9.50	9.25	.34
Percent Choice	54.2	58.3	50.0	10.1
Dressing %	60.9	61.0	61.2	.29

[a]High slight = 12, low small = 13, average small = 14, etc.
[b]High Select = 9, low Choice = 10, average Choice = 11, etc.

Table 5. EFFECT OF INITIAL IMPLANT ON ANIMAL PERFORMANCE AND CARCASS TRAITS (Trial 2)

	None	Synovex	Synovex + Finaplix	SE
Intake, lb/d	21.2[a]	22.3[b]	21.8[ab]	.49
Daily gain, lb	3.59[a]	3.96[b]	3.76[ab]	.11
Feed/Gain	5.91	5.64	5.80	.14
Hot Carcass wt., lb	616[a]	653[b]	631[a]	6.8
Fat Thickness, in.	0.49[a]	0.58[b]	0.52[a]	.01
KPH%	2.01	2.02	2.12	.04
Ribeye Area, sq. in.	11.52	11.89	11.72	.20
Yield Grade	2.82[a]	3.06[b]	2.91[ab]	.06
Marbling Score[c]	13.46	13.15	14.04	.55
Quality grade[d]	9.51	9.49	9.85	.24
Percent Choice	55.0	56.0	70.0	7.6
Dressing %	57.8[a]	59.3[b]	58.5[ab]	.37

[a,b]Least square means in the same row with different superscripts differ ($P<.05$).
[c]High slight = 12, low small = 13, average small = 14, etc.
[d]High Select = 9, low Choice = 10, average Choice = 11, etc.

TABLE 6. EFFECT OF REIMPLANT ON ANIMAL PERFORMANCE AND CARCASS TRAITS (Trial 2)

	None	Synovex	Synovex + Finaplix	SE
Intake, lb/d	22.0	21.7	21.6	.59
Daily gain, lb	3.70	3.87	3.75	.13
Feed/Gain	5.96	5.63	5.76	.17
Hot Carcass wt., lb	630	635	636	8.2
Fat Thickness, in.	0.56	0.51	0.52	.02
KPH%	2.01	2.02	2.11	.05
Ribeye Area, sq. in.	11.56	11.79	11.79	.24
Yield Grade	3.04	2.86	2.90	.08
Marbling Score[a]	13.38	13.59	13.68	.66
Quality grade[b]	9.51	9.57	9.76	.29
Percent Choice	51.6	58.2	71.1	9.0
Dressing %	58.2	58.8	58.5	.45

[a]High slight = 12, low small = 13, average small = 14, etc.
[b]High Select = 9, low Choice = 10, average Choice = 11, etc.

THE EFFECTS OF CORN VS SOYHULLS LIMITED VS AD LIBITUM INTAKE AS A CREEP SUPPLEMENT ON CALF PERFORMANCE, SUBSEQUENT PERFORMANCE DURING GROWING AND FINISHING AND CARCASS CHARACTERISTICS

D. F. Hummel, D. B. Faulkner, D. F. Parrett, and D. D. Buskirk

SUMMARY

Ninety crossbred steers were blocked by age and randomly allotted to one of five treatments to evaluate sources and levels of creep feed on calf performance. In addition, subsequent performance during the growing and finishing stages and carcass characteristics were evaluated. Five treatments consisted of cracked corn (C) and ground soyhulls (S) fed at three levels control (no creep) (0), limited (L), and ad libitum (AL). There were no level by source interactions (P>.14). During the creep period there was a linear increase in calf gain with increasing level of creep. Feed efficiency was not effected (P>.14) by either source or level during the creep period. However, C had an increase in creep intake over S calves. Intake was increased during the growing phase for AL compared to L steers. Improved finishing period feed efficiency was observed in 0 over AL steers. Creep source showed minimal effects in all areas evaluated during the growing and finishing stages. Quality grade was increased with AL feeding and C feeding.

INTRODUCTION

On the surface, the traditional creep feeding method seems very attractive. But the added gain due to this method of creep feeding may not be economical. Cremin et al., 1989 reported that limited and ad libitum creep feeding increased daily gain over non creep fed calves 15 and 27%, respectively, while efficiency of utilization of creep feed was not affected. Highly digestible fiber may be more effective for calves consuming high fiber diets (McDonnell, 1983). Therefore the objectives of this trial were to examine the effects of high fiber versus high grain and level of creep feed on daily gain, feed efficiency, subsequent performance during growing and finishing stages, and carcass merit.

PROCEDURE

Ninety commercial Angus-Hereford cows nursing steer calves were utilized in this trial. Calves were blocked by age into three groups and randomly allotted to each of five treatments. The treatments consisted of 0, L, and AL levels of C, and S. Crude Protein was 10 and 12% on C and S, respectively. Creep feed was weighed weekly and the salt level adjusted to maintain 1 kg/hd/d intake. Salt level was the same for C and S and averaged 11% for LC and LS to restrict intake. There were three replications per treatment with six cow calf pairs in each of fifteen paddocks. Each paddock was three hectares and consisted of endophyte infected tall fescue. Previous research indicated that these paddocks are uniform in composition so the paddocks were not rotated.

Calves had access to creep feed for a 113-day period from June 20 through October 11, 1989. Initial mid-trial and final calf weights were recorded and calf feed intake was measured. Gain and supplemental gain/feed ({supplemented gain-control gain}/supplement intake) were calculated.

Calves were weaned and placed on a growing ration (Table 1) for 77 days. At the end of the growing period calves were then placed on a finishing ration (Table 2) for 167 days. Weights were recorded at the beginning and end of growing and finishing periods, feed intake was recorded, daily gain and gain/feed were calculated.

At the conclusion of the finishing period calves were slaughtered. Carcass parameters recorded were hot carcass weight, adjusted fat thickness, marbling score, rib eye area, internal fat, and Quality grade. Yield grades were also calculated.

Statistical analysis were conducted using GLM procedure of SAS. Performance and carcass data were analyzed using pen as the experimental unit. Treatment mean differences were separated using F-test for least significant difference.

RESULTS

There were no significant (P>.14) interactions between level and source on performance during the creep period, subsequent growing and finishing period or on carcass characteristics. Therefore, only main effects are reported.

During the creep feeding period L calves gained 39% greater (P<.05) than O calves, with AL calves exhibiting a 13% gain greater (P<.05) than L calves (Table 3). Calves fed C as a creep source had higher (P<.05) intake compared to calves fed S (Table 4). There were no significant (P>.15) difference in supplement gain/feed between level or source of creep feed.

Evaluating subsequent performance of creep level during the growing period indicates that AL had increase (P<.05) intake compared to L steers. During the finishing period, O had an improved gain/feed over L and AL steers (Table 5).

During the growing period, C steers also tended (P=.06) to have an increase in daily gain and an improved gain/feed over S steers. However, during the finishing period, S steers had an improved (P<.05) gain/feed when compared to C steers (Table 6).

Increasing level of creep feed from O to AL tended (P=.06) to increase adjusted fat thickness. Consequently, AL steers also had a higher (P<.05) quality grade when compared to O steers (Table 7). Steers that were creep fed C had a higher (P<.05) quality grade than S steers (Table 8). All other carcass parameters measured were similar (P>.12) at the different levels and sources of creep feed.

In this trial, C and S had similar feed efficiencies during the creep period. There were minimal carry over effects during the growing and finishing stage as well as comparable carcass characteristics. Increased level of creep also had minimal carry over effects during the growing and finishing periods and resulted in similar carcass characteristics.

REFERENCES

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McDonnell, M. L., T. Klopfenstein and J. K. Merrill. 1983. Soybean hulls can replace corn in growing rations. Nebraska Beef Cattle Report, University of Nebraska, Lincoln. MP 44:17.

TABLE 1. INGREDIENT COMPOSITION OF GROWING DIET FED TO STEERS

Ingredients	% Dry Matter Basis
Corn	53.0
Corn silage	39.0
Soybean meal	5.75
Urea	.25
Limestone	1.0
Dicalcium phosphate	.50
Salt	.50
Vitamin premix	+

TABLE 2. INGREDIENT COMPOSITION OF FINISH DIET FED TO STEERS

Ingredients	% Dry Matter Basis
Corn	84.0
Chopped hay	10.0
Soybean meal	3.75
Urea	.25
Limestone	1.00
Dicalcium phosphate	.50
Salt	.50
Vitamin Premix	+

TABLE 3. CREEP FEED LEVEL ON CALF PERFORMANCE DURING CREEP PERIOD

Item	Creep Feed Level		
	Control[a]	Limited[b]	Ad Libitum[b]
Supplement intake, Kg/d	---	1.01 ± .07[c]	2.28 ± .07[d]
Calf gain, Kg/d	.66 ± .08[c]	.92 ± .04[d]	1.04 ± .04[e]
Supplement gain/feed	.21 ± .03	.14 ± .03	.03 ± .03
Initial wt., Kg	144.8 ± 9.0	134.9 ± 4.4	135.0 ± 4.4
Final wt, Kg	219.8 ± 16.1	238.5 ± 7.9	252.1 ± 7.9

[a]Mean ± SE; n = 3 pens.
[b]Mean ± SE; n = 6 pens.
[c,d,e]Least square means in a row with different superscripts differ (<.05).

TABLE 4. FEED SOURCE ON CALF PERFORMANCE DURING CREEP PERIOD

Item	Creep Feed Source		
	Corn	Soyhulls	SE
Supplement intake Kg/d	1.77[a]	1.53[b]	.07
Calf gain, Kg/d	.98	.94	.04
Supplement gain/feed	.18	.17	.03
Initial wt., Kg	133.8	139.4	4.5
Final wt, Kg	245.1	246.2	8.3

[a,b,]Least square means in a row with different superscripts differ (P<.05).

TABLE 5. CREEP FEED LEVEL ON SUBSEQUENT PERFORMANCE DURING GROWING AND FINISHING PERIOD

	Creep Feed Level		
	Control[a]	Limited[b]	Ad Libitum[b]
Growing			
Intake, Kg/day	6.10 ± .08	6.13 ± .04[c]	6.26 ± .04[d]
Gain, Kg/day	.42 ± .12	.69 ± .05	.71 ± .05
Gain/feed	.07 ± .02	.11 ± .01	.11 ± .01
Initial wt, Kg	219.8 ± 16.1	238.5 ± .06	252.1 ± .06
Final wt, Kg	252.4 ± 11.3[c]	291.3 ± 5.6	306.4 ± 5.6[d]
Finishing			
Intake, Kg/d	8.33 ± .47	9.26 ± .23	9.44 ± .23
Gain, Kg/day	1.35 ± .09	1.20 ± .05	1.20 ± .05
Gain/feed	.16 ± .01[c]	.13 ± .005[d]	.13 ± .005[d]
Final wt, Kg	477.3 ± 21.1	491.3 ± 10.4	506.4 ± 10.4

[a]Mean ± SE; n = 3 pens.
[b]Mean ± SE; n = 6 pens.
[c,d]Least square means in a row with different superscripts differ (P<.05).

TABLE 6. CREEP FEED SOURCE ON SUBSEQUENT PERFORMANCE DURING GROWING AND FINISHING PERIOD

Item	Creep Feed Source		
	Corn	Soyhulls	SE
Growing			
Intake, Kg/day	6.21	6.14	.04
Gain, Kg/day	.73	.56	.05
Gain/feed	.12	.09	.01
Initial wt, Kg	241.1	246.15	8.31
Final wt, Kg	301.27	289.11	5.77
Finishing			
Intake, Kg/day	9.44	8.97	.24
Gain, Kg/day	1.19	1.23	.02
Gain/feed	.13[a]	.14[b]	.003
Final wt, Kg	499.92	494.62	6.97

[a,b]Least square means in a row with different superscripts differ (P<.05).

TABLE 7. CREEP FEED LEVEL ON CARCASS CHARACTERISTICS

Item	Creep Feed Level		
	Control[a]	Limited[b]	Ad Libitum[b]
Quality grade	9.75 ± .30[d]	10.56 ± .15[d,e]	10.67 ± .15[e]
Yield grade	2.94 ± .24	3.05 ± .12	3.24 ± .12
Fat thickness, in.	.39 ± .05	.47 ± .02	.51 ± .02
Rib eye area, sq. in.	11.26 ± .50	11.79 ± .25	11.90 ± .25
Internal fat, %	2.8 ± .27	2.7 ± .13	3.0 ± .13

[a]Mean ± SE; n = 3 pens.
[b]Mean ± SE; n = 6 pens.
[c]9 = high Select; 10 = high Choice.
[d,e]Least square means in a row with different superscripts differ (P<.05).

TABLE 8. CREEP FEED SOURCE ON CARCASS CHARACTERISTICS

Item	Creep Feed Source		
	Corn	Soyhulls	SE
Quality grade[a]	10.7[a]	10.2[b]	.11
Yield grade	3.17	3.04	.12
Fat thickness, in.	.50	.45	.02
Rib eye area, sq. in.	11.88	11.72	.25
Internal fat, %	2.88	2.80	.13

a = Low Choice.
[b,c]Least square means in a row with different superscripts differ (P<.01).

EFFECTS OF ALKALINE HYDROGEN PEROXIDE-TREATED WHEAT STRAW AND CORN SILAGE SUPPLEMENTED WITH DIFFERENT LEVELS AND SOURCES OF PROTEIN ON PERFORMANCE OF GROWING CATTLE AND SUBSEQUENT FINISHING PHASE PERFORMANCE

C. L. Willms, L. L. Berger, N. R. Merchen and G. C. Fahey, Jr.

SUMMARY

An 84-d growth trial with 162 crossbred steers (565 lb) was conducted to compare the feeding value of alkaline hydrogen peroxide-treated wheat straw (AHP-WS) to corn silage (CS) and the efficacy of different supplemental protein sources and levels in diets based on these roughages. Subsequently, the cattle were finished on a common finishing diet to evaluate carry-over effects of growing phase dietary regimen. Finishing phase performance was evaluated for a constant time on feed (105 d) or fed to similar slaughter weight. A completely randomized design with a 3x3 factorial arrangement of treatments was used. Factors were roughage source [CS, AHP-WS and a 1:1 mixture of CS and AHP-WS (MIX)] and protein treatment [13% and 11% crude protein (CP) with supplemental CP provided by soybean meal (13-SBM) and (11-SBM) and 11% CP with a combination of urea, corn gluten meal and fish meal providing the supplemental CP (U:CG:F)]. AHP-WS decreased ($P<.01$) dry matter intake 1.16 to 1.46 lb/d compared to CS and MIX, respectively. With increasing AHP-WS in the diet, daily gain (ADG) and gain/feed (G/F) decreased ($P<.01$). There was no difference in performance due to protein treatment. Finishing phase ADG and G/F were not affected by growing phase dietary regimen when steers were fed for 105 d. However, MIX-fed steers consumed less ($P<.01$) dry matter in the finishing phase (fed to both end points) than AHP-WS-fed steers. Steers fed CS or AHP-WS in the growing phase had higher ADG ($P<.04$) and tended to have higher ($P=.06$) G/F in the finishing phase than MIX-fed steers when fed to a similar weight. Steers fed AHP-WS tended to have carcasses with lower ($P=.06$) yield grade than MIX-fed steers. These data indicate that steers fed AHP-WS in the growing phase did not compensate for lower growing phase performance in the finishing phase.

INTRODUCTION

The alkaline hydrogen peroxide treatment process has been shown to be very effective in increasing the digestibility of crop residues. Lewis et al. (1987) reported that steers fed alkaline hydrogen peroxide-treated wheat straw (AHP-WS)-based diets performed similarly to cattle fed corn silage (CS)-based diets. However, in this study AHP-WS was pelleted and prepared by soaking wheat straw in sodium hydroxide and hydrogen peroxide rather than the current procedure of spraying the chemicals onto wheat straw while mixing in a horizontal mixer. Further research has shown AHP-WS to be equal to alfalfa hay and CS as a roughage source in cattle finishing diets (Willms et al., 1989a).

Willms et al. (1989b) reported that 12% crude protein (CP) maximized nitrogen (N) retention (% of N intake) and fiber digestibility in 70% AHP-WS diets fed to growing lambs. Cecava et al. (1989) demonstrated with cannulated lambs that feeding slowly degraded supplemental protein sources with complementary amino acid profiles shifted the profile of amino acids entering the intestine compared to soybean meal supplementation in AHP-WS-based diets. These workers used corn gluten meal and blood meal as protein sources rich in sulfur-containing amino acids and lysine, respectively. Methionine and lysine have been implicated as limiting amino acids in ruminant diets. Willms et al. (1989c) reported that lambs fed AHP-WS-based diets had improved performance when supplemented with protein sources with complementary amino acid profiles.

The objectives of this study were to compare AHP-WS prepared by the current procedure to CS in cattle growing diets and to evaluate protein supplementation with a combination of protein sources containing complementary amino acid profiles vs soybean meal in diets based on these roughages. A final objective was to evaluate carry-over effects of growing phase dietary regimen on subsequent finishing phase performance.

PROCEDURE

A completely randomized experimental design with a 3x3 factorial arrangement of treatments was used to allot 162 crossbred steers (565 lb) to treatment in an 84-day growth trial. Factors were roughage source and protein treatment. Roughage sources were CS, AHP-WS and a 1:1 mixture of CS and AHP-WS (MIX) with the roughage level set at 66% of diet dry matter. Dietary CP level and source of supplemental CP for the protein treatments were 13% CP and soybean meal (13-SBM); 11% CP and soybean meal (11-SBM); and 11% CP and a combination of protein sources (U:CG:F). The U:CG:F diets were formulated such that urea, fishmeal and a combination of corn and corn gluten meal each provided 1/3 of the supplemental CP (Table 1). Corn and corn gluten meal are high in sulfur-containing amino acids and fish meal is high in lysine. The 13-SBM treatment served as a positive control. Based on N balance data with lambs (Willms et al., 1989b), the 11% CP treatments were expected to be slightly below protein requirements. All diets were formulated to contain .45% calcium, .30% phosphorus, .80% potassium, .30% trace mineralized salt with selenium, 30,000 IU/hd/d vitamin A and 200 mg/hd/d lasalocid.

The AHP-WS was prepared by grinding large round bales of wheat straw in a tub grinder (3/8 in. screen), then conveying ground straw into a stainless steel horizontal mixer. Each batch contained 235 ± 5 lb of wheat straw (90% DM). While mixing, water, sodium hydroxide (50% solution) and hydrogen peroxide (50% solution) were sprayed onto the wheat straw sequentially to achieve a final product with approximately 65% DM, 5% sodium hydroxide, 2% hydrogen peroxide and a pH of 11.5. Wheat straw, water and sodium hydroxide were mixed 2 min prior to hydrogen peroxide addition. After hydrogen peroxide addition and a final 3 min mixing, treated wheat straw was discharged from the mixer and transported to an oxygen limiting silo for storage.

Diets were fed once daily ad libitum and orts weighed as necessary and analyzed for dry matter. Cattle were weighed at 28-d intervals. Prior to the final 84-d weight, DM intake was equalized for four days by feeding the 13-SBM-CS diet slightly below ad libitum to all cattle. This was done to equalize gut fill and eliminate water retention that could have occurred on the high sodium-containing AHP-WS diets. One steer was removed from the trial for reasons not related to treatment.

Following the growing phase, all cattle were fed a common high concentrate finishing diet (Table 2). Performance was evaluated both at constant time on feed (105 d) and at a similar ending weight. Dry matter intake was equalized across all pens for two days prior to the 105 d weighing to equalize gut fill. When evaluating performance at a similar ending weight, final live weight was adjusted using a constant dressing percentage. Carcass data for determining quality and yield grades were obtained.

Statistical analysis was conducted using a GLM procedure of SAS for a completely randomized design. Variables included in the fixed model were roughage source, protein treatment and roughage source*protein treatment interaction. Performance and carcass data were analyzed using pen and animal as the experimental unit, respectively. Treatment mean differences were separated using the F-test for least significant difference.

RESULTS

Growing phase

Steers fed AHP-WS had lower (P<.01) dry matter intake (DMI) than steers fed CS or MIX (Table 3). Average daily gain (ADG) and efficiency of gain (G/F) decreased (P<.01) with increasing AHP-WS in the diet. Several reasons could exist for the contrast in these results to those of Lewis et al. (1987). First, the AHP-WS was prepared differently. These workers soaked wheat straw in sodium hydroxide and hydrogen peroxide solutions which could allow for a more complete reaction with the cell wall components of the wheat straw resulting in higher digestibility. Further, the AHP-WS was pelleted and could have a faster passage rate, allowing for greater intake. Secondly, an ionophore, lasalocid, was fed in this study, but not in the study of Lewis et al. (1987). Ionophores are involved in exchanging cations (Na^+ and K^+) across bacterial cell walls. Several workers have shown depressed digestibility with ionophores in high sodium and/or potassium-containing diets (Schwingel et al., 1989). Thirdly, because of the high sodium level in the AHP-WS, cattle fed AHP-WS had wetter pens from increased urination than cattle fed CS. This occurred despite a concerted effort to clean and bed these pens frequently. During cold weather, wetter pens would cause steers to have higher maintenance energy requirements and decrease performance. Nevertheless, it should be noted that steers fed 66% of diet dry matter as AHP-WS gained 2.38 lb/d. Calculated expected gain (using NRC, 1984) of steers fed 66% native wheat straw instead of AHP-WS in otherwise identical conditions (steer weight, dry matter intake and 10% increased ADG due to lasalocid) is 1.01 lb/d. The alkaline hydrogen peroxide treatment process is apparently very effective although performance of AHP-WS-fed steers did not equal that of CS-fed steers. However, CS is approximately 50% grain. In effect, CS-fed steers were receiving a 67% concentrate diet (66/2 + 34).

There was no difference in performance due to protein treatment (Table 4). There was, however, a tendency (P=.07) for the U:CG:F treatment to gain less than the 13-SBM treatment. We have no explanation for this decrease. In designing this experiment, we theorized that a roughage source*protein treatment interaction would be detected. We expected U:CG:F to improve post-ruminal supply and/or profile of amino acids and thereby improve performance with the AHP-WS-based diet since AHP-WS is nearly devoid of true protein. Improved performance with U:CG:F was not expected with CS-based diets because CS provides a significant portion of the total dietary CP. Improved performance with U:CG:F was not detected in

AHP-WS diets, probably because protein was overfed for the level of performance obtained on AHP-WS. Thus, differences in post-ruminal supply or quality of protein were masked.

Finishing phase

Since steers fed AHP-WS gained slower during the growing phase, it was of interest to determine if they would compensate in the finishing phase. Corn silage-fed steers were heavier than AHP-WS-fed steers entering the finishing phase and thus finished sooner. Therefore, performance was evaluated at both a constant time on feed and at a similar ending weight. Steers fed MIX and AHP-WS during the growing phase were slaughtered 13 d after CS-fed steers. Based on predicted performance from the most recent 28 d weighing interval, this time frame should have allowed for similar slaughter weights. However, due to extreme hot weather, MIX and AHP-WS fed steers did not gain as predicted and this precluded evaluation of performance at as similar weight as desired. Therefore, evaluation of finishing phase performance at a constant time on feed is confounded by differences in composition of gain while performance evaluation at similar slaughter weight is confounded by environmental effects.

There were no differences in finishing phase DMI, ADG or G/F between steers fed CS or AHP-WS at either end point, although steers fed AHP-WS had numerically higher values (Table 5). Steers fed MIX had lower ($P<.01$) DMI than AHP-WS fed steers at both end points. When fed to similar weights, MIX-fed steers had lower ($P<.04$) ADG and tended ($P=.06$) to have lower G/F. We have no biological explanation for decreased performance of MIX-fed steers. Steers fed AHP-WS tended ($P=.06$) to have carcasses with a lower yield grade (Table 6). These data indicate there was not compensatory growth by the AHP-WS-fed cattle during the finishing phase. However, this would also indicate that high dietary sodium levels in the growing phase were not detrimental to subsequent performance. There were no differences in finishing phase performance or carcass characteristics due to growing phase protein treatment (data not shown).

CONCLUSIONS

Steers fed high roughage diets in the growing phase have reduced performance when fed AHP-WS vs CS-based diets. There were no detrimental carry-over effects on subsequent finishing phase performance due to the high sodium content of the AHP-WS-based diets fed in the growing phase. However, steers fed AHP-WS-based diets did not exhibit compensatory growth in the finishing phase despite poorer performance in the growing phase. There is no benefit to feeding supplemental protein sources with complementary amino acid profiles in either CS or AHP-WS-based diets when the dietary crude protein level is at least 11%.

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Table 1. Growing phase diet composition

Ingredient	CS[a]			MIX[a]			AHP-WS[a]		
	1[b]	2[b]	3[b]	1	2	3	1	2	3
Corn silage	66.0	66.0	66.0	33.0	33.0	33.0			
AHP-WS				33.0	33.0	33.0	66.0	66.0	66.0
Corn	24.52	28.97	30.71	19.86	24.31	26.60	15.21	19.66	22.48
Soybean meal	7.76	3.31		12.53	8.08		17.29	12.84	
Corn gluten			.17			2.94			5.71
Fish meal			1.11			2.51			3.91
Urea			.34			.60			.85
Dicalcium phosphate	.16	.16		.37	.37	.09	.58	.58	.18
Limestone	.66	.66	.54	.56	.56	.36	.46	.46	.17
TM salt[c]	.30	.30	.30	.30	.30	.30	.30	.30	.30
Potassium chloride	.21	.21	.21	.21	.21	.21	.21	.21	.21
Vitamin premix[d]	.04	.04	.04	.04	.04	.04	.04	.04	.04
Lasalocid premix[e]	.13	.13	.13	.13	.13	.13	.13	.13	.13

[a]CS = corn silage, MIX = 1:1 mixture of corn silage and alkaline hydrogen peroxide-treated wheat straw and AHP-WS = alkaline hydrogen peroxide-treated wheat straw.

[b]1 = 13% crude protein with soybean meal as supplemental protein source, 2 = 11% crude protein with soybean meal as supplemental protein source and 3 = 11% crude protein with combination of urea, corn gluten meal and fish meal as supplemental protein sources.

[c]TM salt = trace mineralized salt. Composition: 95.0% sodium chloride, 1.58% zinc, .80% manganese, .55% iron, .056% copper, .007% iodine, .006% cobalt and .002% selenium.

[d]Contains 4,540,000 IU vitamin A and 567,000 IU vitamin D_3.

[e]Provides 10 g lasalocid/lb premix.

Table 2. Finishing phase diet composition

Ingredient	% Dry matter basis
Corn silage	10
Dry corn	77
Liquid molasses	3
Supplement	10
Supplement composition	
Dry ground corn	44.2
Soybean meal	30.9
Urea	5.0
Limestone	10.0
Potassium chloride	5.5
Trace mineralized salt[a]	3.0
Vitamin premix[b]	.4
Lasalocid premix[c]	1.0

[a]Composition: 95.0% sodium chloride, 1.58% zinc, .80% manganese, .55% iron, .056% copper, .007% iodine, .006% cobalt and .002% selenium.
[b]Contains 4,540,000 IU vitamin A and 567,000 IU vitamin D_3.
[c]Provides 10 g lasalocid/lb premix.

Table 3. Effects of roughage source on dry matter intake, daily gain and gain/feed during the 84-d growing phase

Item	Roughage source[a]			SE
	CS	Mix	AHP-WS	
Initial weight, lb	569.4	565.9	560.4	3.80
Final weight, lb	857.3	811.4	760.7	6.79
Dry matter intake, lb/d	17.64[b]	17.94[b]	16.48[c]	.21
Daily gain, lb/d	3.43[b]	2.92[c]	2.38[d]	.07
Feed/gain	5.16[b]	6.16[c]	6.95[d]	.16
Gain/feed	.194[b]	.163[c]	.145[d]	.004

[a]CS = corn silage, MIX = 1:1 mixture of corn silage and alkaline hydrogen peroxide-treated wheat straw and AHP-WS = alkaline hydrogen peroxide-treated wheat straw.
[b,c,d]Means in the same row with different superscript letters differ (P<.01).

Table 4. Effects of protein treatment on dry matter intake, daily gain and gain/feed during the 84-d growing phase

Item	Protein treatment[a]			SE
	13-SBM	11-SBM	U:CG:F	
Initial weight, lb	560.0	565.5	570.2	3.47
Final weight, lb	812.5	810.1	806.8	15.21
Dry matter intake, lb/d	17.37	17.47	17.22	.21
Daily gain, lb/d	3.01[b]	2.91[b,c]	2.82[c]	.07
Feed/gain	5.89	6.16	6.22	.16
Gain/feed	.173	.166	.164	.004

[a]13-SBM = 13% crude protein with soybean meal as supplemental protein source, 11-SBM = 11% crude protein with soybean meal as supplemental protein source and U:CG:FM = 11% crude protein with combination of urea, corn gluten meal and fish meal as supplemental protein sources.
[b,c]Means in the same row with different superscript letters differ (P=.07).

Table 5. Effects of growing phase roughage source on subsequent finishing phase performance

	Growing phase roughage source[a]			
Item	CS	MIX	AHP-WS	SE
Initial weight, lb	857.2	811.6	760.8	6.80
<u>105 d performance</u>				
Final weight, lb	1218.7	1170.9	1140.8	12.31
Dry matter intake, lb/d	21.25[b,c]	20.63[c]	21.92[b]	.292
Daily gain, lb/d	3.44	3.42	3.62	.087
Feed/gain	6.19	6.05	6.06	.113
Gain/feed	.162	.166	.165	.003
<u>Physiological end point</u>				
Final weight, lb	1221.0	1190.1	1174.7	12.82
Time on feed, d	105	118	118	
Dry matter intake, lb/d	21.25[b,c]	20.72[c]	21.93[b]	.276
Daily gain, lb/d	3.46[d]	3.21[e]	3.51[d]	.081
Feed/gain	6.14[f]	6.48[g]	6.27[f]	.113
Gain/feed	.163[f]	.155[g]	.160[f]	.003

[a]CS = corn silage, MIX = 1:1 mixture of corn silage and alkaline hydrogen peroxide-treated wheat straw and AHP-WS = alkaline hydrogen peroxide-treated wheat straw.
[b,c]Means in the same row with different superscript letters differ (P<.01).
[d,e]Means in the same row with different superscript letters differ (P<.04).
[f,g]Means in the same row with different superscript letters differ (P=.06).

Table 6. Effects of growing phase roughage source on carcass characteristics of steers fed a common finishing diet

Item	Growing phase roughage source[a]			SE
	CS	Mix	AHP-WS	
Fat thickness, in	.62	.62	.56	.026
Yield grade	3.60[c]	3.54[b,c]	3.31[b]	.107
Rib eye area, sq in	12.53	12.47	12.53	.199
Internal fat, %	2.81	2.90	2.76	.062
Marbling score[d]	14.69	15.28	14.29	.458
Quality grade[e]	10.20	10.41	9.99	.179
Dressing %	62.11	62.06	62.42	.254

[a]CS = corn silage, MIX = 1:1 mixture of corn silage and alkaline hydrogen peroxide-treated wheat straw and AHP-WS = alkaline hydrogen peroxide-treated wheat straw.

[b,c]Means in the same row with different superscript letters differ (P=.06).

[d]Scale of 1-30 where slight plus = 12, small minus = 13, small average = 14, small plus = 15, etc.

[e]Scale of 1-15 where high select = 9, low choice = 10, average choice = 11, high choice = 12, etc.

EFFECTS OF INCREASING CRUDE PROTEIN LEVEL ON INTESTINAL SUPPLY OF AMINO ACIDS IN LAMBS FED ALKALINE HYDROGEN PEROXIDE-TREATED WHEAT STRAW-BASED DIETS

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SUMMARY

Five St. Croix wethers (34 kg) fitted with ruminal, duodenal and ileal cannulae were used in a 5 x 5 Latin square experiment to study the effects of increasing crude protein (CP) level on the intestinal supply of nitrogen (N) and amino acids (AA) and site and extent of nutrient digestion when fed an alkaline hydrogen peroxide-treated wheat straw-based diet. Treatments were 8, 10, 12, 14 and 16% CP. Protein level was increased by substituting soybean meal for corn. Chromic oxide was used as a digesta flow marker and purines as a bacterial marker. Protein level had no effect on ruminal CP degradability. True ruminal organic matter digestibility increased ($P<.01$) linearly and ruminal ammonia-N concentration increased ($P<.01$) quadratically with increasing CP level. Total, bacterial and nonbacterial N and AA flows to the duodenum increased ($P<.05$) linearly with increasing CP level. Duodenal AA profile (g/100 g AA) was slightly shifted with the essential AA valine, isoleucine, phenylalanine, lysine and arginine increasing ($P<.05$) with increasing CP level. Methionine decreased ($P<.05$) in proportion to other AA with increasing CP level. All flows of indispensable AA increased with increasing CP level. Apparent intestinal N and AA disappearance increased linearly ($P<.05$) while apparent total tract N digestibility increased ($P<.01$) quadratically with increasing CP level.

INTRODUCTION

Previous research has shown alkaline hydrogen peroxide-treated wheat straw (AHPWS) to be a highly fermentable feedstuff (Kerley et al., 1986; Willms et al., 1989). However, it is essentially devoid of true protein. Utilization of AHPWS in practical ruminant diets requires development of recommendations for optimal protein supplementation. Previous research established that maximal nitrogen (N) retention (% of N intake) by lambs fed 70% AHPWS-based diets was achieved at 12% dietary crude protein (CP) when a common protein source (soybean meal) was used (Willms et al., 1989). However, in order to develop a more meaningful means of expressing protein requirements for ruminants, data on intestinal supply of amino acids (AA) must be generated. Therefore, the objective of this study was to characterize the flow of AA to the duodenum and determine site and extent of nutrient digestion due to increasing dietary protein with a standard protein source (i.e., soybean meal).

PROCEDURES

Five cannulated (ruminal, duodenal and ileal) St. Croix wethers (34 kg) were allotted to treatment in a 5 x 5 Latin square design. Diets were formulated to contain 8, 10, 12, 14 and 16% CP (Table 1). Actual CP content determined by analysis was slightly higher than planned for all treatments. Protein level was adjusted by substituting soybean meal for corn. All diets were 65% AHPWS:35% concentrate. Since low CP levels can decrease dry matter intake, a preliminary period was conducted to establish ad libitum intake of the 8% dietary CP treatment for each wether. Wethers were then fed at 90% ad libitum two times daily at 12 h intervals. Dry matter intake averaged 2.6% of body weight. At time of feeding wethers were dosed with 1.5 g chromic oxide (3 g/d) so that sites of nutrient digestion and intestinal flows could be quantified.

Each period was 16 d in length, with 10 d adjustment to diet and 6 d sample collection. Feed, duodenal and ileal digesta samples and feces were collected on d 11-16. Duodenal (100 ml) and ileal (50 ml) digesta samples were collected at 2, 6 and 10 h and 4, 8 and 12 h post AM feeding on alternate days during the collection phase and composited by animal. Samples were dried at 55 C (feed and feces) or freeze dried (duodenal and ileal digesta) and ground through a 1 mm screen using a Wiley mill. All samples were analyzed for dry matter, organic matter (OM), N, neutral detergent fiber (NDF) and acid detergent fiber (ADF). Ruminal samples were collected once daily such that each of the above hours post AM feedings were represented and pH was immediately determined. A 50 ml subsample was acidified with 6N HCl, frozen and subsequently analyzed for ammonia and volatile fatty acid concentration. From the remainder (250 ml), a bacteria rich fraction was isolated. Concentrations of AA were determined for duodenal, ileal and bacterial samples. Duodenal flows of N and AA of bacterial and nonbacterial origin were calculated using purines as a bacterial marker. Bacterial N:purine ratio and AA composition did not differ ($P > .05$) due to diet. Therefore, mean bacterial composition values were used in calculations of bacterial flows.

Data were analyzed as a 5 x 5 Latin square design. Effects of CP level were determined by linear and quadratic orthogonal contrasts using a GLM procedure of SAS. Terms in the model were period, animal and CP level. One animal died after the second period resulting in three missing observations (8, 10 and 12% CP treatments). Ruminal pH, ammonia-N and volatile fatty acid concentrations were analyzed as a split plot in time.

RESULTS AND DISCUSSION

Organic matter digestion data are presented in Table 2. Organic matter intake decreased linearly ($P < .01$) with increasing CP level since each lamb was fed at 90% ad libitum and there were three missing observations. However, this has no biological significance since the difference in OM intake among treatments was only 10 g. There was no difference in apparent OM digestion in the stomach, but true OM digestion in the stomach increased linearly ($P < .01$) with increasing CP level. There was no difference in small intestinal OM digestion. Hindgut OM fermentation tended ($P < .10$) to be higher and thereby compensated for lower stomach digestion on the 8% CP treatment. This resulted in only a tendency ($P < .10$) for total tract OM digestibility to increase linearly with increasing CP level.

Neutral detergent fiber intake (Table 3) decreased linearly ($P < .01$) for the same reasons as OM intake and has no biological significance. Digestion of NDF mirrored OM digestion with linear ($P < .05$) increases in stomach and total tract digestion and a linear decrease

(P<.05) in hindgut fermentation with increasing CP level. Stomach NDF digestion was approximately 62% for 8 and 10% CP treatments and increased to 67% for 12, 14 and 16% CP levels. There was no digestion of NDF in the small intestine. Total tract NDF digestion ranged from 70.8% on the 8% CP diet to 75.0% on the 12 and 16% CP diets. There were no differences in ADF digestion (data not shown) due to treatment although numerical values mirrored NDF digestion. Total tract ADF digestion averaged 53.3%.

Nitrogen intake ranged from 11.3 g/d on the 8% CP diet to 25.2 g/d on the 16% CP diet (Table 4). Total N flow to the duodenum increased linearly from 17.7 to 24.2 g/d with increasing CP level. There was considerable N recycling by lambs fed the low protein diets. Nitrogen flow to the duodenum on the 8 and 10% CP diets was 156 and 126% of N intake, respectively. Bacterial N flow increased linearly (P<.01) as dietary CP increased, but tended toward a quadratic effect (P=.06) with the minimal value being 13.4 g/d on the 12% CP diet. This increase in bacterial N flow was apparently due to increased ruminal OM digestion since there was no difference (P>.05) in efficiency of bacterial protein synthesis expressed either as g/100 g of apparently or truly digested OM in the rumen. These results are consistent with other studies at the University of Illinois where bacterial N flow was not affected by ruminal a ammonia-N concentration less than 5 mg/dl, but increased with increasing OM digestion with no differences in efficiency of bacterial protein synthesis (McCarthy et al., 1989). In this study, efficiency of bacterial protein synthesis was not different across treatments despite a quadratic increase (P<.01) in mean ruminal ammonia-N concentration from 3.3 to 12.8 mg/dl for the 8 to 16% CP diets, respectively (Table 5). When evaluated by hour, ruminal ammonia-N concentration on the 8% CP diet was below 5 mg/dl through 10 h post feeding and near or below 5 mg/dl through 6 h postfeeding on the 10% CP diet. Duodenal nonbacterial N flow (% of N intake, Table 4) was unaffected by protein level. Thus, the proportion of intake CP ruminally degraded was unaffected by CP level. Ruminal CP degradation averaged 69% across treatments. It follows that nonbacterial N flow (g/d) increased with increasing CP level simply due to greater N intake. There was no difference in N flow at the ileum or fecal N excretion which resulted in a linear increase (P<.05) in apparent small intestinal N digestion and a quadratic increase (P<.01) in apparent total tract N digestion as CP level increased. These increases can be partially explained by a dilution of endogenous protein secretions. Further implications are that the intestine has adequate capacity to digest and absorb increasing levels of N-containing compounds. Nitrogen digestion in the hindgut was unaffected (P>.10) by treatment.

Amino acid flows to the duodenum followed the same trends as N flow (Table 6). Increasing CP level resulted in linear increases (P<.01) in total, essential and nonessential duodenal AA flows from bacterial and nonbacterial origin. While it is biologically impossible to have negative flows of nonbacterial AA, negative flows (not significantly different from zero) were obtained for the 8% CP treatment. These may be a result of inaccuracies related to the digesta flow marker. Nonbacterial AA flows were essentially zero for both the 8 and 10% CP diets. This means that all the nonbacterial N flow to the duodenum of lambs fed these diets was non-amino acid-N. The flow of each essential AA increased linearly (P<.01 or P<.05) as dietary CP level increased. With more than a doubling of N intake, flows of lysine, leucine and valine increased 6.0, 5.6 and 4.7 g/d, respectively, while methionine and histidine flows increased only .7 and 1.6 g/d, respectively. The flow of methionine on the 8 and 10% CP diets may be inflated in relation to other treatments since all AA flow originated from bacteria. Diaminopimelic acid (DAPA) is found in the cell walls of bacteria and co-elutes with methionine from the column used for AA analysis. Nevertheless, there would still only be slight increases in methionine flow without the confounding effects of DAPA. It would appear that methionine was the first limiting AA since it had the lowest increase in flow per unit increase in dietary CP level.

There were only subtle changes in the profile of AA (g/100 g total AA) entering the duodenum (Table 7). The profile of duodenal AA was similar to published values for bacterial AA profiles. Valine, isoleucine, phenylalanine, lysine, arginine and aspartic acid increased linearly ($P<.01$ and $P<.05$) in relation to other AA while methionine, glutamic acid, proline and alanine decreased linearly ($P<.01$ and $P<.05$). In general, the proportion of essential AA increased and nonessential AA decreased in relation to total AA as dietary CP level increased. The biological significance of these changes may be unimportant since AA composition of bacteria and digesta can be measured much more accurately than the flow of digesta. Profile of methionine may be inflated on the low protein diets because of confounding with DAPA. Yet the true profile of methionine (without DAPA) could at best be unaffected (rather than decreasing) by increasing CP level. The flows and profile of individual amino acids to the duodenum underscores the difficulty in changing quality of protein when a high ruminally degradable protein source is fed. If methionine is the first limiting AA in bacteria, feeding a highly ruminally degradable protein source such as soybean meal does little to enhance methionine flow to the duodenum.

Net small intestinal disappearance of total, essential and nonessential AA whether expressed as g/d or as a percentage of AA entering the duodenum increased linearly ($P<.05$) with increasing CP level (Table 8). Essentially all the increased flow of AA resulting from increased CP level were absorbed in the small intestine. Increasing dietary CP level from 8 to 16% increased total AA flow 66 g/d (145.1 - 79.1, Table 6) while total AA disappearance from the small intestine increased 64.8 g/d (100.8 - 36.0, Table 8). The intestine apparently has adequate capacity to digest and absorb large quantities of AA. The increase in percentage disappearance of AA with increasing protein level was apparently due to a dilution of endogenous protein secretions.

In summary, because AHPWS is essentially devoid of true protein, nearly all dietary protein is supplied by supplemental protein sources. When a highly degradable protein source is fed, the profile of AA entering the intestines is inherently similar to microbial protein and there is little or no opportunity to enhance the biological value of protein entering the small intestines. Whatever AA are limiting in bacterial protein (presumably methionine) will be the AA limiting production. In contrast, an AHPWS-based diet lends itself to use of ruminally resistant protein sources with complementary AA profiles (Cecava et al., 1990). These researchers demonstrated that combinations of blood meal (high lysine source) and corn gluten meal (high methionine source) increased total flows of amino acids and the profile of lysine and methionine entering the duodenum compared to soybean meal supplemented AHPWS-based diets. Growth data with ram lambs fed a combination of fish meal (high lysine) and distillers dried grains (high methionine) as supplemental protein sources in AHPWS-based diets support this work (Willms et al., 1990).

When viewing this study in conjunction with a previous N balance study using the same treatments and similar lambs (Willms et al., 1989), increasing the flow of AA entering the duodenum does not necessarily translate into greater animal performance. In this study, N and AA flow to the duodenum increased linearly with increasing CP level from 8 to 16%, whereas N retention (% of N intake) was maximized at 12% CP on the previous study. It appears that methionine was the first limiting amino acid since flow of methionine had the lowest increase per unit of increase in dietary CP level. However, the actual requirement for methionine appears to be low since total flow of methionine (and DAPA) to the duodenum did not exceed 2 g/d on the 16% CP diet. It is inappropriate, however, to make an estimate of the methionine requirement from these experiments since they were conducted under different conditions and with different animals.

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Table 1. Dietary ingredients and chemical composition of diets fed to wethers

Ingredient	Protein level, %				
	8	10	12	14	16
	---% dry matter basis---				
AHPWS[a]	65.9	65.9	65.8	65.8	65.7
Ground corn	24.4	18.7	13.1	7.5	2.0
Soybean meal	7.4	13.2	18.9	24.6	30.3
Dicalcium phosphate	.9	.8	.7	.6	.5
Calcium carbonate	.4	.4	.5	.5	.5
Potassium chloride	.6	.6	.6	.6	.6
Trace mineral salt[b]	.3	.3	.3	.3	.3
Vitamin premix[c]	.1	.1	.1	.1	.1
Chemical composition					
Dry matter	66.1	66.2	66.2	66.3	66.3
Organic matter	86.1	85.7	85.4	85.1	84.7
Neutral detergent fiber	47.9	47.6	47.3	47.0	46.8
Acid detergent fiber	33.2	33.2	33.2	33.2	33.2
Nitrogen	1.34	1.76	2.18	2.60	3.01

[a]AHPWS = alkaline hydrogen peroxide-treated wheat straw.
[b]Composition: NaCl = 93 to 98%; Zn = .35%; Fe = .34%; Mn = .20%; Cu = .033%; I = .007%; Se = .0055%; and Co = .005%.
[c]Composition: vitamin A = 681,818 IU/kg; vitamin D = 68,182 IU/kg; vitamin E = 455 IU/kg; vitamin B-12 = 3.6 mg/kg; riboflavin = 227 mg/kg; D-pantothenic acid = 1,250 mg/kg; niacin = 3,409 mg/kg; and choline chloride = 34,091 mg/kg.

Table 2. Organic matter (OM) digestion by lambs fed increasing dietary crude protein

Item	Protein level, %					SE
	8	10	12	14	16	
	-------------------------g/d-------------------------					
OM intake[a]	720	718	715	712	709	.1
OM flow at duodenum	398	392	347	369	373	19.7
OM flow at ileum[b]	292	255	244	255	232	16.4
Fecal OM excretion[c]	210	199	186	198	192	5.4
OM digestion, % of OM intake						
$stomach_A$[d]	44.8	45.4	51.4	48.2	47.7	2.56
$stomach_T$[b,d]	66.5	67.2	72.2	72.8	73.6	2.03
intestine	14.6	19.2	14.2	16.1	19.7	2.32
hindgut[c]	11.4	7.8	8.3	7.9	5.7	1.88
total tract[c]	70.8	72.3	73.9	72.2	73.1	.74

[a]Linear effect due to increasing protein level (P<.01).
[b]Linear effect due to increasing protein level (P<.05).
[c]Linear effect due to increasing protein level (P<.10).
[d]$Stomach_A$ and $Stomach_T$ = apparent and true digestion in the stomach, respectively.

Table 3. Neutral detergent fiber (NDF) digestion by lambs fed increasing dietary crude protein

	Protein level, %					
Item	8	10	12	14	16	SE
NDF intake, g/d[a]	396	394	392	394	391	23.3
NDF digestion, % of NDF intake						
stomach[b]	62.8	62.0	67.7	67.5	67.8	1.85
intestine	-3.6	4.3	0.3	-0.1	2.6	1.87
hindgut[b]	11.6	6.1	7.0	5.5	4.6	1.62
total tract[b]	70.8	72.4	75.0	72.8	75.0	1.17

[a]Linear effect due to increasing dietary protein level ($P<.01$).
[b]Linear effect due to increasing dietary protein level ($P<.05$).

Table 4. Nitrogen (N) digestion by lambs fed increasing levels of dietary crude protein

Item	Protein level, %					
	8	10	12	14	16	SE
	g/d					
N intake[a]	11.3	14.7	18.2	21.7	25.2	.15
Duodenal N flow						
Total[a]	17.7	18.6	19.9	22.3	24.2	1.12
Bacterial[a]	14.1	14.1	13.4	15.8	16.6	.60
Ileal N flow	7.1	7.0	7.4	7.9	7.3	.49
Fecal N flow	6.2	5.9	5.9	6.3	6.2	.17
Nonbacterial-N at duodenum, % of N intake	29.2	30.0	36.0	30.0	29.9	3.21
N digestion, % of N entering						
small intestine[b]	59.8	62.7	63.0	64.3	69.0	2.65
hindgut	10.0	13.8	18.1	19.5	15.4	4.61
total $tract_A$[c,d]	45.3	59.6	67.4	71.1	75.6	.86
Bacterial N synthesis						
g/100 g OMD_A[e]	4.41	4.44	3.67	4.69	5.09	.476
g/100 g OMD_T[e]	2.94	2.95	2.61	3.06	3.21	.195

[a]Linear effect due to increasing CP level ($P < .01$).
[b]Linear effect due to increasing CP level ($P < .05$).
[c]Positive quadratic effect due to increasing CP level ($P < .01$).
[d]Total $tract_A$ = apparent total tract.
[e]OMD_A = organic matter apparently digested in the rumen; OMD_T = organic matter truly digested in the rumen.

Table 5. Effects of increasing dietary crude protein level on ruminal ammonia-N concentrations

	Protein level, %					
Hour post-feeding	8	10	12	14	16	SE
2[a]	1.8	5.4	8.5	8.6	13.7	1.83
4[a]	1.6	2.8	7.5	6.8	10.5	.93
6[a]	1.1	5.2	7.7	9.2	11.5	.84
8[a]	2.3	8.5	9.9	11.9	13.3	.81
10[a]	4.8	10.3	10.8	13.8	14.5	1.35
12[a]	7.3	10.5	10.3	12.9	13.2	.79
Average[b]	3.3	7.1	9.5	10.5	12.8	.47

[a]Linear effect of increasing protein level ($P<.01$).
[b]Positive quadratic effect of increasing protein level ($P<.01$).

Table 6. Duodenal flows of amino acids (AA) in lambs fed increasing levels of dietary crude protein

Item	Protein level, %					
	8	10	12	14	16	SE
	-----------------------		g/d		-----------------------	
Total flows						
Threonine[a]	4.6	5.1	6.7	7.0	8.6	.87
Valine[a]	5.0	5.4	7.2	7.7	9.7	.10
Methionine[b]	1.2	1.3	1.6	1.7	1.9	.21
Isoleucine[a]	4.3	4.8	6.2	6.6	8.3	.85
Leucine[b]	7.8	8.5	10.8	11.2	13.4	1.40
Phenylalanine[a]	3.8	4.4	5.5	5.9	7.3	.73
Histidine[a]	1.8	2.0	2.6	2.8	3.4	.19
Lysine[a]	6.0	7.1	9.0	9.5	12.0	.74
Arginine[a]	3.3	3.8	4.9	5.5	6.9	.38
Total flows[a]	79.1	88.6	112.3	118.4	145.1	14.83
EAA[a,c]	37.8	42.5	54.6	57.9	71.5	7.45
NEAA[a,d]	41.3	46.1	57.7	60.5	73.5	7.38
Bacterial						
Total AA[a]	85.0	85.1	80.9	95.1	100.2	3.61
EAA[a]	42.2	42.2	40.2	47.2	49.7	1.79
NEAA[a]	42.8	42.9	40.7	47.9	50.5	1.82
Nonbacterial[e]						
Total AA[b]	-5.9	3.5	31.4	23.3	44.9	13.56
EAA[b]	-4.4	.3	14.4	10.7	21.8	6.80
NEAA[b]	-1.5	3.2	17.0	12.6	23.1	6.77

[a]Linear effect with increasing protein level ($P < .01$).
[b]Linear effect with increasing protein level ($P < .05$).
[c]EAA = essential amino acids (THR+VAL+MET+ILE+LEU+PHE+HIS+LYS+ARG).
[d]NEAA = nonessential amino acids (ASP+SER+GLU+PRO+GLY+ALA+TYR).
[e]Nonbacterial amino acids include dietary escape, endogenous and possibly some protozoal amino acids.

Table 7. Profiles of amino acids (AA) flowing to the duodenum of lambs fed increasing levels of crude protein

Amino acid	Protein level, %					SE
	8	10	12	14	16	
	g/100 g AA					
Threonine	5.8	5.8	6.0	5.9	5.9	.04
Valine[a]	6.3	6.2	6.5	6.5	6.7	.07
Methionine[b]	1.5	1.5	1.4	1.4	1.3	.07
Isoleucine[a]	5.4	5.4	5.5	5.6	5.7	.04
Leucine	9.8	9.5	9.6	9.4	9.3	.18
Phenylalanine[b]	4.8	5.0	4.9	5.0	5.0	.05
Histidine	2.3	2.3	2.3	2.4	2.4	.04
Lysine[b]	7.6	7.9	8.0	8.0	8.2	.18
Arginine[a]	4.2	4.4	4.4	4.7	4.8	.07
Aspartic acid[a]	11.8	11.7	12.2	12.2	12.2	.06
Serine	5.0	4.8	4.9	4.9	4.9	.10
Glutamic acid[a]	14.5	14.3	14.2	14.1	13.8	.10
Proline[a]	4.8	4.8	4.6	4.5	4.4	.05
Glycine	5.4	5.3	5.2	5.2	5.3	.07
Alanine[a]	6.9	6.9	6.6	6.5	6.5	.08
Tyrosine	3.8	4.1	3.5	3.6	3.6	.19

[a]Linear effect of increasing protein level ($P<.01$).
[b]Linear effect of increasing protein level ($P<.05$).

Table 8. Net disappearance of amino acids (AA) from the small intestine of lambs fed increasing levels of crude protein

Item	Protein level, %					SE
	8	10	12	14	16	
	-----------------------g/d-----------------------					
Threonine[a]	1.9	1.9	3.7	3.8	5.7	.88
Valine[a]	2.3	2.4	4.2	4.5	6.7	.97
Methionine[b]	.3	.3	.7	.9	1.1	.24
Isoleucine[a]	2.4	2.6	4.0	4.3	6.1	.82
Leucine[a]	3.0	3.4	5.9	6.4	9.0	1.42
Phenylalanine[a]	2.1	2.4	3.5	3.7	5.4	.70
Histidine[a]	.7	.80	1.5	1.6	2.3	.19
Lysine[a]	3.4	4.2	6.1	6.6	9.3	.73
Arginine[a]	2.1	2.3	3.5	4.1	5.7	.38
Total AA[a]	36.0	40.0	65.8	70.6	100.8	14.78
EAA[a,c]	18.0	20.3	33.1	35.9	51.3	7.33
NEAA[a,d]	17.9	19.8	32.7	34.7	49.4	7.48
Disappearance, % of AA entering duodenum						
Total AA[b]	45.7	48.6	57.1	58.7	67.6	6.49
EAA[b]	48.0	50.8	59.4	61.2	70.0	6.14
NEAA[b]	43.5	46.5	55.0	56.4	65.2	6.82

[a]Linear effect of increasing protein level ($P<.01$).
[b]Linear effect of increasing protein level ($P<.05$).
[c]EAA = essential amino acids (THR+VAL+MET+ILE+LEU+PHE+HIS+LYS+ARG).
[d]NEAA = nonessential amino acids (ASP+SER+GLU+PRO+GLY+ALA+TYR).

EFFECTS OF SUPPLEMENTAL PROTEIN SOURCE AND LEVEL OF UREA ON INTESTINAL AMINO ACID SUPPLY IN LAMBS FED ALKALINE HYDROGEN PEROXIDE-TREATED WHEAT STRAW-BASED DIETS

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SUMMARY

A 5 x 5 Latin square experiment was conducted with five cannulated (ruminal, duodenal and ileal) Suffolk-cross wethers (61 kg) to determine the effects of different protein sources and level of supplemental urea on intestinal supply of nitrogen (N) and amino acids (AA) in animals fed alkaline hydrogen peroxide-treated wheat straw (AHPWS)-based diets. Treatments were soybean meal (SBM), a combination of urea, distillers dried grains (DDG) and fish meal with each crude protein (CP) source providing an equal portion of supplemental CP (UDF), and three levels of urea (17, 33 and 50% of supplemental CP) fed in combination with DDG (U17, U33 and U50). Organic matter (OM) and N digestibilities were decreased (P<.05) in lambs fed U17. Duodenal N and AA flows were greatest (P<.05) for U17 and UDF compared to other CP sources. There were no differences (P>.05) in bacterial N or AA flows to the duodenum due to supplemental CP source despite large differences in ruminal ammonia-N concentrations and lower ruminal OM digestion in lambs fed U17. Duodenal nonbacterial N and AA flows were highest (P<.05) in lambs fed U17 and UDF and lowest in lambs fed U50 and SBM. Lysine content of duodenal digesta decreased in relation to other AA with each incremental increase in DDG. Data are interpreted to indicate that no more than 33% of supplemental CP should originate from urea in AHPWS-based diets. Seventeen percent urea appears adequate to maximize bacterial protein synthesis. Feeding a combination of ruminally resistant protein sources with complementary AA profiles of lysine and methionine (UDF) may enhance the quality of protein entering the duodenum.

INTRODUCTION

Urea is a common source of supplemental crude protein (CP) in ruminant diets. Although urea has been used for many years, there is considerable debate concerning conditions and levels that promote optimal use. Urea has value to the ruminant animal only when it is converted to microbial protein. Energy level and type of diet (roughage vs concentrate) are major determinants of effective urea usage. Also, dietary protein level and ruminal degradability of other dietary protein sources influence urea utilization.

Burroughs et al. (1972) suggested that low protein, highly fermentable feedstuffs (>75% TDN) have the greatest potential for being supplemented with urea. Alkaline hydrogen peroxide-treated wheat straw (AHPWS) is a high fiber (65% NDF), highly fermentable (70% dry matter digestibility), low protein (1-3% CP) feedstuff. Urea supplementation could be advantageous in AHPWS-based diets since AHPWS has these characteristics. A feasible approach to minimizing supplemental CP cost is to optimize combinations of urea and ruminally resistant protein sources such as distillers dried grains (DDG) and fish meal. Distillers dried grains improved cattle performance when included in corn cob based-diets that had little true protein in basal ingredients (Waller et al., 1980). Cecava et al. (1990) demonstrated the complementary effects of corn gluten meal (rich methionine source) and blood meal (rich lysine source) on the profile of amino acids (AA) entering the small intestine. Similar results may be achieved with DDG (high methionine) and fish meal (high lysine).

The objectives of this trial were to determine the effects of level of urea supplementation and different sources of supplemental protein on intestinal AA supply and site and extent of nutrient digestion.

PROCEDURES

A 5 x 5 Latin square design was used to allot five cannulated (ruminal, duodenal and ileal) Suffolk-cross wethers (61 kg) to five supplemental protein treatments. Treatments were soybean meal (SBM), a combination of urea, DDG and fish meal in which each protein source provided equal portions of supplemental protein (UDF), and three levels of urea fed in combination with DDG and corn. Levels of urea and DDG (% of supplemental CP basis) were 17% urea:83% DDG (U17), 33% urea:67% DDG (U33) and 50% urea:50% DDG (U50). All diets were 65% AHPWS:35% concentrate and formulated to contain 12.5% CP (Table 1). However, due to differences in N content of fish meal compared with that analyzed prior to initiation of the trial, and(or) sampling and mixing errors, the UDF diet was higher in CP than expected. The fish meal-containing diet was expected to be the least acceptable. Therefore, a pretrial period was conducted to determine ad libitum intake on this diet. All lambs were fed two times daily at 12 h intervals at 90% ad libitum of the lamb consuming the least feed. At time of feeding, wethers were dosed with 1.5 g chromic oxide (3.0 g/d) so that sites of nutrient digestion and intestinal flows of AA could be quantified.

Each 16 d period consisted of 10 d for diet adaptation and 6 d for sample collection. Feed, duodenal and ileal digesta samples and feces were collected on d 11-16. On odd and even numbered days during the collection phase, duodenal (100 ml) and ileal (50 ml) samples were collected at 2, 6 and 10 h and 4, 8 and 12 h post-AM feeding, respectively, such that a total of 18 samples were collected and composited by animal each period. Samples were dried at 55 C (feed and feces) or freeze dried (duodenal and ileal digesta) and ground through a 1 mm screen using a Wiley mill. All samples were analyzed for dry matter, organic matter (OM) and nitrogen (N). Ruminal contents (250 ml) were collected once daily, such that each of the above hours post AM feeding were represented, to obtain a bacteria-rich fraction. Ruminal contents were homogenized with an equal volume of saline for 30 sec, strained through 4 layers of cheesecloth and frozen. Subsequently, composited samples were thawed and bacteria isolated by differential centrifugation. Concentrations of AA were determined for duodenal, ileal and bacterial samples. Duodenal flows of N and AA of bacterial and nonbacterial origin were calculated using purines as a bacterial marker. On the last day of each period, ruminal contents (50 ml) were collected at 3, 6 and 9 h post AM-feeding and pH immediately determined. Ruminal samples were acidified with 6N HCl, frozen and subsequently analyzed for ruminal ammonia-N and volatile fatty acid concentrations.

Data were analyzed as a 5 x 5 Latin square design using GLM procedures of SAS. Terms in the model were period, animal and protein source. Treatment mean differences for effects of protein source were separated using the LSD method only when protected by a significant F-test ($P<.05$). There was one missing observation due to the death of one animal. Data collected at various times post-feeding (ruminal pH, ammonia-N and volatile fatty acid concentrations) were analyzed as separate Latin squares for each time and the average across time was analyzed as a separate square.

RESULTS AND DISCUSSION

Organic matter apparently and truly digested in the rumen increased from 41.5 and 63.6% of OM intake on the U17 diet to 50.4 and 71.5% of OM intake on the SBM diet, respectively (Table 2). True ruminal OM digestion in lambs fed U17 tended ($P<.09$) to be lower than in lambs fed U33 and UDF. Wethers fed U50 tended ($P<.06$) to have lower true ruminal OM digestion than wethers fed SBM. Small intestinal and hindgut digestion were unaffected by protein treatment. Small intestinal OM digestion ranged from 12.1% to 16.8% of OM intake on the U17 and SBM diets, respectively, while hindgut OM fermentation ranged from 7.6 to 13.7% of OM intake on U33 and U50 diets, respectively. Total tract digestibility was lowest ($P<.05$) on the U17 diet compared to all other treatments. There were no differences in total tract OM digestibility among all other treatments.

Ruminal characteristics reflect the differences in OM digestion. Total volatile fatty acid (TVFA) and acetate concentrations (mM) were lower ($P<.05$) in lambs fed U17 compared to all other treatments (Table 3). Lambs fed SBM had higher ($P<.05$) TVFA and acetate concentrations than lambs fed U33. Ruminal TVFA and acetate concentrations were intermediate for lambs fed U50 and UDF. There were no differences in propionate concentration among protein treatments, but the percent propionate was highest and the acetate:propionate ratio lowest in wethers fed the U17 diet. Soybean meal-fed lambs had higher valerate and isovalerate concentrations compared to all other treatments. Ruminal pH was greater than 6.0 for all treatments and likely had no effect on digestion kinetics. Differences in pH are reflective of the differences in TVFA concentrations. Increases in OM digestion increased TVFA concentration and lowered pH.

These differences in OM digestion and ruminal characteristics can be related in part to differences in ruminal degradability of DDG and SBM. There were approximately 18 percentage units difference in ruminal escape of dietary CP from the concentrate portion of the diets (nonbacterial N as a percent of N intake, excluding N from urea and AHPWS) between U17- and SBM-fed lambs in this study (Table 4). The concentrates represent approximately 505 g of OM intake (1530 g OM intake x 33% concentrate, excluding minerals). Assuming a similar difference in OM digestion, this difference in ruminal degradability accounts for 90 g nondigested OM (505 g x 18%). Lambs supplemented with SBM digested 136 g more OM in the rumen than those fed U17.

Nitrogen intake was affected by supplemental CP source which may confound some of the results (Table 4). Diets were formulated to be isonitrogenous but variability in dietary ingredients from initial analysis, and(or) sampling and mixing errors, precluded N intake being similar across all treatments. Total N flow to the duodenum ranged from 38.0 to 45.6 g/d for the U50 and UDF diets, respectively. There were no differences in bacterial N entering the duodenum despite large differences in ruminal ammonia-N concentrations (Table 5). At 3 h post-feeding, lambs fed U50 had a ruminal ammonia-N concentration of 26.2 mg/dl, while lambs fed SBM, U33 and UDF had ammonia-N concentrations ranging from 5.2 to 11.9 mg/dl. At none of the sampling times (3, 6 and 9 h post-feeding) did lambs fed U17 have ammonia-N concentrations greater than 3.0, yet bacterial N flow was similar to that for other treatments. Wethers fed SBM had a higher ($P<.05$) ruminal ammonia-N concentration at 9 h post-feeding than lambs fed the other treatments, indicating greater N recycling. There were no differences ($P>.05$) in efficiency of bacterial CP synthesis expressed either as g per 100 g apparently or truly digested in the rumen (Table 4). However, lambs fed U17 had similar bacterial N flow to the duodenum despite lower ruminal OM digestion due to a nonsignificant increase in efficiency of bacterial protein synthesis. These data are interpreted to indicate that urea-N was not efficiently incorporated (in relation to amount fed) into microbial protein when 50% of the supplemental protein was provided by urea. Urea supplied sufficient ruminal ammonia-N to maximize postruminal supply of bacterial protein when fed at 17 or 33% of the supplemental protein. Soybean meal supplemented lambs had numerically higher bacterial N flow entering the duodenum than U17-, U33- and U50-fed lambs. Other studies have shown numerically higher bacterial N flow when SBM was the supplemental protein source vs urea. This could be due to SBM being highly degradable in the rumen and increasing the supply of AA and(or) peptides to bacteria. Several studies have been conducted with urea providing 33 to 40% of the supplemental CP to ensure adequate ruminal ammonia-N levels to maximize bacterial protein synthesis. In AHPWS-based diets fed to lambs, approximately one-half this amount appears to be adequate.

Since there were no differences in bacterial N flow among protein treatments, differences in total N flow are due primarily to differences in nonbacterial N (NBN) flow (Table 4), although increased N intake could account for some of the increased NBN in UDF fed lambs. Nevertheless, lambs fed U17 had similar amounts of NBN entering the duodenum than lambs fed UDF even though UDF-fed lambs had higher N intake. Nonbacterial N flow was lowest for U50 and SBM diets and highest for U17 and UDF diets. Low NBN flow in lambs fed U50 and SBM is due to decreased dietary true protein and the high ruminal degradability of SBM, respectively. Nonbacterial N flow tended ($P<.10$) to be higher on U33 and was increased ($P<.05$) on U17 and UDF diets compared to SBM. Thus, decreased ruminal degradability of DDG, corn and fish meal vs SBM more than offset the dilution of true protein in the diet due to inclusion of urea. Corn, DDG and fish meal are relatively resistant to ruminal degradation as evidenced by ruminal escape N (NBN, nonurea, non-AHPWS-N intake). Ruminal escape N was lower ($P<.05$) in lambs fed SBM compared to lambs fed U17, U33 and UDF and tended (P<.10) lower than lambs fed U50.

Nitrogen digestion in the small intestine (Table 4) was similar for lambs fed the urea-containing diets. Lambs fed SBM had greater (P<.05) small intestinal N digestion than lambs fed U17, U50 and UDF and tended (P<.10) to have higher N digestion than U33. There were no differences in digestion of N-containing compounds in the hindgut. Total tract N digestion was lower (P<.05) for lambs fed U17 compared to all other treatments.

Flows of AA entering the duodenum are presented in Table 6. Lambs fed UDF had higher (P<.05) duodenal flows of threonine, histidine and arginine than lambs fed other supplemental CP sources. Lambs fed U17 had more (P<.05) leucine entering the duodenum. Lysine flow was greatest (P<.05) in lambs fed SBM and UDF compared to other diets. There were no significant differences in duodenal methionine flow although lambs fed SBM and UDF had numerically the lowest and highest methionine flow, respectively. Total flows of essential and nonessential AA to the duodenum were lowest for wethers fed U50 and highest for wethers fed UDF. Total, essential and nonessential duodenal AA flows were similar (P>.05) for lambs fed U50 and SBM and for lambs fed U17 and UDF. In general, as urea level increased, total, essential and nonessential AA flows decreased. There were no differences in flows of AA from bacterial origin. However, wethers fed SBM and UDF had numerically higher flows of bacterial AA to the duodenum than U17, U33- and U50-fed wethers. Nonbacterial essential and nonessential AA flows were numerically highest for lambs fed U17. Lambs fed U17, U33 and UDF had higher (P<.05) nonbacterial AA flows than lambs fed SBM or U50. Nonbacterial essential and nonessential AA flows tended (P<.10) to be higher in lambs fed U17 than in lambs fed U33.

Proportion of each AA (g/100 g total AA) entering the duodenum, except methionine, was affected by supplemental protein source (Table 7). Duodenal threonine and isoleucine content in relation to other AA was highest (P<.05) in lambs fed SBM. Lambs fed U17 had the highest (P<.05) concentration of leucine, glutamic acid and proline. Lambs fed UDF had the lowest (P<.05) phenylalanine and highest (P<.05) glycine concentration in relation to other AA entering the duodenum. Lysine content in relation to other AA decreased (P<.05), and methionine content numerically increased, with each incremental increase in DDG and corn (U50 to U33 to U17). Lambs fed SBM had the highest (P<.05) lysine content and numerically the lowest methionine content compared to other supplemental crude protein sources. Lambs fed UDF had a higher proportion (P<.05) of lysine than lambs fed U17 and U33, but a lower (P<.05) proportion than lambs fed SBM. While maintaining a relatively high proportion of lysine, lambs fed UDF had numerically the highest methionine content. Methionine and lysine have been implicated as limiting AA for ruminants when predominantly bacterial protein enters the duodenum. Manipulating the profile of AA entering the small intestine by use of escape protein may enhance the biological value of protein entering the duodenum. Fish meal is a rich source of lysine and DDG is a rich source of methionine. Cecava et al. (1990) reported similar results in AHPWS-based diets with corn gluten meal and blood meal combinations.

There were no differences (P>.05) in net disappearance of total, essential and nonessential AA in the small intestine, although there were differences in disappearance among individual essential AA (Table 8). Total, essential and nonessential AA disappearance from the small intestine was numerically lowest in lambs fed U50 and highest in lambs fed UDF. This is consistent with other reports where disappearance of AA increased as the quantity of AA entering increased. However, net disappearance of total and nonessential AA expressed as a percentage of AA entering was lower (P<.05) in lambs fed U17, U50 and UDF than in lambs fed SBM. This indicates that SBM protein that escapes ruminal degradation is more digestible than that of DDG.

In conclusion, these data are interpreted to indicate that no more than 33% of supplemental CP should be derived from urea in AHPWS-based diets. Feeding higher levels of urea decreased total and nonbacterial AA flow to the duodenum. As little as 17% supplemental CP protein from urea was adequate to maximize bacterial protein synthesis. Feeding a high level of DDG (e.g., U17 diet) can lead to decreased OM, N and AA digestion. Supplementing diets with a combination of ruminally resistent protein sources with complementary AA profiles may improve the quality of protein entering the small intestine. In particular, lambs fed UDF had a higher concentration of lysine than lambs fed urea in combination with DDG and a nonsignificant increase in methionine profile compared to SBM fed lambs.

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Table 1. Dietary ingredients and chemical composition of diets fed to wethers

	Protein source[a]				
Ingredient	SBM	U17	U33	U50	UDF
AHPWS[b]	63.8	64.3	64.3	64.3	64.1
Corn	18.6	3.0	10.8	18.6	18.1
Soybean meal	15.8				
Distillers dried grains		30.5	21.9	13.3	10.2
Fish meal					5.5
Urea		.6	1.2	1.8	1.2
Dicalcium phosphate	.5	.2	.4	.6	
Calcium sulfate[c]			+	+	.1
Calcium carbonate	.5	.6	.6	.6	
Trace mineralized salt[d]	.3	.3	.3	.3	.3
Potassium chloride	.3	.3	.3	.3	.3
Vitamin premix[e]	.2	.2	.2	.2	.2
Chemical Composition					
Dry matter	66.9	66.4	66.4	66.4	66.6
Organic matter	87.3	87.3	87.6	87.8	88.0
Neutral detergent fiber	47.4	55.9	55.1	53.0	52.4
Acid detergent fiber	30.9	34.1	33.4	32.1	31.8
Nitrogen	1.9	2.0	2.0	2.1	2.4

[a]Levels (% of supplemental protein basis) and protein sources are: SBM = soybean meal; U17 = 17% urea and 83% distillers dried grains (DDG) and corn; U33 = 33% urea and 67% DDG and corn; U50 = 50% urea and 50% DDG and corn; and UDF = 33% each of urea, DDG and corn, and fish meal.

[b]AHPWS = alkaline hydrogen peroxide-treated wheat straw.

[c]Calcium sulfate content was .02% and .05% in the U17 and U33 diets, respectively. Calcium sulfate was added to obtain a N:sulfur ratio of 10:1.

[d]Composition: NaCl = 93 to 98%; Zn = .35%; Fe = .34%; Mn = .20%; Cu = .033%; I = .007%; Se = .0055%; and Co = .005%.

[e]Composition: vitamin A = 681,818 IU/kg; vitamin D = 68,182 IU/kg; vitamin E = 455 IU/kg; vitamin B-12 = 3.6 mg/kg; riboflavin = 227 mg/kg; D-pantothenic acid = 1,250 mg/kg; niacin = 3,409 mg/kg; and choline chloride = 34,091 mg/kg.

Table 2. Organic matter (OM) digestion by lambs fed different sources of supplemental dietary crude protein

Item	Protein source[a]					
	SBM	U17	U33	U50	UDF	SE
	----------g/d----------					
OM intake	1533	1533	1530	1513	1525	12.5
OM flow at duodenum	761	897	804	817	839	29.6
OM flow at ileum	504[b]	711[d]	548[b,c]	621[c]	604[c]	23.8
Fecal OM excretion	404[b]	537[c]	433[b]	413[b]	416[b]	30.6
OM digestion, % of OM intake						
$stomach_A$[e]	50.4[d]	41.5[b]	47.5[c,d]	46.1[b,c,d]	45.0[b,c]	1.77
$stomach_T$[e]	71.5[c]	63.6[b]	67.9[b,c]	67.1[b,c]	67.4[b,c]	1.47
small intestine	16.8	12.1	16.7	12.9	15.5	1.68
hindgut	6.5	11.4	7.6	13.7	12.3	2.27
total tract	73.7[c]	65.0[b]	71.7[c]	72.8[c]	72.7[c]	1.95

[a]Levels (% of supplemental protein basis) and protein sources are: SBM = soybean meal; U17 = 17% urea and 83% distillers dried grains (DDG) and corn; U33 = 33% urea and 67% DDG and corn; U50 = 50% urea and 50% DDG and corn; and UDF = 33% each of urea, DDG and corn, and fish meal.

[b,c,d]Means in the same row with different superscript letters differ ($P < .05$).

[e]$Stomach_A$ and $stomach_T$ = OM apparently and truly digested in the stomach, respectively.

Table 3. Effects of different sources of supplemental dietary crude protein on ruminal volatile fatty acid concentrations and molar percentages and pH

	Protein source[a]					
Item	SBM	U17	U33	U50	UDF	SE
Total VFA, mM[e]	106.3[d]	84.8[b]	94.8[c]	100.6[c,d]	100.5[c,d]	2.80
Acetate, mM	72.7[d]	55.4[b]	63.9[c]	66.6[c]	68.4[c,d]	1.95
Propionate, mM	19.3	18.6	18.5	21.0	19.9	.84
Butyrate, mM	11.3	9.0	10.2	11.0	10.0	.62
Isobutyrate, mM	.8	.4	.7	.3	.5	.13
Isovalerate, mM	1.4[c]	.9[b]	.9[b]	1.0[b]	1.1[b]	.08
Valerate, mM	.8[c]	.6[b]	.5[b]	.6[b]	.6[b]	.04
Acetate, %	68.3[c]	65.4[b]	67.6[b,c]	66.3[b,c]	68.2[c]	.83
Propionate, %	18.1[b]	21.7[d]	19.4[b,c]	20.8[c,d]	19.7[b,c]	.62
Butyrate, %	10.7	10.6	10.7	10.9	9.9	.17
Acetate:propionate	3.8[c]	3.1[b]	3.5[b,c]	3.2[b]	3.5[b,c]	.14
pH	6.3[b]	6.6[d]	6.5[c,d]	6.5[c,d]	6.4[c]	.05

[a]Levels (% of supplemental protein basis) and protein sources are: SBM = soybean meal; U17 = 17% urea and 83% distillers dried grains (DDG) and corn; U33 = 33% urea and 67% DDG and corn; U50 = 50% urea and 50% DDG and corn; and UDF = 33% each of urea, DDG and corn, and fish meal.

[b,c,d]Means in the same row with different superscript letters differ ($P < .05$).

[e]Total VFA = total volatile fatty acids (sum of acetate, propionate, butyrate, isobutyrate, isovalerate and valerate).

Table 4. Nitrogen (N) digestion by lambs fed different sources of supplemental dietary crude protein

Item	Protein source[a]					
	SBM	U17	U33	U50	UDF	SE
	------------------------------g/d------------------------------					
N intake	33.2[b]	34.6[c]	35.6[c]	36.9[d]	41.5[e]	.30
Duodenal N flow						
total	41.1[c]	43.4[c,d]	42.0[c]	38.0[b]	45.6[d]	.89
bacterial	32.5	31.4	30.8	30.8	33.7	1.02
nonbacterial	8.6[b,c]	12.0[d]	11.2[c,d]	7.2[b]	11.9[d]	.90
Ileal N flow	14.1[b]	19.4[d]	16.7[c]	16.5[c]	19.0[c,d]	.73
Fecal N excretion	12.1[b]	17.0[c]	14.5[b,c]	12.8[b]	14.2[b]	.83
Nonbacterial N at duodenum, % of NUNWS-N intake[f]	29.8[b]	47.2[c,d]	52.6[d]	39.9[b,c]	43.4[c,d]	3.72
N digestion, % of N entering						
small intestine	65.6[c]	55.4[b]	60.2[b,c]	56.5[b]	58.4[b]	1.71
hindgut	13.5	10.4	11.7	21.2	24.6	6.16
total tract	63.5[c]	51.0[b]	59.3[c]	65.3[c]	65.7[c]	2.24
Bacterial N synthesis						
g/100 g OMD_A[g]	4.26	5.13	4.30	4.48	4.95	.347
g/100 g OMD_T[g]	2.98	3.25	2.96	3.04	3.38	.134

[a]Levels (% of supplemental protein basis) and protein sources are: SBM = soybean meal; U17 = 17% urea and 83% distillers dried grains (DDG) and corn; U33 = 33% urea and 67% DDG and corn; U50 = 50% urea and 50% DDG and corn; and UDF = 33% each of urea, DDG and corn, and fish meal.

[b,c,d,e]Means in the same row with different superscript letters differ ($P<.05$).

[f]NUNWS-N = nonurea, nonalkaline hydrogen peroxide-treated wheat straw-nitrogen.

[g]OMD_A = organic matter apparently digested in the rumen; OMD_T = organic matter truly digested in the rumen.

Table 5. Effects of different sources of supplemental dietary crude protein on ruminal ammonia-N concentration

Hours post-feeding	Protein source[a]					SE
	SBM	U17	U33	U50	UDF	
	------------------------mg/dl------------------------					
3	5.2[b,c]	2.9[b]	9.8[c,d]	26.2[e]	11.9[d]	1.43
6	6.9	.5	2.7	5.3	5.1	1.40
9	12.4[c]	2.9[b]	4.3[b]	6.5[b]	4.8[b]	1.14
average	8.2[c]	2.1[b]	5.6[c]	12.7[d]	7.3[c]	.86

[a]Levels (% of supplemental protein basis) and protein sources are: SBM = soybean meal; U17 = 17% urea and 83% distillers dried grains (DDG) and corn; U33 = 33% urea and 67% DDG and corn; U50 = 50% urea and 50% DDG and corn; and UDF = 33% each of urea, DDG and corn, and fish meal.

[b,c,d,e]Means in the same row with different superscript letters differ ($P < .05$).

Table 6. Duodenal flows of amino acids (AA) in lambs fed different sources of supplemental dietary crude protein

	Protein source[a]					
Amino acid	SBM	U17	U33	U50	UDF	SE
	--------------------------g/d--------------------------					
Total flows						
Threonine	10.7[c]	10.3[c]	10.0[b,c]	9.3[b]	11.5[d]	.27
Valine	11.8[c,d]	12.3[d,e]	11.2[b,c]	10.4[b]	13.3[e]	.32
Methionine	2.3	2.7	2.8	2.9	3.2	.27
Isoleucine	10.4[c,d]	10.2[c,d]	9.7[b,c]	8.9[b]	11.1[d]	.32
Leucine	17.3[b]	22.4[d]	20.3[c]	17.7[b]	20.8[c,d]	.58
Phenylalanine	10.4[b,c]	11.2[c,d]	10.4[b,c]	9.5[b]	11.5[d]	.30
Histidine	4.3[c]	4.6[c]	4.3[c]	3.8[b]	4.7[d]	.11
Lysine	13.4[c]	10.2[b]	10.6[b]	10.6[b]	13.6[c]	.40
Arginine	9.6[d]	8.9[c,d]	8.5[b,c]	7.7[b]	10.8[e]	.30
Total flows	193.3[b,c]	206.9[c,d]	195.4[b,c]	178.0[b]	222.0[d]	5.62
Essential AA[f]	90.1[c]	92.7[c,d]	87.8[b,c]	80.8[b]	100.5[d]	2.69
Nonessential AA[g]	103.2[b,c]	114.2[d]	107.6[c,d]	97.2[b]	121.5[d]	2.97
Bacterial						
Total AA	156.9	143.1	145.7	143.2	161.1	5.81
Essential AA	74.8	67.5	69.3	68.2	76.5	2.77
Nonessential AA	82.1	75.6	76.4	75.0	84.6	3.06
Nonbacterial[h]						
Total AA	36.4[b]	63.8[c]	49.7[b,c]	34.8[b]	60.9[c]	4.82
Essential AA	15.3[b]	25.2[c]	18.5[b,c]	12.6[b]	24.0[c]	2.22
Nonessential AA	21.1[b]	38.6[c]	31.2[c]	22.2[b]	36.9[c]	2.62

[a]Levels (% of supplemental protein basis) and protein sources are: SBM = soybean meal; U17 = 17% urea and 83% distillers dried grains (DDG) and corn; U33 = 33% urea and 67% DDG and corn; U50 = 50% urea and 50% DDG and corn; and UDF = 33% each of urea, DDG and corn, and fish meal.

[b,c,d,e]Means in the same row with different superscript letters differ ($P < .05$).

[f]Essential AA = (THR + VAL + MET + ILE + LEU + PHE + HIS + LYS + ARG).

[g]Nonessential AA = (ASP + SER + GLU + PRO + GLY + ALA + TYR).

[h]This fraction contains dietary escape, endogenous and possibly some protozoal AA.

Table 7. Profile of amino acids (AA) entering the duodenum of lambs fed different sources of supplemental dietary crude protein

Amino acid	Protein source[a]					SE
	SBM	U17	U33	U50	UDF	
	------------------------g/100 g AA------------------------					
Threonine	5.5[e]	5.0[b]	5.1[c]	5.2[d]	5.2[c,d]	.04
Valine	6.1[d]	6.0[c,d]	5.7[b]	5.9[b,c]	6.0[c,d]	.07
Methionine	1.2	1.3	1.4	1.6	1.5	.10
Isoleucine	5.4[c]	4.9[b]	5.0[b]	5.0[b]	5.0[b]	.05
Leucine	8.9[b]	10.8[f]	10.4[e]	9.9[d]	9.4[c]	.08
Phenylalanine	5.4[c]	5.4[c]	5.3[c]	5.3[c]	5.2[b]	.03
Histidine	2.3[d]	2.2[c,d]	2.2[b,c]	2.2[b]	2.1[b]	.02
Lysine	6.9[e]	4.9[b]	5.4[c]	6.0[d]	6.1[d]	.09
Arginine	5.0[c]	4.3[b]	4.3[b]	4.3[b]	4.9[c]	.03
Aspartic acid	11.6[e]	9.9[b]	10.2[c]	10.5[d]	10.6[d]	.08
Serine	5.1[b]	5.1[b]	5.1[b]	5.1[b]	5.3[c]	.05
Glutamic acid	14.8[b]	16.7[e]	16.2[d]	15.7[c]	15.1[b]	.12
Proline	5.0[b]	6.5[e]	6.2[d]	5.9[c]	6.0[c,d]	.07
Glycine	5.2[d]	4.8[b]	4.9[b,c]	5.0[c]	5.9[e]	.04
Alanine	6.7[b]	7.6[d]	7.5[d]	7.3[c]	7.2[c]	.05
Tyrosine	5.0[b,c]	4.7[b]	5.0[b,c]	5.2[c]	4.7[b]	.11

[a]Levels (% of supplemental protein basis) and protein sources are: SBM = soybean meal; U17 = 17% urea and 83% distillers dried grains (DDG) and corn; U33 = 33% urea and 67% DDG and corn; U50 = 50% urea and 50% DDG and corn; and UDF = 33% each of urea, DDG and corn, and fish meal.

[b,c,d,e,f]Means in the same row with different superscript letters differ ($P<.05$).

Table 8. Net disappearance of amino acids (AA) from the small intestine of lambs fed different sources of supplemental dietary crude protein

Amino acid	Protein source[a] SBM	U17	U33	U50	UDF	SE
	g/d					
Threonine	6.7[d]	5.5[b,c]	5.8[b,c]	5.0[b]	6.5[c,d]	.35
Valine	7.7	6.9	6.6	6.1	7.7	.41
Methionine	2.0	2.1	2.3	2.4	2.6	.32
Isoleucine	7.5[c]	6.5[b,c]	6.5[b,c]	5.8[b]	7.4[c]	.36
Leucine	12.6[b,c]	15.5[d]	14.4[c,d]	12.2[b]	14.2[c,d]	.62
Phenylalanine	7.4[c]	7.3[c]	7.1[b,c]	6.1[b]	7.6[c]	.32
Histidine	3.1[d]	2.6[b,c]	2.6[b,c]	2.3[b]	2.9[c,d]	.14
Lysine	9.9[c]	6.1[b]	7.0[b]	6.9[b]	9.0[c]	.46
Arginine	7.5[c]	6.1[b]	6.1[b]	5.2[b]	7.8[c]	.33
Total AA	132.9	124.6	126.0	109.2	138.2	6.50
Essential AA[e]	64.3	58.6	58.5	51.8	65.7	3.14
Nonessential AA[f]	68.6	66.0	67.5	57.4	72.5	3.38
Disappearance, % of AA entering duodenum						
Total AA	68.7[c]	60.5[b]	64.4[b,c]	61.0[b]	62.0[b]	1.90
Essential AA	71.4	63.4	66.5	63.8	65.0	1.91
Nonessential AA	66.4[c]	58.0[b]	62.7[b,c]	58.8[b]	59.4[b]	1.90

[a]Levels (% of supplemental protein basis) and protein sources are: SBM = soybean meal; U17 = 17% urea and 83% distillers dried grains (DDG) and corn; U33 = 33% urea and 67% DDG and corn; U50 = 50% urea and 50% DDG and corn; and UDF = 33% each of urea, DDG and corn, and fish meal.

[b,c,d]Means in the same row with different superscript letters differ ($P < .05$).

[e]Essential AA = (THR + VAL + MET + ILE + LEU + PHE + HIS + LYS + ARG).

[f]Nonessential AA = (ASP + SER + GLU + PRO + GLY + ALA + TYR).

EFFECTS OF FEEDING ALKALINE HYDROGEN PEROXIDE-TREATED OAT HULL-BASED AND RICE STRAW-BASED DIETS ON FEED INTAKE AND NUTRIENT DIGESTIBILITY BY GROWING WETHERS

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INTRODUCTION

Approximately 80 to 85% of the feed consumed by ruminants in their lifetime production cycle consists of forages and roughages. About 500 million tons of farm crop residues are produced each year in the U.S. (Walker and Kohler, 1981). Large quantities of by-products are grown in the central region of the U.S. where much of the nation's corn, soybeans and small cereal grains are produced. Oat hulls (OH) are a lignocellulosic by-product of the oat milling industry. Because of their low digestibility and crude protein content, OH have been used primarily as a carrier for other ingredients. In addition, OH are bulky (193 kilograms/cubic meter) and unacceptable to ruminants unless mixed with other ingredients. Another lignocellulosic residue is rice straw (RS), a by-product of the rice milling industry. Rice straw is comparatively low in lignin (4 to 5%) but is relatively high in silica (13 to 16%) and, together, have a depressing influence on digestibility (Garrett et al., 1979). In recent years, the development of treatment processes that are economical and which will improve the nutritive value of lignocellulosics for ruminants has been the aim of many researchers. Chemical treatment of lignocellulosic feedstuffs should increase both nutrient availability (digestibility) and roughage acceptability (intake). Recent research has shown that treatment with alkaline hydrogen peroxide (AHP) increased susceptibility of plant structural carbohydrates (cellulose, hemicelluloses) to fiber-digesting microorganisms in the ruminant digestive tract (Kerley et al., 1987). A more recent study showed that pelleted AHP-OH increased daily DM intakes (by 2.36 kg), apparent digestibility (by 4.9%), and digestible dry matter intake (by 2.3 kg) by beef heifers when compared with dehydrated alfalfa pellets (Berger et al., 1989). Despite the large amounts of OH and RS available each year, feeding the untreated forms have resulted in low intakes and low digestibilities. This has limited their use as components of ruminant diets.

The primary objectives of this experiment were to: 1) determine the effects of varying treatment conditions in the preparation of AHP-OH on its subsequent nutrient intake and apparent digestibility when fed to sheep, and 2) determine the effects of AHP treatment of RS on the same criteria.

MATERIALS AND METHODS

Sixteen Dorset wethers with a mean body weight (BW) of 32 kg (range: 23 to 41 kg) were used in a feed intake and nutrient digestibility experiment consisting of three 15-d periods. Each period had a 10-d adaptation phase and a 5-d fecal collection phase. Twelve lambs were used for the OH experiment. The wethers were randomly allotted to the OH diets at the beginning of each period such that each wether would not be fed the same OH diet during the experiment. Four wethers were assigned to the two RS diets and were used in a switchback design. During the collection phase, total feces were collected and a 15% aliquot of feces from each lamb was saved for further analyses. During the experiment, wethers were individually housed in elevated mesh bottom crates in a temperature controlled (23^oC) room with constant fluorescent lighting and fed daily at 0700 and 1900.

All wethers were fed a complete mixed diet of 80% forage (F) and 20% concentrate (C) on a DM basis with 65% OH or RS and 15% alfalfa hay (AH) as the sources of forage (Table 1). The complete mixed diets were fed ad libitum, allowing for at least 10% orts. Water was available continually. Diets were balanced to meet the minimal nutrient requirements for growing lambs (NRC, 1975). Diets contained at least 14% CP, .45% Ca, .30% P, 1.20% K, .26% S, and .25% Cl. The concentrate portion of each diet consisted of soybean meal, ground shelled corn, minerals, and vitamins (Table 1). Ingredient and chemical composition of diets fed to the wethers are presented in Tables 1 and 2.

The AHP treated OH and RS required for the experiment was prepared using a 3041 Marion Batch Mixer (Marion Mixers, Inc., Marion, IA) in conjunction with a Toledo 8142 Digital Indicator (Toledo Scale, Westerville, OH) and load cell system. The Toledo 8142 was programmed to start and stop the appropriate motors and pumps which delivered the OH or RS, water, and chemical reagents to the batch mixer in weighed amounts for mixing. Hydrogen peroxide (H_2O_2), sodium hydroxide (NaOH), and water were pumped into the batch mixer and applied via three spray nozzles. Upon starting the mixing sequence, the system collected OH or RS with a belt conveyor from a forage wagon, conveyed it to the batch mixer, and weighed the allotted amount of roughage. Sodium hydroxide was added at the level of 5.0% of the DM of the roughage. Both the water and NaOH pumps were started and the solution was sprayed onto the roughage until the scale reached a set point. The pumps shut off automatically, and mixing continued for 3 minutes. Upon completion of the 3 minute mix, H_2O_2 was added at 2.0% of the DM (except for treatment 2 where only 1% H_2O_2 was used). Water and H_2O_2 were sprayed onto the byproduct until the scale reached the final set point, the pumps shut off, mixing continued for 3 minutes, and the end product was discharged into another forage wagon. Feedstuffs were stored in cardboard barrels in an unheated building.

The eight treatments were: 1) 65% AHP-OH (prepared to contain 17.9% moisture in the final product), 15% AH, 20% C; 2) same as treatment 1 except only 1% hydrogen peroxide was used; 3) same as treatment 1 except AHP-OH were prepared to contain 36.0% moisture in the final product; 4) same as treatment 1 except AHP-OH were pelleted using a California pellet mill (pellets were approximately 15 mm long and 5 mm in diameter); 5) 65% untreated OH, 15% AH, 20% C; 6) same as treatment 1 except AHP-OH were commercially prepared in Cincinnati, OH; 7) 65% AHP-RS (prepared to contain 35.7% moisture in the final product), 15% AH, 20% C; 8) 65% untreated RS, 15% AH, 20% C.

Dry matter (DM) intakes were measured daily. Samples of feed and orts were collected on d-11 through 15 and saved for analyses. Samples were dried at 55°C, ground through a Wiley mill (2-mm screen), and composited at the end of each collection period. Feed and orts were analyzed for DM and OM (AOAC, 1980). Nitrogen was measured using the Kjeldahl method (AOAC, 1980). Neutral detergent fiber (NDF) was measured using the procedure of Robertson and Van Soest (1977) as modified by Jeraci et al. (1988). Acid detergent fiber (ADF) and acid detergent lignin (ADL) were measured according to Goering and Van Soest (1970). Body weights were taken on d-1 and 15 of each period.

Data were analyzed by analysis of variance for a completely randomized design (CRD) according to the General Linear Models (GLM) procedure of SAS (1982). Model sums of squares for the CRD included animal, period, and diet effects. Sums of squares for diet effects were separated further into orthogonal contrasts.

Contrasts for the OH experiment were: diet 5 vs all other diets, diet 1 vs diet 5, diet 1 vs diets 2 and 3, diets 2 and 3 vs diet 4, and diet 3 vs diet 6. The contrast for the RS experiment was AHP-RS vs untreated RS. The following single observations were lost: commercially treated AHP-OH diet (period 1), AHP-treated RS diet (period 1), and untreated RS diet (period 2) for reasons unrelated to treatment.

RESULTS AND DISCUSSION

Chemical composition of feeds used in the digestibility experiments is presented in Table 2. Oat hulls were AHP treated using five different procedures. The first treatment consisted of AHP-OH at a low (17.9%) moisture level (diet 1). The second treatment was AHP-OH prepared at a lower (1%) hydrogen peroxide level than normal (2%); diet 2. The third treatment consisted of AHP-OH prepared at a high (36.0%) moisture level (diet 3). The fourth treatment consisted of pelleted AHP-OH at 14.7% moisture (diet 4). The control diet was untreated OH (diet 5). The treatment (sixth test diet) involved commercial preparation of AHP-OH (diet 6). This was done to determine if AHP treatment of OH would be equally efficacious using different treatment facilities. Two RS treatments were tested: AHP-RS at 35.7% moisture (diet 7) and untreated RS (diet 8). Treatment of OH and RS with AHP appeared to solubilize a portion of the structural carbohydrate fraction of the cell wall matrix when compared with untreated residues. Alkaline hydrogen peroxide-treated OH averaged 12.9 percentage units less NDF when compared with untreated OH. Percentage ADF decreased slightly for the AHP-OH treatments compared to the untreated OH. Treatment 3 (high moisture) had a greater NDF loss in comparison to treatment 1 (low moisture). This may be attributed to the higher level of moisture during the treatment process, allowing for a more favorable treatment response. This suggests that increasing moisture content of the cell wall of the byproduct allows for a more thorough application of the chemicals, thus increasing the area that fiber-digesting microorganisms may attack. Treatment of RS with AHP decreased NDF content by 10.8 percentage units with little effect on ADF content. There was a slight decrease in ADL content in both AHP-OH and AHP-RS when compared to the untreated residues. Both AHP-OH and AHP-RS are higher in cell wall carbohydrates as compared to alfalfa hay.

The least square means for nutrient intakes, apparent nutrient digestibilities, and digestible nutrient intakes are presented in Tables 3 and 4. Dry matter intakes and digestible DM intakes were increased such that wethers fed the AHP-OH diets consumed, on average, 484 g/d and 458 g/d more DM and digestible DM, respectively, than wethers fed the untreated OH diet. There was no effect of pelleting (diet 4) on DM intake (in comparison to diets 2 and 3). However, apparent DM digestibility of diet 2 and 3 DM ($P<.01$) increased (68.1%) when compared to diet 4 (61.0%). In addition, wethers fed diets 2 and 3 had higher ($P<.05$) DM digestibility (68.1%) compared to wethers fed diet 1 (63.5%). This suggests that moisture level is important in obtaining an optimal response with the AHP-treatment procedure and, in this study, the higher moisture level (diets 2 and 3) resulted in increased DM digestibility when compared to the low moisture treatment (diet 1). Intake, expressed as a percentage of body weight (BW), was increased ($P<.01$) to 4.4% for wethers fed the AHP-OH diets vs 3.1% for wethers fed the untreated OH diet (diet 5). There was also a difference ($P<.05$) in intake, expressed as a percentage of BW, between wethers fed diet 4 vs those fed diets 2 and 3. Generally, pelleting a low quality forage will increase DM intake when compared to feeding coarse-chopped or long-stem roughage diets.

Alkaline hydrogen peroxide treatment of RS increased ($P<.01$) DM digestibility (Table 4) to 67.7% compared with 55.6% for the untreated RS diet (diet 8). It was observed that during the adaptation phase of each period, wethers fed AHP-OH diets reached maximal intakes sooner in each period than did wethers fed the untreated OH or either of the RS diets, suggesting that diets containing the AHP-OH were more acceptable. It also was observed that wethers continually lost BW during each period when fed either of the RS-based diets resulting in an average loss of 7 kg per wether for the trial.

Organic matter (OM) intake and apparent OM digestibility followed similar trends to those of DM, with wethers fed the AHP-OH diets consuming more (1283 g/d) than the wethers fed the untreated OH diet (890 g/d). Organic matter digestibility averaged 65.6% for AHP-OH diets compared to 51.9% for wethers fed the untreated OH diet, an increase of 13.7 percentage units. This resulted in 381 g/d more digestible OM intake by wethers fed the AHP-OH diets. Data indicated that OM digestibility was greater ($P<.05$) for diets 2 and 3 (average, 68.5%) when compared to diet 1 (63.5%). There was also a decrease ($P<.01$) in OM digestibility to 61.0% for wethers fed diet 4 from an average of 68.5% for wethers consuming diets 2 and 3. Organic matter digestibility (Table 4) by the wethers fed RS was increased ($P<.01$) from 58.2% for those fed the untreated RS diet to 70.7% for those fed the AHP-RS diet.

Crude protein digestibility by wethers was higher ($P<.01$) for the untreated OH diet in comparison to the AHP-OH diets, suggesting that the low CP intakes by wethers fed diet 5 resulted in a slower turnover rate which increased digestion of CP as time spent in the gastrointestinal tract probably was increased. However, digestible CP intakes by wethers fed AHP-OH diets were higher at 161 g/d compared to 125 g/d for the untreated OH diet. Crude protein digestibility was higher ($P<.05$) for treatment 1 (76.6%) when compared to treatments 2 and 3 (71.4%), resulting in an increased digestible CP intake of 16 g/d. Digestibility of CP also was higher ($P<.01$) for treatment 4 (79.0%) when compared to treatments 2 and 3 (71.4%), resulting in an increase in digestible CP intake of 28 g/d. Treatment of RS with AHP had no effect on CP intake, CP digestibility, or digestible CP intake when compared to wethers fed the untreated RS diet (Table 4).

Wethers fed the AHP-OH diets consumed, on average, 427 g/d digestible NDF while wethers fed the untreated OH diet consumed 193 g/d digestible NDF. This is a 2.2-fold increase in digestible NDF intake. Wethers fed diets 2 and 3 consumed, on average, 112 g/d more digestible NDF than did those fed diet 4. In addition, there was an increase ($P<.01$) in NDF digestibility to 64.4% for wethers fed diets 2 and 3 vs 53.4% for wethers fed diet 1. It appears that higher moisture levels resulted in a more optimal treatment response which may increase susceptibility of plant structural carbohydrates to fiber-digesting microorganisms and allow for higher NDF digestibility. Furthermore, there were differences ($P<.05$) in NDF digestibility between diet 3 (66.0%) and diet 6 (59.6%), suggesting that the AHP treatment response for OH can be variable among treatment facilities. Alkaline hydrogen peroxide-treatment of RS increased ($P<.01$) apparent NDF digestibility (66.6%) when compared to the untreated RS control (45.5%), yet no differences in digestible NDF intake were noted (Table 4).

Acid detergent fiber intakes and digestibilities followed similar trends to those of NDF; however, there was less of an effect among the different treatment procedures. Alkaline hydrogen peroxide-treatment of OH increased ($P<.01$) digestible ADF intake by 151 g/d when compared to the untreated OH diet, a 2.8-fold increase. Acid detergent fiber digestibility (P<.1) increased to 55.6% for diets 2 and 3 when compared to 40.7% for diet 4. Alkaline hydrogen peroxide-treatment of RS (Table 4) increased (P<.01) ADF digestibility from 36.5% for wethers fed the untreated RS to 55.5% for wethers fed the AHP-RS diets, but no effects on ADF intake or digestible ADF intake were noted.

In summary, the results with OH suggest that growing wethers fed diets containing AHP-OH had higher nutrient intakes and fiber digestibilities when compared to wethers fed the diet containing untreated OH. Alkaline hydrogen peroxide treatment of RS increased nutrient digestibilities, except for CP, when compared to untreated RS. Variations in treatment procedures affect nutrient digestibilities, while intakes and digestible nutrient intakes remain somewhat constant. The higher moisture level at the time of AHP treatment results in increased digestibilities of DM, OM, and NDF when compared to the low moisture AHP-treatment of OH. Pelleting of AHP-OH appeared to decrease digestibilities of DM, OM, NDF, and ADF when compared to unpelleted AHP-OH. The only significant difference between facilities (diet 3 vs diet 6) occurred in NDF digestibility. The AHP treatment of OH at the high moisture level resulted in increased nutrient digestibilities and subsequent increases in digestible nutrient intakes. Although AHP treatment of RS significantly increased nutrient digestibilities of DM, OM, NDF, and ADF, digestible nutrient intakes were not improved as a result of the low intakes.

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TABLE 1. Ingredient composition of diets.

	Diet[1]							
Item	1	2	3	4	5	6	7	8
	%							
AHP-OH	65	65	65	65		65		
AHP-RS							65	
Untreated OH					65			
Untreated RS								65
Alfalfa Hay	15	15	15	15	15	15	15	15
Concentrate[2]	20	20	20	20	20	20	20	20

[1]Diet 1 = low moisture (17.9%) AHP-OH; Diet 2 = low hydrogen peroxide (1%) AHP-OH; Diet 3 = high moisture (36.0%) AHP-OH; Diet 4 = pelleted AHP-OH (14.7% moisture); Diet 5 = untreated OH; Diet 6 = commercially processed AHP-OH; Diet 7 = AHP-treated RS; Diet 8 = untreated RS.

[2]Contained soybean meal (87.64%), ground shelled corn (4.90%), potassium chloride (2.28%), trace mineral salt (1.38%), vitamin premix (1.38%), dicalcium phosphate (.91%), calcium sulfate (.78%), and limestone (.73%). Trace mineral salt and vitamin premix contained a minimum percentage of the following minerals: iodine (.025), iron (2.0), zinc (3.0), manganese (3.0), magnesium (5.0), copper (.5), cobalt (.004), selenium (.015), sulfur (10.0), and potassium (7.5). Vitamin A (2,200,000), Vita-min D_3 (660,000), and Vitamin E (7,700) are expressed as IU/kg premix.

TABLE 2. Chemical composition of feeds used in growing wether diets.

Ingredient	DM[1]	OM	CP	NDF	ADF	ADL
		Chemical component				
		% DM				
AHP-OH[2]						
Trt 1	82.1	88.5	4.4	70.3	39.8	6.7
Trt 2	65.5	89.9	4.6	68.6	38.8	6.3
Trt 3	64.0	88.5	4.3	63.2	38.9	6.5
Trt 4	85.3	90.0	4.5	66.5	37.5	6.4
Trt 6	81.4	88.5	4.4	65.3	38.0	7.2
Untreated OH	86.3	94.8	4.7	79.7	40.7	7.4
AHP-RS[2]	64.3	75.9	8.3	63.1	48.4	6.7
Untreated RS	88.3	79.8	8.8	73.9	49.0	7.5
Alfalfa hay[3]	89.6	89.8	18.0	49.0	35.9	8.6
Concentrate	90.0	86.0	45.2	10.6	6.1	.9

[1]DM on an as-fed basis.
[2]AHP-OH = alkaline hydrogen peroxide-treated oat hulls.
AHP-RS = alkaline hydrogen peroxide-treated rice straw.
[3]Chopped alfalfa hay.

TABLE 3. Least squares means for nutrient intake, apparent nutrient digestibility, and digestible nutrient intake of chemically treated or untreated oat hull-based diets fed to growing wethers.

	Diet[1]						
ITEM	1	2	3	4	5	6	Pooled SEM
Intake, g/d							
DM[a,b]	1490	1472	1345	1526	961	1392	63.0
OM[a,b]	1329	1311	1188	1360	890	1228	56.3
CP[a,b]	222	224	207	233	147	206	8.7
NDF[a,b,d]	828	780	665	788	593	713	35.3
ADF[a,b]	478	461	427	461	305	434	21.2
Apparent digestibility, %							
DM[a,b,d,e]	63.5	68.1	68.0	61.0	51.0	66.8	1.4
OM[a,b,d,e]	63.5	68.6	68.4	61.0	51.9	66.7	1.4
CP[a,b,d,e]	76.6	73.4	69.3	79.0	83.5	71.8	1.6
NDF[a,b,c,e,h]	53.4	62.9	66.0	46.9	33.7	59.6	2.1
ADF[a,b,g]	56.3	52.5	58.7	40.7	30.8	50.7	6.5
Digestible nutrient intake, g/d							
DM[a,b]	945	1002	904	931	479	922	41.5
OM[a,b]	844	899	803	812	453	812	37.7
CP[a,b,d,e]	170	164	143	182	125	148	4.4
NDF[a,b,e]	445	492	430	349	192	416	25.2
ADF[a,b]	285	248	243	176	84	221	36.2
Intake, % of BW[a,b,f]	4.4	4.5	4.1	4.7	3.1	4.2	.2

[1]Diet 1 = low moisture (17.9%) AHP-OH; Diet 2 = low hydrogen peroxide (1%) AHP-OH; Diet 3 = high moisture (36.0%) AHP-OH; Diet 4 = pelleted AHP-OH (14.7% moisture); Diet 5 = untreated OH; Diet 6 = commercially processed AHP-OH.

Contrast: Diet 5 vs all other diets; [a]P<.01
Diet 1 vs Diet 5; [b]P<.01
Diet 1 vs Diets 2 and 3; [c]P<.01, [d]P<.05
Diets 2 and 3 vs Diet 4; [e]P<.01, [f]P<.05, [g]P<.1
Diet 3 vs Diet 6; [h]P<.05

TABLE 4. Least squares means for nutrient intake, apparent nutrient digestibility, and digestible nutrient intake of chemically treated or untreated rice straw-based diets fed to growing wethers.

Item	Diet[1] 7	Diet[1] 8	Pooled SEM
Intake, g/d			
DM	699	730	134.1
OM	566	610	108.3
CP	127	123	27.3
NDF	366	422	71.5
ADF	270	277	52.2
Apparent digestibility, %			
DM[a]	67.7	55.6	1.3
OM[a]	70.7	58.2	1.5
CP	76.1	77.0	1.2
NDF[a]	66.6	45.1	2.2
ADF[a]	55.5	36.5	2.5
Digestible nutrient intake, g/d			
DM	468	415	96.3
OM	396	366	81.0
CP	96	96	22.3
NDF	237	205	50.3
ADF	148	110	31.6
Intake, % of BW	2.1	2.0	.4

[1]Diet 7 = AHP-treated RS; Diet 8 = untreated RS.

[a]P<.01.

THE EFFECT OF MELENGESTROL ACETATE ON THE FERTILITY OF BEEF HEIFERS

D. J. Kesler, L. L. Berger, D. B. Faulkner and R. J. Favero

SUMMARY

Beef heifers were fed a ration with (n=17) or without (n=16) melengestrol acetate (MGA) for 11 weeks. Five days after the last feeding all heifers were administered the Syncro-Mate B estrous synchronization procedure. Pregnancy rates to the timed artificial insemination were similar regardless of the addition of MGA to the feed. Therefore long term feeding of MGA alone is not detrimental to reproductive function.

INTRODUCTION

Estrous synchronization procedures have been developed which use melengestrol acetate (MGA) to suppress estrus in beef females. This type of a program is attractive to some producers because the compound can be fed and does not require the number of animal handlings or animal restraints that other estrous synchronization procedures require. Research has shown that reduced fertility is associated with the first estrus following a prolonged feeding (>12 days) of MGA. Consequently most procedures utilize a 12 to 14 day feeding of MGA which is followed by an injection of prostaglandin $F_2\alpha$ approximately 14 days after the last MGA feeding. Following the injection most females will display estrus, but the interval from injection to estrus is variable and will not allow a timed artificial insemination. It is the opinion of these authors that the stage of the estrous cycle at the initiation of an estrous synchronization procedure, and more importantly the interval between ovulations has an effect on the fertility at the synchronized estrus. The reduced fertility associated with prolonged feeding of MGA may be more a function of an increased interval between ovulations than carry-over effects of the progestin. The purpose of the study reported herein is to investigate if MGA feeding can be followed with a Syncro-Mate B estrous synchronization procedure which utilizes a timed artificial insemination.

PROCEDURE

Beef heifers (n=33) were randomly assigned to treated or control groups. Treated heifers received approximately .5 mg melengestrol acetate (MGA) daily, in a complete mixed ration. Control heifers received the same ration except that it did not include the MGA. The ration was fed continuously for approximately 11 weeks. Five days after the last feeding of MGA, all heifers were administered Syncro-Mate B (SMB). The SMB treatment consists of a 6.0 mg norgestomet ear implant which is subcutaneously inserted in the convex surface of the ear. At the time of implant insertion an intramuscular injection of 5.0 mg of norgestomet and 3.0 mg of estradiol valerate was administered. The norgestomet implant was removed after 9 days. Approximately 47 hours after implant removal all heifers were artificially inseminated. Rectal palpation of the reproductive tract was conducted on day 63 after AI to determine pregnancy rate.

RESULTS

The results of this study are shown in Table 1. The long-term feeding of melengestrol acetate (MGA) had no adverse effects on the fertility on a synchronized estrus following MGA feeding. Numerically the pregnancy rate of the treated heifers was higher, but with the small numbers in the study the difference was non-significant.

CONCLUSIONS

Prolonged feeding of MGA had no adverse effects on fertility of SMB synchronized beef heifers. Prior feeding of MGA may have increased pregnancy rate by having treated heifers at an early stage of the estrous cycle at the initiation of the SMB synchronization procedure. This would insure that the females did not have an increased interval between ovulations, which may be detrimental to fertility.

TABLE 1. FERTILITY OF BEEF HEIFERS PREVIOUSLY EXPOSED TO PROLONGED FEEDING OF MGA PRIOR TO SMB ESTROUS SYNCHRONIZATION

Treatment Group[1]	n	Conception Rate (%)
Control	16	4/16(25)
Treated	17	8/17(47)

[1]Treated heifers were fed .5 mg MGA daily for 11 weeks and SMB was administered 3 days after the last day of MGA feeding.

THE EFFECT OF REPETITIVE SYNCRO-MATE B TREATMENT ON FERTILITY OF BEEF HEIFERS

R. J. Favero, D. B. Faulkner, J. W. Castree and D. J. Kesler

SUMMARY

Utilizing the Syncro-Mate B (SMB) injection along with a norgestomet implant decreased ($P<.01$) the pregnancy rate of previously synchronized beef heifers to almost zero. The norgestomet implant alone has been demonstrated to enhance the previously synchronized pregnancy rate. Therefore, the SMB injection would appear to be luteolytic when administered on day 12 after conception.

INTRODUCTION

In previous reports we have demonstrated that norgestomet (N) implants administered on days 12 to 21 after a synchronized artificial insemination (AI) increased the conception rate to the initial AI. Norgestomet implants inhibited estrus and thus upon removal synchronized estrus in the non-pregnant females.

The purpose of the study reported herein is to investigate the effect of the administration of a complete Syncro-Mate B treatment (a 9 day N implant and an injection of 5.0 mg estradiol valerate and 3.0 mg N at implantation) administered on day 12 following a synchronized AI.

PROCEDURES

Estrus in 41 yearling beef heifers was synchronized using Syncro-Mate B (SMB). The SMB treatment involves a 6.0 mg norgestomet (N) implant that is subcutaneously inserted into the convex surface of the ear. At the time of implantation an injection of 5.0 mg of estradiol valerate (EV) and 3.0 mg N is administered. After 9 days the implant is removed and all heifers are artificially inseminated (AI) approximately 47 hours after implant removal. Twelve days after AI heifers were assigned to control or treated groups. All control and treated heifers received one N ear implant. Treated heifers also received an intramuscular injection that contained 5.0 mg EV and 3.0 mg N. Nine days after implant insertion (day 21 after AI) the N implants were removed. Pregnancy status was determined by rectal palpation of the reproductive tract on day 63 after AI.

RESULTS AND DISCUSSION

One of the treated heifers was eliminated from the study because the second norgestomet implant was lost. Results for the other 21 treated and 19 control heifers are summarized in Table 1.

CONCLUSIONS

We have previously demonstrated the efficacy of norgestomet implants 12 to 21 days post AI. This study would demonstrate the importance of observing our previous protocol. One cannot simply utilize the commercially available Syncro-Mate B (SMB) procedure. The results would suggest that the SMB injection (that contains both estradiol valerate and norgestomet) is luteolytic. This is in contrast to the reputed theory of SMB treatment to bovine females during mid to late luteal phase. These results would also suggest that SMB is an abortifacient. These results, however, are based on one limited stage of pregnancy (approximately day 12).

TABLE 1. PREGNANCY RATES OF HEIFERS ADMINISTERED NORGESTOMET IMPLANTS (CONTROL) OR SMB (TREATED) TWELVE DAYS AFTER AI

Treatment Group	Pregnancy Rates
Control (Norgestomet Implant)	10/19 (52.6%)
Treated (SMB)	1/21 (4.8%)[1]

[1]Groups are significantly different (P<.01).

FERTILITY OF PRENATALLY ANDROGENIZED FEMALES

D. J. Kesler, L. L. Berger, D. B. Faulkner, K. C. DeHaan and R. J. Favero

SUMMARY

Sixty-five untreated and 50 prenatally androgenized beef heifers at two locations were synchronized with Syncro-Mate B and artificially inseminated (AI) 47 hours after implant removal. All heifers that returned to estrus in the first 25 days of the breeding season were inseminated a second time. In Trial 1 natural service was used for the remainder of the 60 day breeding season, while AI was used as the method of rebreeding in a 70 day breeding season in Trial 2. Pregnancy rates (first service and end of the breeding season) were higher for prenatally androgenized heifers than for control heifers at both locations. Therefore, prenatal androgenization does not adversely affect fertility.

INTRODUCTION

It has been well documented that exposure of unborn female calves to testosterone propionate (prenatal androgenization) increases postnatal growth and performance. Past studies have been focused on the growth and carcass characteristics of the prenatally androgenized females. The purpose of this study was to investigate the effect of prenatal androgenization on the fertility of yearling beef females.

PROCEDURES

Crossbred beef females (n=235) were randomly assigned to treated or control groups 30 days after the end of a 60 day breeding season. Treated females were administered 4 testosterone propionate (TP) implants each. The implants were made of a medical grade silicone tubing with an internal diameter of .635 cm and an external diameter of .953 cm. Implants were 15 cm in length and contained approximately 2.25 g of TP. Implants were subcutaneously inserted behind the shoulder and over the dorsal aspect of the rib cage. Implants were removed approximately 3 weeks prior to the onset of the calving season.

The resulting prenatally androgenized (offspring of TP treated cows; n=50) and control heifers (n=66) were weaned from their dams at approximately 7 months of age and were retained as replacement heifers for the beef herd. This study was conducted in two trials, Trial 1 was conducted at the beef unit at the Dixon Springs Agricultural Center at Simpson, Il. and Trial 2 was conducted at the Orr Beef Research Center at Perry, Il. Prior to and during the breeding season, control and treated heifers were maintained together. In both trials, estrus was synchronized with Syncro-Mate B (SMB). The SMB procedure consists of a norgestomet (N) implant which is subcutaneously inserted into the convex surface of the ear. At the time of implant insertion an intramuscular injection of 5.0 mg of estradiol valerate and 3.0 mg of N was administered. The N implant was removed at the end of 9 days. Approximately 47 hours after implant removal all heifers were artificially inseminated (AI). In trial 1, heifers that returned to estrus in the first 25 days of the breeding season were artificially inseminated a second time. Natural service was used on days 25-60 of the breeding season. In trial 2, estrus detection ant AI were used throughout a 70 day breeding season. Rectal palpation of the reproductive tract was conducted on days 63 and 153 after the initial AI to determine pregnancy rate to the synchronized AI and overall pregnancy rate.

RESULTS

Results (summarized in Table 1) were similar between both locations. Prenatal androgenization clearly had no adverse affects on reproductive function. In fact one could speculate that fertility was enhanced by prenatal androgenization.

CONCLUSION

Prenatal androgenization does not adversely affect reproductive function.

TABLE 1. EFFECT OF PRENATAL ANDROGENIZATION ON REPRODUCTIVE PERFORMANCE OF BEEF HEIFERS

Trial	Control	Treated[1]
	First Service Pregnancy Rate (%)[2]	
1	17/49(35)[3]	15/33(45)
2	4/16(25)	8/17(47)
Combined	21/65(32)	23/50(46)
	Pregnancy Rate - End of Breeding Season (%)	
1	37/50(74)	27/33(82)
2	10/16(63)	13/17(76)
Combined	47/66(71)	40/50(80)

[1]Treated heifers were prenatally androgenized.
[2]Conception rate to the initial SMB timed AI.
[3]One control heifer lost the SMB implant and was not included in the first service conception rate.

THE EFFECT OF TESTOSTERONE TREATED GOMER COWS ON POSTPARTUM REPRODUCTION

D. J. Kesler, D. B. Faulkner, G. F. Cmarik, and R. J. Favero

SUMMARY

One hundred and seventy suckled beef cows were randomly assigned to one of two groups at parturition. Treated cows were exposed to testosterone-treated gomer cows. Ovarian cyclicity was determined just prior to the breeding season. A higher percentage of the cows exposed to the testosterone-treated gomer cows were cyclic at the beginning of the breeding season. This was particularly apparent for cows that were at an earlier postpartum stage.

INTRODUCTION

The length of the anestrous period after parturition is one of the main factors limiting beef cattle productivity. In order for a beef cow to maintain a one year interval between calves she must be pregnant within 80 to 90 days after calving. If females are young, have a long gestation, are heavily lactating and/or nutritionally deficient, then this may be a difficult goal.

Previous studies have found that exposure of postpartum cows to bulls will stimulate estrous cyclicity at an earlier stage postpartum. Intact, vasectomized or surgically altered bulls will reduce the interval from calving to first postpartum estrus by 15 to 20 days. In previous studies we have demonstrated that beef females treated with testosterone develop male sexual behavior patterns and can be used as gomer animals for estrous detection. The study reported herein investigates the effect of testosterone treated cull cows on the anestrous period of suckled postpartum beef females.

PROCEDURE

Approximately 170 spring calving beef cows and first calf heifers were maintained at the University of Illinois Beef Cattle Research Unit at the Dixon Springs Agricultural Center near Simpson, Illinois. All cows were fed 10 pounds of corn silage and 1 pound of a 40% crude protein corn:urea mix daily. Cows had access to fescue hay and fescue pasture before and after calving.

Approximately 1 week prior to the initiation of the calving season 6 non-pregnant beef females were treated with 4 testosterone propionate implants each (gomer cows). The implants were made of a medical grade silicone tubing with an internal diameter of .635 cm and an external diameter of .953 cm. Implants were 15 cm in length and contained approximately 2.25 g of testosterone propionate. Implants were subcutaneously inserted behind the shoulder and over the dorsal aspect of the rib cage. Additionally the 6 testosterone treated gomer cows received a subcutaneous injection of 1.0 g testosterone enanthate dissolved in 10 ml of absolute ethanol each. Past studies have demonstrated that the above testosterone-treatment is able to induce and maintain male behavior patterns in beef females.

Shortly after calving, females were randomly assigned to similar pastures that contained 2 testosterone-treated cows (gomer cows) or pastures that contained no gomer cows. As the pastures became fully stocked, additional pastures were used. A total of 3 pastures with gomer cows and 3 control pastures were used. In late march serum samples were collected from all cows. A second serum sample was collected eleven days after the first. At the time of the second blood sample, an estrous synchronization program using Syncro-Mate B was initiated.

A validated enzyme immunoassay was used to determine progesterone concentrations of al serum samples. Progesterone concentrations greater than 1.5 ng/ml in one or both of the serum samples indicates that the female is exhibiting estrous cycles. If both of the serum samples had progesterone levels less than 1.5 ng/ml then the female is anestrous and has not initiated estrous cycles after calving.

RESULTS

The females that were treated with testosterone (gomer cows) did exhibit male sexual behavior patterns. Gomer cows moved through the herd attempting to locate females that were in estrus. The gomer cows displayed an intense interest in females that were in estrus and frequently mounted estrous females.

A total of 6 pastures were used for this experiment, 3 of the pastures housed control cows and 3 pastures contained gomer cows. A high proportion of the cows calved early in the calving season. Therefore data were combined for the first 2 pastures of control and gomer exposed cows. The number of cows, stage postpartum and average days postpartum is shown in Table 1. It can also be seen that cows that are at an early postpartum stage (late calvers) may benefit the most from gomer cow exposure. Overall gomer cows appear to induce estrous cycles at an earlier postpartum stage in suckled beef cows.

CONCLUSIONS

Gomer cows increased the proportion of suckled beef cows that were exhibiting estrous cycles prior to the initiation of the breeding season. In breeding programs utilizing artificial insemination, gomer cows may be beneficial by aiding in estrous detection and by helping to reduce the interval to estrus following calving.

TABLE 1. EFFECT OF GOMER COWS ON ESTROUS STATUS OF POSTPARTUM BEEF COWS.

Treatment Group	n	Stage Postpartum	Average Days Postpartum	Percent Cyclic[1]
Control	34	Early	56.5	41.2
Gomer exposed	33	Early	57.4	63.6
Control	54	Late	81.5	79.6
Gomer exposed	50	Late	81.5	84.0
Overall				
Control	88	All	71.8	64.8
Gomer exposed	83	All	71.9	75.9

[1]Percent of females that had initiated estrous cycles prior to the breeding season, based on elevated progesterone concentrations.

THE EFFECT OF RESYNCHRONIZATION OF BEEF FEMALES BRED BY VARIOUS METHODS

R. J. Favero, D. B. Faulkner, G. F. Cmarik, and D. J. Kesler

SUMMARY

In 4 trials beef females (n=309) were initially synchronized with Syncro-Mate B (SMB). Twelve days after the SMB timed artificial insemination (AI), all females received a norgestomet ear implant for 9 days. At the time of norgestomet implant removal (day 21 post SMB timed AI) females were assigned to control and treated groups. Estrus in control females was visually detected and AI was performed approximately 12 hours following detection of estrus (Trials 1, 2 and 3). Treated females in Trial 1 were visually detected for estrus, but all AI were conducted at 47 hours after implant removal. In Trials 2 and 3, treated females that had low serum progesterone concentrations at implant removal were AI at 47 hours after implant removal. In Trial 4, control females were treated the same as treated females in Trials 2 and 3 whereas treated females were all AI irregardless of corpus luteum status. In all Trials 1, 2, 3 and control females in Trial 4, the results indicate that timed AI was as good, if not superior to, breeding based on detected estrus and the AM/PM rule. Breeding however, should not be conducted without some regard to corpus luteum status.

INTRODUCTION

Several methods have been developed to effectively synchronize estrus in beef females. Some of these methods of estrous synchronization achieve the precision required for a single timed artificial insemination (AI). Females that do not conceive to the timed AI return to estrus approximately 17 to 23 days later, and estrous detection is required if the females are going to be bred by AI.

In previous reports we have demonstrated that norgestomet implants administered on days 12 to 21 after a synchronized AI 1) increased the conception rate to the previous AI and 2) synchronized estrus in the non-pregnant females. In this study we investigated the use of timed methods of rebreeding at the return estrus, thus allowing for two synchronized timed AI.

PROCEDURES

Beef females were initially synchronized using Syncro-Mate B. The Syncro-Mate B treatment consists of administration of a 6.0 mg norgestomet ear implant and an injection of 5.0 mg of estradiol valerate and 3.0 mg of norgestomet. The implant was inserted subcutaneously into the convex surface of the ear. After 9 days the implant was removed and all females were artificially inseminated (AI) approximately 47 hours after implant removal.

Females that exhibited estrus in the first 12 days after AI were removed from the study. On day 12 after AI females were administered a silicone ear implant that contained approximately 3.6 mg of norgestomet. The implant was removed 9 days after insertion (day 21 post AI).

This study involved 4 trials, in Trial 1, 90 heifers were used. Trial 2 utilized 90 heifers, Trial 3 included 90 postpartum suckled cows and Trial 4 utilized 39 heifers. At the time of implant removal the females were randomly assigned to treated or control groups. Additionally at the time of implant removal serum samples were collected from all females. Serum progesterone concentrations were determined by validated enzyme immunoassay. In Trials 1, 2 and 3 the females in the control groups were artificially inseminated approximately 12 hours after being detected in estrus (Table 1). Estrus detection was conducted on the treated females in Trial 1, but all artificial inseminations were preformed at approximately 47 hours after implant removal regardless of when estrus was detected. If the treated females in Trials 2 and 3 or the control heifers in Trial 4 had progesterone concentrations less than 1.5 ng/ml at the time of norgestomet implant removal, then the female was AI 47 hours after implant removal. In Trial 4 all treated females were AI 47 hours after implant removal regardless of corpus luteum status. Pregnancy rates were determined by calving dates for Trial 1 and by rectal palpation of the reproductive tract in Trials 2, 3 and 4.

RESULTS

Females were randomly assigned to control and treated groups. Based on randomization the first service conception rate should have been equal for both control and treated groups. Overall this is true, however, there were obvious differences among trials. Overall, the first service conception rate is low (39%, Trials 1, 2 and 3, Table 2) however it should be noted that all animals were inseminated regardless of efficacy of the SMB treatment and regardless weather females displayed estrus or not.

This experiment was designed to analyze the effect of method of breeding at the second synchronization. Results (summarized in Table 2) demonstrate that timed AI was at least equal to, if not better, than breeding based on estrus and the AM/PM rule. Overall, 39% more females conceived if they were inseminated at a predetermined time than if they were bred by detected estrus (Trials 1, 2 and 3). Furthermore, 13% more females were inseminated if timed breeding was performed than if females were bred by estrus (Trials 1, 2 and 3). This resulted in an increase in the cumulative 2 time AI program (see Trials 1, 2 and 3, Table 2). In Trial 4 the mass breeding of the females appeared to decrease fertility. The control group in Trial 4 (see Table 2) was treated identical to the treated females in Trials 1, 2 and 3 and conception rates were similar (58% vs 60%). The heifers in Trial 4 that were mass inseminated had a cumulative conception rate of 40% or a 31% decrease.

CONCLUSIONS

The results of this study indicate that the breeding at the second AI at a predetermined time was not only equal to breeding by estrus but in fact resulted in more pregnancies over 2 AI's for 3 out of 3 years. Breeding, however, should not be done without regard to corpus luteum status.

TABLE 1. TREATMENT PROTOCOL FOR REBREEDING OF BEEF FEMALES FOLLOWING NORGESTOMET IMPLANT REMOVAL ON DAY 21 AFTER A SMB TIMED AI

Trial	Treatment Group	n	Estrous Detection Y or N	Method of Rebreeding
1	Control	52	Y	AI by AM/PM rule[1]
	Treated	52	Y	AI at 47 hours after IR[2]
2	Control	41	Y	AI by AM/PM rule[1]
	Treated	41	N	AI at 47 hours if low P_4[3]
3	Control	42	Y	AI by AM/PM rule[1]
	Treated	42	N	AI at 47 hours if low P_4[3]
4	Control	19	N	AI at 47 hours if low P_4[3]
	Treated	20	N	All females AI at 47 hours

[1]AI approximately 12 hours after being visually detected in estrus.
[2]AI approximately 47 hours after implant removal if detected in estrus.
[3]AI approximately 47 hours after implant removal if day 21 serum progesterone concentrations were less than 1.5 ng/ml.

TABLE 2. **EFFECT OF METHOD OF REBREEDING ON FERTILITY OF BEEF FEMALES**

Trial	Treatment Group	First Service CR (%)[1]	Second Service CR (%)[2]	Cumulative CR (%)[3]
1	Control	22/52(42)	7/21(33)	29/52(56)
	Treated	16/52(31)	14/26(54)	30/52(58)
2	Control	13/41(32)	5/18(28)	18/41(44)
	Treated	21/41(51)	7/17(41)	28/41(68)
3	Control	18/42(43)	3/7(43)	21/42(50)
	Treated	18/42(43)	4/11(36)	22/42(52)
Overall				
	Control	53/135(39)	15/46(33)	68/135(50)
	Treated	53/135(39)	25/54(46)	80/135(59)
4	Control	9/19(47)	2/5(40)	11/19(58)
	Treated	6/20(30)	2/8(25)[4]	8/20(40)

[1]Conception rate to the initial SMB timed AI.
[2]Conception rate to the AI following Implant removal on day 21 after the initial SMB timed AI.
[3]Cumulative conception rate to the first and second AI.
[4]Based only on the females with low P_4. None of the females with high P_4 conceived to the second AI.

REDUCING ENERGY CONSUMPTION AND IMPROVING WATER QUALITY WITH BEEF CATTLE

Dan B. Faulkner

Appropriate utilization of forages and manure can reduce input costs and soil erosion on many farms. Beef cattle fit into such a farming system because of their unique ability to utilize forages and prosper with minimal management inputs. Other ruminant animals may utilize forage but they require more management. Profitable beef producers have year-round systems of beef production that maximize forage use by the grazing animal, minimize fertilization, minimize grain feeding and minimize the use of purchased supplemental feeds. This reduces farm expenses and limits the use of hydrocarbon based fuels for nitrogen fertilization and harvesting. This can result in economically profitable, environmentally sound, and biologically efficient alternatives for farm enterprises.

The integration of ruminants onto Midwest farms may improve productivity and profitability. The production of animal products is an excellent example of a value added enterprise, because livestock and crop production can be mutually supportive. The ruminants can graze forages and recycle nutrients through the decomposition of manure. Rotational grazing of grass/legume pastures, sequential grazing of cool and warm season grasses, and supplemental feeding of ruminants grazing crop residues can be used to control animal movement to further enhance the fertility contribution of manure. The challenge is to integrate economical production systems with available forage resources.

These systems should also have a positive impact on soil productivity and water quality. As concern about the environment increases, there is more interest in potential sources of surface and ground water contamination from agriculture. Cultivated rowcrop land and pasture are potential sources of concern. Pasture management practices have become increasingly dependent on the use of agricultural chemicals, specifically nitrogen fertilizer. The evaluation of sustainable management programs, that minimize surface water and ground-water contamination, becomes more critical if agricultural production and water quality are to coexist.

Hay and pasture land has a lower potential for contamination of surface and ground water than for crops. There is less water runoff from hay and pastures than from row crops. Water runoff from hay and pasture is cleaner than runoff from row crop land, has less soil sediment, has less fertilizer nutrients and has less pesticides. Pastures filter the runoff water, keeping a greater percentage of the water contaminants in the hay and pasture field than do row crops.

Hay and pasture use less pesticides than row crops. Herbicides may be used to establish perennial hay and pasture fields, but this occurs only once every 4 or more years. Herbicides may be used for maintenance of hay and pasture, but only if weed populations begin to depress production or present a health hazard to livestock. These applications are rarely over the entire acreage, thus the total amount of herbicide used is normally small. Insecticides are used for hay production and for some of the most productive pastures. The total insecticide application per acre to pasture is less than for hay, and both are less than for corn.

Much of the land in the midwest is subject to erosion. Erosion can be reduced if appropriate rotation, tillage and management practices are utilized. The crop residues can be an economical feed resource, particularly if they are strip grazed and if some residue is left in the field to control soil erosion. Many farms have some land that is not suitable for row crop production. Erosion can be controlled on this land with sod-forming grasses and legumes.

Cool-season grasses (e.g., tall fescue, orchardgrass, Kentucky bluegrass) make the majority of their growth in the spring and autumn. This growth pattern often leads to a deficiency of summer pasture for ruminants. When forage is a limiting factor, weight gains will be reduced unless harvested or purchased feeds are fed. Split applications of nitrogen fertilizer can improve the yield distribution of cool season grasses to a limited degree, but labor costs and the threat of water contamination may increase.

Generally, hay and pasture are fertilized at lower levels than row crops. Nitrogen is used on the more productive grass pastures, but rarely more than 150 pounds per acre. Although water runoff from hay fields and pastures can carry nitrogen, there is less nitrogen lost from hay fields and pastures than row crops because of the "filtering" action of hay and pasture plants and the lower net amount of nitrogen available for loss.

This midsummer problem is intensified because fescue is the predominant cool season grass in southern Illinois. Much of this fescue is infected with an endophytic fungus (Acremonium coeniphialum) which reduces animal performance, particularly during the hot midsummer period. The endophytic fungus has been shown to reduce stocker cattle gains about 50 g/day for each 10 percentage unit increase in infection. Conception rate is also reduced when cows graze heavily infected tall fescue pasture. We have demonstrated that changing management practices (like calving season) can alleviate much of this problem. Legumes are particularly effective in reducing the toxic effects of the tall fescue endophyte when seeded in infected tall fescue pastures.

Legumes are also important in forage systems as a source of nitrogen for cool season grasses, improved forage yield during midsummer and high quality nutrients for the animal. Legumes grown in association with cool season grasses can improve the summer productivity of the pasture as well as eliminate the need for nitrogen (N) fertilizer. Legumes can be added to grass pastures with no-till seeding systems. Legumes provide the nitrogen needs of the associated grass and improve the feed nutrient value of the pasture for the grazing animal. Legumes produce nitrogen symbiotically with the proper Rhizobium bacteria. Symbiotically produce nitrogen has little risk of contaminating surface or ground water. The nitrogen is produced, stored and released from nodules on the legume root. The release rate is relatively slow so associated grasses or the legume plants themselves utilize the released nitrogen to make plants grow. Legumes reduce the dependency on petroleum derived nitrogen, but may require additional lime, phosphate, potash and other minerals, and pesticides to maintain high productivity. This could result in substantial energy savings since about 33% of the energy used in U.S. agriculture is used to produce N fertilizer.

Legumes have higher concentrations of crude protein, total nonstructural carbohydrates and digestible dry matter with lower concentrations of cell wall constituents (fiber) compared to grasses. Therefore, legumes can be effective in supplementing lower quality forages when added to the diet at the rate of 15-

30%. Illinois research has shown that the addition of alfalfa may increase rate, extent, and overall digestibility of the diet. Legumes used in a crop rotation as a source of nitrogen would be available for this type of supplemental cattle feeding.

Legumes are effective in improving animal performance when grazed and persist well when used in rotational grazing system. Sequential grazing demonstrations on farms in southern Illinois have shown animal gain per acre that would give similar returns to row crops based on commercial grazing costs.

Warm season grasses [e.g., big bluestem (Andropogan geradii Vitman), swtichgrass (Panicum virgatum L.)], as the name implies, produce most of their growth in the summer and provide another alternative forage system for midsummer. The different patterns of growth of cool season and warm season grasses permit a complementary pasture system to be developed. Furthermore, warm season perennial grasses require little nitrogen for high yields. We have evaluated warm season grazing systems for the past 4 years and found that more cattle can be grazed than on cool season grasses alone, but there also is a small decrease in animal performance.

It is important that the use of harvested forages in beef systems be minimized. Forage harvesting methods are energy intensive and utilization of stored forages may result in waste of up to 40% during harvest, storage and feeding. Reductions in the amount of harvested forage fed to beef cattle may be possible if the forage is accumulated, winter cover crops are grown, or if crop residues are utilized for late fall or winter grazing. It would be most efficient to utilize harvested forages only when necessary due to lack of pasture or snow cover.

Although grazing is the most economical part of the beef system, it cannot be utilized without an economical way of wintering ruminants. The total system must be considered as one begins to apply available technology to produce livestock economically. Producers need economical forage based systems to improve productivity and water quality.

During the past decade, studies world-wide have clearly shown that nitrates and some pesticides are being delivered to groundwater from routine agricultural practices. Regionally, in response to hydrologic settings, nitrates in groundwater has increased in a direct, linear fashion, paralleling the increased use of nitrogen fertilizers. Numerous studies show a direct relationship between the nitrate concentration in groundwater and nitrogen fertilizer rates. Surface water quality deterioration has also been linked to the application of nitrogen fertilizer to pasture land.

Our goal is to combine crop residues, winter cover crops, and forage resources into economical, environmentally sound production systems. Work in this area will continue at Dixon Springs Agricultural Center and at the Orr Center.

CROSSBREEDING PROGRAMS - PRACTICAL CONSIDERATIONS

D. F. Parrett

INTRODUCTION

Crossbreeding is a management tool that can increase net productivity by 20 percent or more over straightbreeding. Crossbreeding offers two major production advantages:

1. The desirable characteristics of two or more breeds can be combined together to achieve a better combination of traits than found in a single bred.

2. Crossbreeding allows the producer to benefits of heterosis (hybrid vigor), which allows the crossbred animal to perform better than average of the straightbred parent animals. Lowly heritable traits like fertility, calf survival and vigor respond well to crossbreeding.

In general, crossbred females are more fertile and heavier milking than straightbreds. The crossbred calves generally grow faster and have higher calf survival rates. Thus with improvements in fertility and growth rate, profit potential for a beef herd is generally increased.

Crossbreeding has many advantages and few disadvantages in general if the crossbreeding system and choice of breeds are based on sound information and if the crossbreeding system is practical. A practical system is one that matches well the management and resources of the operation.

High levels of heterosis increase efficiency and reduce the cost of producing beef. The level of heterosis in rotational crossbreeding systems increases as the number of breeds used in the rotation increases. All breeds of cattle would be used if level of heterosis were the only factor considered in beef production. However all breeds are not equally efficient for given production environments with varying feed and management resources.

Seldom can a cattleman let the demands of his cattle production system pull him too far away from his economically available forage resource without incurring substantial economic risk. This line of thinking does not rule out the judicious use of pasture improvement techniques, strategic supplemental feeding and other cost effective technology to enhance the productivity of the forage system. There is, however, a big difference between using cattle to package the forage that your land resource can economically produce as opposed to manufacturing feed to support the needs of a type of cattle you may happen to like. In other words, the feed resources should play a major role in dictating the production levels for various traits and the kinds of cattle that can profitably be produced.

DEVELOPING A CROSSBREEDING SYSTEM

In a stepwise fashion a producer should consider the following production guidelines:

1) Evaluate the production environment and the resources available. This includes the amount and quality of feed available, the length of the growing season and the flexibility of the forage system to adapt to extremes in weather changes.

2) Match the level of management to the environment. This includes the number of pastures available, whether or not AI will be utilized, time available for the producer to spend with the cattle and the ability of the producer to modify the environment without affecting cattle producing abilities.

3) Match the crossbreeding system to the environment. This primarily refers to the number of breeding pastures available and forage available for the cattle.

4) Match the type of crossbred cow to the environment. "Type" of cow considers cow size and milk production which will dictate feed requirements per cow.

5) Match the sire genotype to the dam type in accordance to crossbreeding system, management, and market. The sire genotype may already be determined by the crossbreeding system and type of cow. Rotational systems utilize different sire genotypes than a terminal sire system.

TYPES OF CROSSBREEDING SYSTEMS

Table one demonstrates the types of crossbreeding systems that can be adapted to most beef farms. A large majority of farms will be utilizing the one breeding pasture system.

TABLE 1. CROSSBREEDING SYSTEMS FOR ONE OR TWO BREEDING PASTURE OPERATIONS[1]

Type of Crossbreeding System	Advantage (%)[2]
<u>One Breeding Pasture</u>	
1. Buy F_1 females, terminal sire	28%
2. Rotate sire breeds (3 breeds)	16%
3. Composite (3 or 4 breeds)	15%
4. Multiple sire breeds (3), X-bred female	15%
5. Multiple sire breeds (2), straight-bred female	7%
<u>Two Breeding Pastures</u>	
1. Rotate sire breeds (3) - terminal sire	25%
2. 2-breed rotation[1] rotation sire breed	19%
3. 2-breed rotation	16%

[1]Kress and Nelson (1988)
[2]Advantage in amount of calf weaned per cow exposed when compared to average of breeds involved in crossbreeding system. Also assumes cow breed type has been adequately matched to environment.

Of course an effective AI program allows a producer to utilize different sires even with only one breeding pasture. Heifers can be bred AI to calving ease bulls and mature cows to terminal sires. Cows can be bred AI once for replacement heifer production, then a terminal sire breed be used for natural service.

Rotational crossbreeding systems use some breeds proportionately more than others. A problem with rotational systems is that bulls of all breeds need to be available each year. Also cows need to be identified and sorted so that the next breed they are bred to is known. In extensive management systems this may be difficult.

BREED SELECTION

In general, breeds perform to definable performance levels. A good classification of breeds is shown in Table 2. This data was developed from research at the USDA Meat Animal Research Center in Clay Center, Nebraska. This center represents the most extensive research of beef breeds available. Of course we know that there is a great deal of variation within each breed and producers can choose animals within breeds to specific match their production goals.

TABLE 2. SELECTED BEEF BREED CLASSIFICATION BY BIOLOGICAL TYPES[A]

Breed	Lean	Marbling	Milk	Puberty	Growth
Charolais	very high	low	low	late	very high
Chianina	very high	low	low	late	very high
Limousin	very high	low	low	late	moderate
Simmental	high	moderate	high	moderate	very high
Maine Anjou	high	moderate	high	moderate	very high
Gelbvieh	high	moderate	high	moderate	very high
South Devon	moderate	moderate	high	early	moderate
Tarentaise	moderate	moderate	high	early	moderate
Salers	moderate	moderate	high	early	moderate
Angus	low	high	moderate	moderate	moderate
Hereford	low	high	moderate	moderate	moderate
Shorthorn	low	high	moderate	moderate	moderate
Longhorn	low	high	moderate	moderate	low

[a]Based on MARC data (Cundiff, et al., 1988.)

BREEDING PROBLEMS TO RESOLVE

We have already identified some practical limitations to developing a crossbreeding system (primarily number of pastures). Many specific questions have to be asked when choosing animal types. Some animal type questions to consider include:

1) Whether you can or will purchase replacement females. This decision is a primary one before finalizing a crossbreeding system.

2) Cow size must be matched to the available feed resources. Larger or smaller body size may have important biological advantages for adaptation to climate, feed resources, and marketing specifications. Large body size may have advantages in tolerance of cold stress and in efficient use of abundant feed supplies, whereas smaller size may be an advantage in hotter, drier climates with sparse seasonal grazing.

3) Antagonisms exist between growth and calving ease, between fleshing ability or marbling and carcass leanness, and between high productivity and maintenance requirements.

4) High levels of milk production result in more feed and higher quality feed for cows to stay productive. There are optimum levels of milk production which is not equal to maximum levels of milk production. if a producer retains ownership of his cattle to the yearling stage then increases in milk are not very important.

5) Optimum performance is not a single trait phenomenon; it is a multiple trait phenomenon. it is not sensible to apply selection on a single trait to the ultimate selection limit, there are too many trade-offs involved. The realistic approach would seem to be selection for optimum performance levels in traits important to economic efficiency.

BEEF PERFORMANCE RECORDS - FITTING EPD'S TO YOUR PRODUCTION OBJECTIVES

D. F. Parrett

INTRODUCTION

A beef cattle program is a long range program. The bulls selected to be used on commercial cows are the primary source of genetic improvement or change that occurs in that herd. The bulls supply half of genetics for each calf and when replacement heifers are retained, the bulls impact is magnified to up to 87% of the influence on the genetic make-up of future calf crops. It is critical for each producer to utilize all available information in order to buy bulls that will have a positive impact on a breeding program.

Genetic evaluation programs designed by a majority of the purebred breed associations have resulted in Expected Progeny Differences (EPD) as a powerful tool to use to make changes in a cattleman's breeding program.

An EPD is a prediction of how future progeny of a sire are expected to perform for a particular trait as compared to a fixed breed average. **Difference** is the key to understanding EPD. If bull A has a weaning weight EPD of +30 pounds and bull B has a weaning weight EPD of +5 pounds, and each is bred to a representative sample of your cowherd, you would expect the progeny of bull A to average 25 pounds [+30-(+5)lb] more than bull B's offspring at weaning under the same management system.

There is no such thing as a "good" or "bad" EPD. What is "good" for one program or environment may be less than ideal for another. The EPD are not a contest or a race. Single trait selection has been proven to lead to negative changes in genetically correlated traits of economic importance. EPD should guide selection decision and aid producers in genetically describing the cattle they will utilize in their breeding programs. A simplified table of definitions for EPD is listed at the end of this paper.

DEFINING PRODUCTION GOALS

Before you begin to establish a bull's value, a producer must define his production goals and determine what traits need improvement. Some questions to consider:

1) What is the purpose of the bull? (e.g., calving ease, growth rate, sire replacement females, etc.)
2) In my production environment what are EPD optimums, or trait priorities? (e.g., feed and labor availability, sell calves at weaning, current herd milk levels, etc.)
3) Based on where I sell my cattle, what traits are most important?
4) What are the trade-offs for selecting for extremes in traits? (e.g., growth vs calving difficulty, milk production vs reproduction, etc.)

Utilizing EPD a producer can target his production objectives and breed to sire that will specifically change the important traits in his breeding program.

EXAMPLES TO FOLLOW

For example purposes , use the following list of bulls is being considered by producers to satisfy their breeding objectives.

EPD VALUES, lb.

Bull	Birth	Weaning	Milk	Yearling
1	+5.2	+38.6	-3.2	+34.4
2	+1.2	+28.2	+7.3	+43.6
3	+2.5	+33.3	+13.6	+51.3
4	+0.3	+20.3	+11.4	+34.4

Given the following producer objectives then, select the best bull to fit the defined objectives.

Producer	Selection Objectives
A	Minimize calving difficulty in first calf heifers while maintaining good growth to weaning
B	Increase milking ability in a replacement females and post weaning gain in all calves
C	Use as a terminal sire to produce fast growing feedlot cattle, keeping back no replacement females

From the bulls given, producer A would select either bull 2 or 4. Bull 4 should sire the lightest calves. Unless the producer's heifers are small, bull 2 may sire acceptably light calves with more growth.

For producer B bulls 3 and 4 should sire daughters with improved milking ability, but bull 3 has a big advantage in post-weaning gain with a higher yearling EPD.

For producer C, bull 1 offers the most growth for cattle and his negative milk EPD is of no importance since no replacement females are to be retained. Bull 1 does have a higher birth weight EPD which could be a problem if a producer uses bull 1 on small cows or first calf heifers.

BALANCE TRAIT SIRES

Many producers with small herds use only one bull to breed to both heifers and mature cows. If this is the case, then birth weight EPD (i.e., calving ease) is a major priority in bull selection. Unfortunately it is hard to find bulls that are low birth weight and high growth. From our example data, bull 3 exhibits a good balance of all traits, if he is acceptable for birth weight.

Milk EPD are an indicator of how a bull's daughters milk production will influence weaning weight. Producers should remember that extremely high milk production levels demand increased feed for cows to stay fertile. Milk EPD need to be matched to feed resources available for a producer to optimize production. Growth traits generally should be maximized only after the birth weight and milk EPD optimums are established.

SELECTING BULLS FROM DIFFERENT BREEDS

An individual bull's EPD are generated within his breed and a producer should compare actual EPD values of animals only within the same breed. This allows a producer to identify sires or dams with advantages for selected traits. A purebred breeder should also look at an animal's EPD as compared to the breed average. This enables the producer to establish where the selected animal ranks for a trait within the breed population. Purebred breeders should utilize sires that rank in the top of their breed if they want to successfully change their breeding program. Each breed's EPD averages are developed from analyzing totally different data which has evolved over a varying number of years.

Breed average or the percentile ranking of a bull within his breed (top 10%, top 40%, bottom 30%, etc.) does offer a means for a producer to compare the relative value of bulls of different breeds. For example, an Angus bull with a +20 lb. weaning weight EPD will only be average (50%) for the Angus population. A Simmental bull with a +20 lb. weaning weight EPD will rank in the top 5% of the Simmental population for weaning weight. A producer looking to buy bulls of different breeds should be familiar with the relative ranking of EPD values in a specific breed population. <u>A word of caution</u>! Different breeds perform differently for selected traits. In general, some breeds are heavier milking, some grow faster, and some marble at earlier ages. However, EPD are still the best predictors available for determining genetic value. By establishing where a bull ranks within his breed population, a producer can begin to determine relative dollar values to assign to bulls. As has always been the case, bulls with desirable performance values will be worth the most money.

THE DEFINITION OF VARIOUS EPD

Breeding associations will differ as to what EPD they generate and report. The following is a description of some of these EPD:

Birth Weight--Indicates the relative size at birth of calves by a sire as compared to the average bull included in the evaluation (expressed in pounds).

Weaning Weight--Indicates the relative weight at 205 days of age of calves by a sire as compared to the average bull of the evaluation who was a weaning weight EPD of 0.0 (expressed in pounds).

Yearling Weight--The relative weight at 365 days of age of calves produced by a sire as compared to calves produced by the average bull of the evaluation with a yearling weight EPD of 0.0 (expressed in pounds).

Milk--The difference in average weaning weight produced by a bull's daughter which is due to her milking ability. Expressed as pounds of calf, not pounds of milk.

Total Maternal--Expressed in pounds, this indicates the ability of the bull's daughter to wean heavier calves. This includes 1/2 of a bull's weaning weight EPD plus his milk EPD.

Gestation Length--Data reported in days compares gestation length of a sire's progeny to the average gestation length of the progeny of all sires in the evaluation.

Calving Ease Direct--Reported as a ratio, this indicates the relative ease with which a bull's calves are born to first-calf heifers. Ratios greater than 100 indicate below average calving ease.

Maternal Calving Ease or Calving Ease Daughter--Reported as a ratio indicates the relative ease with which a bull's daughters calve as first-calve heifers. Values greater than 100 indicate above average calving ease.

ILLINOIS
INTENSIVE GRAZING MANAGEMENT
'89 UPDATE

Tom Saxe, Area Livestock Adviser

Intensive Grazing Management (IGM) is a process of planned rotational grazing which affords maximum satisfaction to the requirements of both forage and animal. IGM is implemented by a short grazing period (e.g., 3 days) followed by a longer rest period (e.g., 30 days) on a given area of pasture. It utilizes a large number of paddocks (e.g., a pasture divided into 11 smaller units) so the animal has access to grazeable forage at all times during the grazing season. This grazing concept maximizes the quantity of forage harvested by reducing trampling losses. This improves beef production efficiency by spreading fixed costs over more pounds of production.

In late 1987, University Extension employees Jim Kaiser, Tom Saxe, Jim Ahrenholz, Bob Frank, and Mike Plumer designed a three year project to investigate and demonstrate IGM technology. A project proposal was written and program support was solicited. Co-sponsors providing multi-year cash grants are: Illinois Beef Council, Illinois Forage and Grassland Council, and Egyptian Livestock Association. Supporting sponsors supplying animal health products, fencing materials and other beef related supplies are: IMC/Ralgro, MSD/AgVet, American Cyanamid, Syntex Corporation, and Gallagher Power Fencing.

PROJECT OBJECTIVES

A broad ranging list of objectives was formulated by the committee:

1. to demonstrate advantages of IGM
2. to teach the concepts involved in IGM
3. to teach producers and educators the agronomic and animal husbandry technology to enhance a successful IGM experience
4. to measure and document results of IGM demonstrations
5. to develop, duplicate, and distribute IGM management guidelines
6. to conduct IGM field days and seminars for producer orientation
7. to develop cow path soil erosion control methodology through IGM practices

DEMONSTRATION COOPERATORS

Seven cooperator farmers initiated demonstrations in 1988. Four utilized stocker animals. They were Curt and Bruce Dean at Ava, Lester Saxe at Thompsonville, Keith Glasco at Cobden, and Ed Billingsley from Goreville. Three cow/calf demonstrations were conducted by Joe Hayes at Marion, Walter Bollmann at Ava, and Carl Woods from Anna. The results are printed in 1989 - 90 Winter Beef Meeting Proceedings.

New cooperators for 1989 were: Warren Dannehold at Waterloo, Ernie Duckworth at Benton, Duane Smith at Allendale, David and Edgar Bremer at Metropolis, David and Clarence Allbritton at Belknap, and John Rueter from St. Libory.

Cooperators conducting demonstrations for the first time in 1990 are: Greg Wells at Annapolis, Larry Ruhl at Fairfield, John Woodcock at Valmeyer, Keith Ellis from Dongola, Rich Hunter from Moweaqua, and Chip Unsicker from Peoria. Results of 1990 will be available at their completion.

'89 ANIMAL PERFORMANCE HIGHLIGHTS

The 41 acre **BILLINGSLEY** demonstration was largest in terms of acreage. This cow/calf program measured production from stock-piled Fescue: Lespedeza from September 18 through December 24. It yielded a low of 260 pounds of adjusted beef per acre. But, during the short 96 day fall grazing season produced a very respectable 2.7 pounds of adjusted beef per acre per day.

BREMER BROTHERS had a mixture of winter born cow/calf pairs and yearling stockers. The effectively reduced stocking rate by removal of the cows at mid season. This demonstration started earliest on April 6. An early start is one key to increasing pounds of beef per acre as well as keeping growth of cool season grasses under control. Early season animal performance was good but tailed off the last half, e.g., yearling steers gained 1.4 from April 6 to July 6, then slipped to .99 pounds per head per day from July 6 to October 10.

The **BOLLMANN** demonstration was basically cow/calf. Animal performance increased over the preceding year whereas most repeat cooperators realized reduced individual gains. Adjusted beef per acre was up 189 pounds. Cows gained .67 pounds per day faster. Calves ADG was .11 greater in '89 as compared to '88. And, pinkeye was not a problem this season. The latter observation may have contributed to the greater gains. the alleviation of the pinkeye problem was felt to be due to eliminating barn access where ammonia buildup irritated eyes in '88. Bollmann's 637 pounds of adjusted beef per acre was highest amongst cow/calf demonstrations.

DEAN FARM was a second year cooperator whose 653 pounds of adjusted beef per acre with stocker heifers was good but below the 768 recorded in 1988. ADG was also reduced .24 pounds from '88. Dean's project was apparently hampered by wild animals which stampeded the cattle on several occasions presenting management problems of regrouping cattle and reconstruction of fences.

WARREN DANNEHOLD had a 111 day grazing season. The new o-till seeding of alfalfa was beleaguered by alfalfa weevils and weed pressure. Dannehold's fleshy 648 pound stockers only gained 1.13 pounds per day but still produced a very respectable 503 pounds of adjusted beef per acre. Plans are to start earlier in 1990.

The **DUCKWORTH** demonstration showed excellent results during the first half of the grazing season. A new seeding, dry weather and drouthy soils took their toll in the last half of the summer. Duckworth was the only cooperator who exercised daily rotation and demonstrated that the animals could harvest almost 100% of the forage produced. Utilization to this extent reduced animal performance and indicated the need to reduce stocking rate and/or offer additional supplemental feed during periods of drouth.

JOHN RUETER demonstrated a sequential grazing concept in addition to Intensive Grazing Management. He rotationally grazed Fescue: Ladino from April 16 to June 12. He sequentially moved to Sudax: Alfalfa from June 12 to September 28. Then he sequentially moved back to the Fescue: Ladino from September 28 to November 10. The respective ADG's for the three periods (Spring, Summer, Fall) were 2.02, 1.23, and 1.65 pounds. The sum of the Fescue: Ladino yielded 495 pounds of beef per acre with 100 days of grazing. The mid season 108 days on Alfalfa: Sudax produced 640 pounds of gain per acre. The cattle showed a taste preference for Sudax as indicated by grazing habit.

SAXE FARM was a second year cooperator. Their adjusted beef per acre increased from 306 in 1988 to 719 pounds in 1989. This occurred as a result of 14.8 inches of rainfall in '89 compared to 7.25 inches in '88. Saxe Farm effectively reduces stocking rate per acre during the dry part of the summer by enlarging paddock size by about 100%. The paddocks are simply extended onto areas of the pasture where hay was harvested earlier in the season. The harvested hay accounted for 306 pounds of the adjusted beef per acre equivalent.

SUGARTREE RANCH was tops this year with 959 pounds of adjusted beef produced per acre. The 16 acre demonstration carried 101 stockers during 131 days of grazing. Rainfall totaled 23.9 inches during the season with 8.1 and 5.9 respectively coming in the critical July and August periods. This enhanced forage production which garnered 7.3 pounds of adjusted beef per acre per day. Average daily gain was 1.29 pounds on steers averaging 508 pounds.

The **CARL WOODS** project improved over last year. It supported 122 days of grazing in 1989 compared to 73 in 1988. Increased carrying capacity was due mostly to an overseeding of Lespedeza into the Fescue pasture. Adjusted beef per acre was higher by 131 pounds at a respectable 398 pounds per acre for the cow/calf demonstration. Individual animal performance was lower this year as it was for most second year demonstrations. But, Woods' 463 adjusted Animal Unit Days per acre was tops amongst all 1989 cooperators.

See Table 1 for further animal performance details.

Table 1. Animal Performance Details

Cooperator	Acres	Days	No. Head	ADG	Adj. Beef/Acre[1]
Billingsley	41	96	68 cows	.73	260
			62 calves	1.37	
			3 heifers	1.20	
Bollmann	6.9	164	10 cows w/calf	.78	637
			10 calves	1.74	
			1 bull	1.94	
			2 cows	2.05	
			1 steer	1.97	
Bremer	21	187	19 cows w/calf	.49	598
			19 calves	2.10	
			30 steers	1.17	
			12 heifers	.96	
			15 calves	.98	
Dannehold	3.5	111	16 stockers	1.13	503
Dean	15	136	90 stockers	1.23	653
Duckworth	8	161	12 cows	.06	324
			12 calves	1.45	
			1 bull	-.92	
Rueter	14.2	208	24 stockers	1.54	626
Saxe	12	152	30 stockers	1.37	719
Sugartree	16	131	101 stockers	1.29	959
Woods	7	122	14 cows w/calves	-.51	398
			14 calves	1.37	
			4 cows w/o calves	.92	
			1 bull	-.56	
			2 stockers	.92	

[1]Beef per acre was adjusted to account for supplemental feed fed and/or hay harvested from the project area.

ECONOMIC ANALYSIS

An economic analysis is made each year by Region 7 Farm Management Specialist Dr. James Ahrenholz. The 1989 economic summary is presented in Table 2.

Table 2 1989 ECONOMIC SUMMARY
Intensive Grazing Management Demonstration

Farm	Animals	Days	Weight	Cost/lb.[1] Beef Prod.
Dannehold	16 stockers (11S,5H)	111	650	.75
Dean	90 stocker heifers	136	505	.59
Rueter	25 stockers (10S,15H)	208	400	.34
Saxe	30 stocker heifers	152	515	.47
Sugartree	101 stockers (97S,4H)	131	420	.37
Billingsley	62 calves	96 @ 43d		
		22 @ 71d		
		20 @ 96d	275	
	68 cows	20	865	.45
	3 bred heifers	96	760	
Bollmann	10 cows/10 calves	164	1105/pr	
	2 cows	50	975	.36
	1 bull	62	1400	
	1 steer	68	715	
Bremer	19 cows/19 calves	91	1500/pr	
	30 steers	187	625	.36
	12 heifers	187	560	
	15 calves	96	515	
Duckworth	12 cows/12 calves	151	995/pr	.77
	1 bull	151	1225	
Woods	14 cows/14 calves	122	1120/pr	
	4 bred cows	122	1125	.66
	1 bull		910	
	2 stockers		715	

[1]Reflects only costs incurred during the project period thus would not include year round costs of the cow/calf herd.

EPD GROUP RANKING

Dave Seibert
Area Livestock Adviser

EPD's (Expected Progeny Differences) are an extremely powerful tool for purebred and commercial cow-calf producers to make genetic changes in their herd. However, many cow-calf producers have trouble understanding what the specific numbers mean and how to use them.

Thus, for the 1990 and 1991 Illinois Performance Tested Bull Sale, held during the Winter Beef Expo in Springfield, a new method of EPD Group Ranking has been initiated. This concept ranks sale bulls within a breed for the four traits of birth weight, weaning weight, yearling weight, and maternal milk. These rankings reflect each bull's EPD ranking within its breed for a similar birth year.

WHY GROUP RANKINGS?

Group Ranking was implemented to assist the commercial bull buyer to: (1) sort bulls within a breed, and (2) identify bulls for different situations.

First, Group Ranking allows cow-calf producers to sort bulls within a breed without having to know the specific EPD numbers. This is especially important since the average and range of a trait for a breed continually changes from year to year as more performance information is added. Thus, with Group Ranking, the cow-calf producers can easily identify where a bull ranks within his breed for a trait.

Secondly, Group Ranking helps the cow-calf producers identify bulls for a specific PROGRAM, ENVIRONMENTAL CONDITION or OBJECTIVE.

a. Your PROGRAM can be a cow-calf operation that sells calves as feeder cattle, backgrounded yearlings, finished cattle or possibly as purebred seedstock. With each of these programs, you might emphasize different trait EPD's. Also, your program is affected by the amount of observation and assistance provided at calving which would directly affect the level of birth weight EPD's that are acceptable.

b. ENVIRONMENT (temperature and rainfall) is greatly different from the extreme southern to the northern part of Illinois. Likewise, the other environmental factors (level of nutrition, management, etc.) can be equally as varied between two operations located next to one another. Whether you provide an EXCELLENT ENVIRONMENT for your cow herd (high quality summer pasture and hay or corn silage in winter) or a POOR ENVIRONMENT (unimproved brush pasture and poor quality forage or crop residue in the winter), will greatly affect the level of EPD's (especially maternal milk) that you purchase for your herd.

c. OBJECTIVES are the traits that you would like to improve or complement in your herd. Do you want to purchase a bull to INCREASE, MAINTAIN or DECREASE birth weight, weaning weight, yearling weight, milk production, frame size, scrotal size (age at puberty), etc?

Evaluation of your cow-calf herd's STRENGTH/WEAKNESS, ENVIRONMENT & PROGRAM and then matching the EPD's of the available bulls are what will make your use of EPD's PAY OFF.

1991 PERFORMANCE TESTED BULL SALE GROUP RANKING SYSTEM":

EPD Group Ranking System

Rank	% breed at each Level	EPD Trait Level of Performance			
		Birth	Wean	Year	Milk
AA	0 to 5%	Lightest	Highest	Highest	Most
A	6 to 20%	....	....	....	....
B	21 to 40%	....	....	....	....
C	41 to 70%	moderate	moderate	moderate	moderate
D	71 to 90%	....	....	....	....
E	91 to 100%	heaviest	lowest	lowest	least

The EPD Group Ranking System that will be used at the 1991 Illinois Performance Tested Bull Sale is divided into FIVE different groups. Each of these groups represents what percentile a bull ranks as compared to bulls for a similar birth year.

WHAT DOES EPD GROUP RANKING MEAN??

For BIRTH WEIGHT those bulls with an AA, A & B Ranking would be expected to sire calves with the LIGHTEST birth weight and should probably be used on replacement heifers. Bulls with C Ranking for birth weight are MODERATE for their breed, while D and E Ranking will result in calves with the HEAVIEST birth weight and should be used on mature cows. One consideration that must be made is that EPD's are within breed, and breed calving differences should be considered.

For WEANING & YEARLING WEIGHT those bulls with an AA, A & B Ranking would be expected to sire calves with the HEAVIEST weights. Bulls with C Ranking are MODERATE for their breed, while D and E Ranking will result in calves with the LOWEST weight gains.

It is extremely important that the level of milk you need in your herd must MATCH THE ENVIRONMENT (level of nutrition and MANAGEMENT) and complement the current milk production level of your herd. Milk EPD's are ranked from MOST (AA & A) to least (E), with neither of these being most desirable for ALL situations. Examples for level of milk might include the following:

a. EXCELLENT ENVIRONMENT & MANAGEMENT (high quality summer pasture and hay or corn silage in winter) - B, A or possibly AA or C.

b. POOR ENVIRONMENT & MANAGEMENT (unimproved brush pasture and poor quality forage or crop residues in the winter) - C or possibly D.

c. TERMINAL SIRES (level of milk production in offspring daughters are not important since all offspring go to market) - E or any other level is acceptable as long as HIGH level of WEANING & YEARLING WEIGHT EPD's.

DIFFERENCES BETWEEN BREEDS:

Obviously there are Levels of Performance Difference between BREEDS. Therefore, B in one breed (for a trait) does not equate to the same number of pounds as a B in another breed. However, a B of one breed (for a trait) does mean that that bull falls into the same percentage Group Ranking as all the other B's in the same breed.

SUMMARY

Selecting a Herd Sire is like purchasing seed corn or any other genetics. Time spent analyzing your specific situation (Program, Environment and Objective) prior to attending a bull sale might be the most important part of buying your next bull.

Fencing System Comparisons

Types of fencing systems

Non-electric

Woven-wire plus a top barb, five-strand barbed wire, and the "New Zealand" type smooth wire fence materials are commonly used as non-electric perimeter fences in Illinois. Woven-wire and barbed wire fences are very familiar, as they have been used in the state for many years. Smooth wire fencing has not been available for as long, and did not enjoy immediate acceptance when it was first introduced since it requires some specialized equipment and methods for installation.

Smooth wire fence relies on the high tensile strength of special galvanized steel wire to retain cattle. One or more tensioning springs on each strand of wire keeps the fence tight, so that cattle rubbing on the wires do not permanently deform the fence as they do a woven-wire or a barbed wire fence. Several strands of wire are used; eight or ten strands is a common configuration, with ten strands preferred. Long staples are used to hold the wires to the line posts, and the staples are hammered to the posts in such a way that the wires can slip back and forth through the staples. Because there is so much force on the posts in a smooth-wire fence, conventional tamped-earth post embedment normally is not suitable. Treated-wood posts are used, driven small-end down using a tractor-mounted post driver. Posts can be placed farther apart than in a woven-wire or barbed wire fence.

Electric

Multiple-strand perimeter fence

A perimeter electric fence of heavy-gauge high-tensile galvanized wire (such as 12-1/2 gauge) has the same life expectancy as woven-wire, or greater. As in a non-electric smooth-wire fence, several strands are used and each strand has its own tensioning spring.

Smooth-wire paddock fence

Where a pasture is divided into segments, or paddocks, single strands of wire are used to form the division fences. High-tensile wire can be used to advantage for longer runs, due to the wire's strength and good electrical conductivity compared to light-gauge wire. However, softer steel wire is easier to work with and costs less than high-tensile, and therefore has good acceptance among beef producers. Innovative posts, end

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Material adapted for the 1990-91 Proceedings, Winter Beef Meetings, University of Illinois Cooperative Extension Service, by Ted Funk, Area Agricultural Engineer, Effingham, IL.

insulators, standoff insulators, and drive-over gates have been developed to make single- and multiple-strand smooth-wire paddock fences very labor-efficient and cost-effective.

Flexible line paddock fence

For temporary electric fencing of paddocks where cattle are accustomed to electric fence, flexible strand materials can be used to reduce labor and materials costs. Flexible strand materials are usually plastic twine or tape, with some very fine strands of stainless steel wire woven into the plastic to carry the electric current. Lightweight fence posts made of insulating materials (fiberglass or other plastic) eliminate the need for separate insulators and make the fence very easy to put in place and move when the paddock boundaries need to be changed.

Bases for comparisons

Economic

Initial investment

Although component prices for fencing vary with time and throughout the region, some typical costs are presented here to stimulate comparison. Initial investment costs for the various types of fences are as follows:

Fence type	**Fence Cost, $/100 ft.** Materials	Labor	Total
Woven wire + 1 barb	70.00	25.00	95.00
Five-strand barb	44.00	27.00	71.00
Ten-strand high-tensile	55.00	20.00	75.00
Three-strand high-tensile electric	20.00	4.00	24.00
One-wire portable electric	6.00	--	6.00

Among perimeter fences, the three-strand high-tensile electric fence materials cost about one-fourth as much as woven wire, and about a third that of five-strand barbed wire. The cost for non-electric ten-strand high-tensile fence lies between barbed wire and woven wire.

One-strand electric fence has no competitors for temporary fencing. Solid wire is preferred over flexible materials for long runs (greater than one-half mile); otherwise the flexible material wins out because of lower labor costs.

Installation equipment

Multiple-strand smooth-wire fence construction requires certain special tools as a minimum: a tractor-mounted fence post driver, a "spinning jenny" wire unrolling mechanism, and crimping tools for splicing the wire and installing braces.

Labor

Cost of labor for installing perimeter fence favors the three-strand electric fence, and even the ten-strand non-electric high-tensile fence requires less labor than the more traditional woven-wire and barbed fences.

Labor for installing temporary electric fencing is very low compared to perimeter fences, and is not considered a factor of fence length here.

Annual ownership cost

Annual cost of ownership includes depreciation, interest on investment (8% per year assumed here), and maintenance. Note that the useful life of the high-tensile fence is extended beyond that of other steel products, assuming that you buy domestic steel wire with extra-heavy galvanized coating.

Fence type	**Useful life**	**Annual cost, % of initial cost**
Woven wire + 1 barb	20 years	8%
Five-strand barb	20 years	8%
Ten-strand high-tensile	30 years	3%
Three-strand high-tensile electric	30 years	6%

Performance

Several performance factors enter into the decision of what fence system to build:

Livestock retention

Any of the perimeter fences can do an adequate job of holding cattle. However, it should be remembered that an electric fence is primarily a psychological barrier, and a non-electric fence is a physical barrier. An electric fence will do a better job of holding cattle that have been accustomed to it than will a non-electric fence, whereas a non-electric fence presents a more formidable barrier to cattle that are unfamiliar with electric fence. Electric fencing systems have less wear from cattle pressure simply because the animals respect the fence and keep their distance at all times.

Wildlife control: deer, coyote

Deer pose a menace to temporary electric fences because the animals usually attempt to go under or through the wire rather than jump over. High-tensile wire is less susceptible to damage and more satisfactorily repaired when damaged than is soft steel wire. Certain perimeter electric fence construction types have been shown to be effective in keeping deer out of pastures.

Coyotes learn to dig under perimeter fences, whether electrified or not. Use of a grounded "trip wire" just outside the fence and near the ground has been shown to be useful in preventing coyotes from crawling under fences. Alternating hot and grounded wires in the fence also reduces the incidence of coyotes jumping through the fence.

Animal and/or human injury

Barbed wire fences are notorious for snagging hides and cutting the legs of animals that insist on tangling with the fence. Smooth wire non-electric high-tensile fences can cut legs, but the problem is rare in fences that have a large number of strands. For non-electrified perimeter fences ten strands are recommended.

Electric fences that are charged by a good-quality controller generally do not pose a hazard to livestock or humans; the extremely short duration of the electric shock gives time for the affected animal or person to let go of the fence and back away. Any fence construction that allows an animal or human to be caught in the fence is hazardous, however. For this reason, barbed wire fences should not be electrified.

"Weed-burner" controllers that have a long-duration shock should never be used on any electric fence. They are a fire and safety hazard.

Visibility

Single-strand temporary electric fences can be difficult to see under some circumstances. The flexible strand materials are made of brightly-colored plastics and are therefore much more visible to humans and animals against most vegetative backgrounds than are galvanized wire materials.

Esthetics

While woven-wire and multiple-strand barbed wire fences are viewed as traditional and esthetically acceptable, all the perimeter fences depend on a good quality layout and installation for a pleasing addition to a farm landscape. High-tensile wire installations do not sag with age and cattle pressure as woven-wire and barbed wire do, since there are built-in tensioning springs. Corrosion is less of a problem with high-tensile wire that has extra-heavy galvanized coating.

Maintenance

Restretching of fencing is sometimes required on perimeter fences, especially in wooded areas where trees fall across the fenceline. Smooth-wire high-tensile fencing is much easier to repair after tree removal. Wire splicing of smooth wire is much quicker and retains the strength of the wire through the splice, compared with repairs to barbed or woven wire.

Performance checks on electric fencing systems are required periodically, and the use of a special voltmeter (cost: $75 to $100) is recommended. Cattle will test the fence inadvertently on occasion, and a "cold" electric fence will eventually be breached.

Removal of weeds and crops from a fenceline is somewhat easier in high-tensile wire fence systems because there are no vertical wire stays in the fence; in addition, wider post spacings are used than with woven-wire fence.

Fence controller maintenance on electric fences is mainly limited to periodic checks of the voltage on the fence, except in the case of battery-operated fence controllers that require recharging or replacement of batteries. Solar-powered fence controllers use solar energy to recharge the batteries, decreasing or eliminating the need to switch batteries that have run low.

GROWTH OF SPRING AND FALL CALVED HEIFERS GRAZING HIGH OR LOW ENDOPHYTE INFECTED TALL FESCUE PASTURES

DIXON SPRINGS AGRICULTURAL CENTER

GENE M. ZINN and R. S. OTT

SPRING CALVED HEIFERS:

Twenty eight yearling beef heifers, calved in the spring of 1989, were divided by weight into three groups. Animals in each group were randomly allotted to a high (>75%) endophyte (HE) or a low (<25%) endophtye (LE) infected tall fescue pasture. Animals were weighed at 28 day intervals for 112 days and the average daily gain (ADG) was computed. The heifers grazing the HE pastures had an ADG of .46 kg/day (1.02 lb/day) while the LE group had an ADG of .64 kg/day (1.41 lb/day) which is a 38% increase (Table 1).

FALL CALVED HEIFERS:

Thirty one beef heifers, calved in the fall of 1989, were divided by weight into three groups. Animals in each group were randomly allotted to HE or LE tall fescue pastures as previously described. Animals were weighed at approximately 28 day intervals for 138 days and the ADG was computed. The heifers grazing the HE fescue pastures had an ADG of .25 kg/day (.56 lb/day) while the LE pasture group had an ADG of .44 kg/day (.96 lb/day) which is a 71% increase (Table 2).

These data indicates animal age may be a factor influencing ADG by animals grazing HE infected tall fescue pastures.

TABLE 1. 1990 HIGH & LOW ENDOPHYTE FESCUE PASTURE STUDY USING HEIFERS CALVED THE PREVIOUS SPRING.

CAF ID NUMBER	REP NO	FESCUE ENDOPHTE	CF BIRTH --DATE--	--CALF-- -BREED--	WNG WWT	08-May WGHT	05-Jun WGHT	03-Jul WGHT	31-Jul WGHT	28-Aug WGHT	WNG RAT	R K	OVERALL ADG
9295	1	HIGH	2-24-89	AN	525	720	750	795	795	820	111	2	0.89
9308	1	HIGH	3-4-89	HP-AN	419	630	710	720	750	735	96	4	0.94
9309	1	HIGH	3-5-89	HP-AN	500	675	720	765	795	815	109	2	1.25
9322	1	HIGH	3-22-89	AN-HP	454	700	800	810	850	840	107	2	1.25
9346	1	HIGH	4-8-89	AN	363	660	725	745	755	740	91	5	0.71
AVG WT					452	677	741	767	789	790			1.01
ADG							2.29	0.93	0.79	0.04			
9294	1	LOW	2-23-89	BN-AN	463	645	720	745	765	785	106	2	1.25
9301	1	LOW	2-26-89	AN-HP	493	700	775	805	830	830	114	2	1.16
9304	1	LOW	2-28-89	AN	520	700	790	821	845	865	120	1	1.47
9344	1	LOW	4-7-89	HP-HP.SM	455	680	715	795	840	850	118	1	1.52
AVG WT					483	681	750	792	820	833			1.35
ADG							2.46	1.48	1.02	0.45			
9281	2	HIGH	2-6-89	BN-AN	450	640	680	720	755	770	97	4	1.16
9293	2	HIGH	2-22-89	BN-AN	425	585	660	685	730	755	98	4	1.52
9306	2	HIGH	3-1-89	BN-AN	434	570	640	660	695	710	102	2	1.25
9307	2	HIGH	3-3-89	AN-HP	390	580	650	655	680	695	89	6	1.03
9354	2	HIGH	5-8-89	HP-JE.AN	375	580	625	625	670	660	113	2	0.71
AVG WT					415	591	651	669	706	718			1.13
ADG							2.14	0.64	1.32	0.43			
9297	2	LOW	2-25-89	HP-SM.HP	453	625	690	720	730	775	105	2	1.34
9305	2	LOW	3-1-89	BN-HP	428	566	655	705	720	775	92	5	1.87
9310	2	LOW	3-7-89	BN-AN	405	580	655	705	735	780	98	4	1.79
9327	2	LOW	3-23-89	HP-AN.HP	406	590	650	695	710	745	96	4	1.38
9347	2	LOW	4-11-89	AN	392	580	625	670	695	725	100	3	1.29
AVG WT					417	588	655	699	718	760			1.53
ADG							2.39	1.57	0.68	1.50			
9284	3	HIGH	2-12-89	BN-AN.SM	366	505	580	595	610	615	83	6	0.98
9285	3	HIGH	2-12-89	BN-AN	394	545	600	625	655	665	88	6	1.07
9343	3	HIGH	4-7-89	AN	394	540	605	615	625	630	99	3	0.80
9351	3	HIGH	4-17-89	AN-HP	392	555	615	640	660	655	102	3	0.89
9356	3	HIGH	5-28-89	AN-AN.HP	342	550	610	635	655	640	115	1	0.80
AVG WT					378	539	602	622	641	641			0.91
ADG							2.25	0.71	0.68	0.00			
9299	3	LOW	2-25-89	AN	368	525	605	628	660	690	87	6	1.47
9317	3	LOW	3-18-89	HP-AN.HP	412	545	615	630	655	680	95	5	1.21
9324	3	LOW	3-23-89	HP-AN	370	560	630	669	690	720	87	6	1.43
9348	3	LOW	4-12-89	AN	370	555	635	656	685	705	95	5	1.34
AVG WT					380	546	621	646	673	699			1.36
ADG							2.68	0.88	0.96	0.94			

TABLE 2. 1990 HIGH & LOW ENDOPHTYE FESCUE PASTURE STUDY USING HEIFERS CALVED THE PREVIOUS FALL.

CAF ID NUMBER	REP NO	FESCUE ENDOPHYTE	CF BIRTH --DATE--	--CALF-- --BREED-	WNG WGT	19-Apr WGHT	15-May WGHT	12-Jun WGHT	10-Jul WGHT	07-Aug WGHT	04-Sep WGHT	WNG RAT	R K	OVERALL ADG
9370	1	HIGH	9-11-89	AN-AN.HP	433	510	486	495	535	565	579	111	2	0.50
9380	1	HIGH	9-14-89	AN	457	540	507	525	555	585	629	119	1	0.64
9397	1	HIGH	9-24-89	AN	425	515	481	495	500	540	553	116	1	0.28
9400	1	HIGH	9-27-89	AN	457	525	511	525	560	590	621	122	1	0.70
9408	1	HIGH	10-5-89	AN-AN.SM	433	515	498	495	525	550	576	124	1	0.44
AVG WT					441	521	497	507	535	566	592			0.51
ADG							-0.94	0.37	1.00	1.11	0.91			
9367	1	LOW	9-9-89	AN	435	520	505	530	540	565	610	106	3	0.65
9371	1	LOW	9-11-89	AN-SM.HP	456	520	527	555	590	630	657	116	1	0.99
9383	1	LOW	9-15-89	AN	420	475	478	475	495	515	556	106	3	0.59
9389	1	LOW	9-20-89	AN-SM.HP	395	515	427	565	605	640	695	105	3	1.30
9392	1	LOW	9-22-89	AN-SM.HP	427	525	512	530	580	600	657	115	2	0.96
AVG WT					427	511	490	531	562	590	635			0.90
ADG							-0.82	1.47	1.11	1.00	1.61			
9368	2	HIGH	9-9-89	AN-CH	397	450	442	460	485	505	540	97	4	0.65
9374	2	HIGH	9-12-89	AN	445	510	512	520	525	533	559	111	2	0.36
9385	2	HIGH	9-16-89	AN-AN.SM	390	465	464	485	505	530	569	102	3	0.75
9399	2	HIGH	9-26-89	AN	410	495	485	510	515	535	562	108	3	0.49
9405	2	HIGH	10-2-89	AN	375	445	435	460	495	525	558	102	3	0.82
AVG WT					403	473	468	487	505	526	558			0.61
ADG							-0.21	0.69	0.64	0.74	1.14			
9361	2	LOW	9-7-89	AN	375	455	453	485	485	510	540	91	5	0.62
9372	2	LOW	9-11-89	AN-AN.SM	372	455	466	510	525	565	611	92	5	1.13
9376	2	LOW	9-13-89	AN-JE.HP	398	465	470	510	540	560	610	103	3	1.05
9388	2	LOW	9-18-89	AN	354	445	457	490	500	525	570	94	4	0.91
9401	2	LOW	9-29-89	AN-JE.AN	395	505	482	505	550	580	638	110	2	0.96
AVG WT					379	465	466	500	520	548	594			0.93
ADG							0.02	1.23	0.71	1.00	1.64			
9359	3	HIGH	9-6-89	AN-AN.HP	368	450	451	465	490	500	538	93	5	0.64
9379	3	HIGH	9-13-89	AN	365	440	455	475	485	510	527	91	5	0.63
9393	3	HIGH	9-22-89	AN	341	440	410	425	465	485	525	92	5	0.62
9404	3	HIGH	10-1-89	AN	357	430	418	425	455	475	510	97	4	0.58
9407	3	HIGH	10-5-89	AN-SM.AN	352	435	423	435	470	475	509	102	4	0.54
9412	3	HIGH	10-29-89	AN-HP	357	440	440	440	455	465	499	117	1	0.43
AVG WT					357	439	433	444	470	485	518			0.57
ADG							-0.24	0.40	0.92	0.54	1.18			
9358	3	LOW	9-5-89	AN-AN.HP	341	425	440	478	510	550	580	86	5	1.12
9377	3	LOW	9-13-89	AN	355	440	453	480	515	545	570	92	5	0.94
9384	3	LOW	9-16-89	AN	332	455	455	505	525	597	635	84	5	1.30
9391	3	LOW	9-22-89	AN-HP	343	410	418	455	480	525	545	93	4	0.98
9403	3	LOW	9-30-89	AN	330	455	445	475	520	547	575	97	4	0.87
AVG WT					340	437	442	479	510	553	581			1.04
ADG							0.20	1.30	1.12	1.53	1.01			

A GUIDE FOR ESTIMATING SEASON LONG PASTURE DAYS IN ILLINOIS

C. J. (Jim) Kaiser
Forage Production and Pasture Management

The two most powerful tools producers have for influencing the level of animal output under grazing are (1) system of grazing management and (2) concentration of animals per unit area (stocking rate). The concept of grazing management implies decision-making. Profitable decision-making requires knowledge about pasture species, animal response desired relative to the market, and the pasture-animal interaction.

Knowledge of the carrying capacity of a pasture as animal unit days (the amount of forage needed to maintain one mature cow or 1,000 pounds of live weight for one day) can be useful in planning for forage establishment (Table 1) or for planning the season long grazing (Table 2) of established pastures. Yield losses of continuously grazed pastures is assumed to be 33 percent of the dry matter grown. Animal unit pasture day (24 pounds of dry matter) per acre may also be related to hay produced per acre by the use of the following formula.

Tons hay (dry matter) grown x .67 = tons hay equivalent

Tons hay equivalent x 83.33 = animal unit pasture days

Animal unit pasture days x 0.012 = tons hay equivalent

Tons hay equivalent x 1.49 = Tons hay (dry matter) produced

The animal unit days may be determined for legume grass mixtures by estimating the percent of each grass and legume components and multiplying the it by the estimated animal unit pasture days.The sum of these values may be used as the estimated animal unit pasture days for the mixture.

The values are estimates only of pastures continuously grazed. Intensively grazed pastures consisting of eleven or more paddocks grazed on a 33 day cycle of 30 days rest per paddock and 3 days of grazing are expect to be higher in estimated grazing days, hay equivalent and hay yields.

Table 1. Estimated Animal Unit Pasture Days, Hay Equivalent, and Hay Yields per Acre for the Growing Season of Selected Pasture Crops under continuous grazing management.

Pasture Species	Animal Days	Hay equivalent Tons	Hay Tons
Alfalfa	170	2.04	3.04
Red clover	135	1.62	2.41
Large white clover	77	0.92	1.38
Birdsfoot trefoil	94	1.13	1.68
Sweet clover	95	1.14	1.70
Sericea lespedeza	96	1.15	1.72
Lespedeza	65	0.78	1.16
Perennial cool season grasses			
Kentucky bluegrass	88	1.06	1.57
Orchardgrass	155	1.86	2.77
Tall fescue	168	2.02	3.00
Reed canarygrass	139	1.67	2.49
Smooth bromegrass	154	1.85	2.75
Perennial ryegrass	60	0.72	1.07
Timothy	82	0.98	1.47
Redtop	67	0.80	1.20
Perennial warm season grasses			
Bermudagrass	118	1.42	2.11
Switchgrass	110	1.32	1.97
Eastern gamagrass	120	1.44	2.15
Big bluestem	105	1126	1.88
Indiangrass	100	1.20	1.79
Annual summer grasses			
Sorghum x sudangrass	98	1.18	1.75
Pearlmillet	97	1.16	1.73
Spring seeded forages			
Spring rape	50	0.60	0.89
Spring oat	55	0.66	0.98
Fall seeded forages			
Winter rye	80	0.96	1.43
Fall rape	40	0.48	0.72

Table 2. Estimated Animal Unit Pasture Days, Hay Equivalent, and Hay Yields per Acre for the Growing Season of Selected Pasture Cr… under Continuous Grazing Management in Illinois

Pasture Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total Days	Tons H E	Tons Hay
Alfalfa	0	0	5	15	30	30	25	25	20	15	5	0	170	2.04	3.04
Tall fescue	0	0	10	25	30	30	12	7	12	22	15	5	168	2.02	3.00
Orchardgass	0	0	5	25	30	25	15	10	15	20	10	0	155	1.86	2.77
Smooth bromegrass	0	0	5	25	30	30	15	7	12	20	10	0	154	1.85	2.75
Reed canarygrass	0	0	10	25	30	30	25	7	10	2	0	0	139	1.67	2.49
Red clover	0	0	5	15	25	25	25	15	10	10	5	0	135	1.62	2.41
Eastern gamagrass	0	0	0	0	10	30	30	20	20	10	0	0	120	1.44	2.15
Bermudagrass	0	0	0	0	8	24	30	30	20	6	0	0	118	1.42	2.11
Switchgrass	0	0	0	0	20	30	30	15	10	5	0	0	110	1.32	1.97
Big bluestem	0	0	0	0	15	30	30	25	5	0	0	0	105	1.26	1.88
Indiangrass	0	0	0	0	10	15	25	30	15	5	0	0	100	1.20	1.79
Sorghum-sudangrass	0	0	0	0	0	8	30	30	25	5	0	0	98	1.18	1.75
Pearl millet	0	0	0	0	0	5	30	30	25	7	0	0	97	1.16	1.73
Sericea lespedeza	0	0	0	3	10	20	20	18	15	10	0	0	96	1.15	1.72
Sweet clover	0	0	3	15	20	20	10	5	5	15	2	0	95	1.14	1.70
Birdsfoot trefoil	0	0	2	10	20	20	15	10	12	5	0	0	94	1.13	1.68
Bluegrass	0	0	2	15	25	10	5	3	6	15	7	0	88	1.06	1.57
Timothy	0	0	2	15	20	20	5	4	6	8	2	0	82	0.98	1.47
Winter rye	0	0	15	20	0	0	0	0	0	15	20	10	80	0.96	1.43
White clover	0	0	6	15	15	15	5	2	5	10	4	0	77	0.92	1.38
Redtop	0	0	0	12	18	18	5	2	5	7	0	0	67	0.80	1.20
Lespedeza	0	0	0	0	0	7	15	15	15	13	0	0	65	0.78	1.16
Perennial ryegrass	0	0	0	0	15	20	10	5	5	5	0	0	60	0.72	1.07
Spring oat	0	0	0	5	25	25	0	0	0	0	0	0	55	0.66	0.98
Spring rape	0	0	0	0	0	5	15	15	10	5	0	0	50	0.60	0.89
Fall rape	5	0	0	0	0	0	0	0	0	5	15	15	40	0.48	0.72

Tons H E equals Tons Hay Equivalent

FORAGE PRODUCTION

Dr. C. J. Kaiser, University of Illinois Forage Agronomist, headed up the forage production analysis of intensively grazed pastures during 1989. Measurements were taken by farmer cooperators with a forage meter board each time cattle were moved to and from a paddock. Hand clippings were taken monthly during the grazing season to calibrate the meter board. Samples were laboratory tested for dry matter, protein and energy values.

Table 3 lists some general parameters of the forage data:

Table 3. Forage Parameters

Cooperator	Forage Specie	Days Grazed	No. Paddocks	No. Cycles	Tons DM Produced	Tons DM Consumed
Billingsley	TF:Lesp.	96	9	3	6.1	3.6
Bollmann	ALF	161	8	6	5.6	3.0
Bremer	TF:ALF	188	11	6	3.5	2.1
Dannehold	ALF:TF	114	9	4	3.3	1.4
Dean	ALF:OG	146	10	6	5.4	3.5
Duckworth	ALF:OG, TF:RC	171	36	9	6.7	4.1
Rueter	TF:RC, ALF:SdAX	209	6	10	10.2	5.8
Saxe	ALF:TF	153	14	5	6.3	3.1
Smith	ALF	141	12	4	3.5	1.6
Woods	TF:Lesp.	160	12	8	4.7	2.7

FURTHER INTERESTS

Cattlemen who have further questions about Intensive Grazing Management can contact the producer cooperators for additional information. Tom Saxe and Jim Ahrenholz at 618-439-7263 or Jim Kaiser at 217-333-4424 will respond to questions about the Animal Performance, Economic Analysis and Forage Production results, respectively.

MANAGING BEEF REPLACEMENT HEIFERS

Richard K. Knipe

The replacement beef heifer is an extremely important, although sometimes overlooked, segment of the cow herd. Proper development of replacement heifers is a critical part of improving herd productivity. Heifers should grow rapidly, reach puberty early and conceive early for high productivity.

In Illinois, we have an abundance of feed and therefore economics dictate that heifers be bred to calve at two years of age. Therefore, the rest of this paper will work with the assumption that all heifers will be bred at 13-15 months of age.

The management and development of the replacement heifer will be discussed in four phases:

1) Pre-weaning
2) Weaning to breeding
3) Breeding to calving
4) Rebreeding the first-calf heifer

Pre-weaning

It is important that replacement heifers weigh at least 450 pounds at weaning and that this growth be normal skeletal and muscle growth, and not a lot of excess body fat. Thus, heifers should be grown on the cow without the use of high energy creep rations. Plane of nutrition and growth rate have been shown to exert significant effects on mammary development and milk production of beef heifers. The general relationship between rate of gain during rearing and subsequent milk production is that both inadequate nutrition (too low rate of gain) and overfeeding (too high rate of gain) can result in reduced milk yields. This relationship has been described in numerous studies in dairy cattle, and has also been demonstrated in beef cattle and sheep.

Early evidence for negative effects of overfeeding beef replacement heifers on their future productivity came from observations that heifers that were heaviest at weaning often weaned the lightest calves. Research at Colorado State shows a cyclic trend in calf weaning weights due to excess milk production. This cycle operated such that heifers (1st generation) from the highest weaning weight group weaned lighter calves. The 2nd generation heifers weaned heavier calves on average, which in turn the 3rd generation heifers weaned lighter calves. The cycle may be explained as follows: 1) High weaning weight heifers are overfed, causing the expected reduction in mammary development, milk production, and progeny weaning weights; 2) Progeny of overfed heifers receive less milk, thus are lighter at weaning, but have normal mammary development and milk production, and therefore wean heavier progeny. These trends then continued over subsequent generations.

It is widely recommended that commercial producers implant nursing calves. Since it is economically beneficial to implant the nursing calf, it becomes necessary to implant calves before the replacements are selected. The question then becomes, "What affect does the implant have on future reproductive performance?" A great deal of research has been done to answer that question, and you can find data to defend any opinion. However, it has been shown that one implant between one month of age and weaning is safe and beneficial and most studies show that the second implant begins to have a negative effect on reproductive performance. It can be argued that increasing the nutritional level will eliminate the reproductive problems of multi-implanted heifers. However, this also results in increased feed costs to develop this heifer. It is therefore very difficult to justify the cost of implanting the replacement heifer.

Weaning to Breeding

In a well-managed beef operation, heifers are bred three to four weeks prior to the cows to insure they have adequate time to rebreed. In order to have a high percentage of the heifers bred early, 80 to 90% of the heifers will need to have reached puberty by the time they are 12 to 13 months old.

Puberty is the period at which the heifer shows first estrus and ovulation. The age at which the heifer reaches puberty is a function of her body weight and frame size. Heifers need to reach the 550-750 pound weight range in order to begin cycling. As heifer frame size increases so does the body weight requirement for puberty. For example, small frame heifers should reach puberty at 550-600 pounds while large frame heifers may have to weigh 750 pounds.

If your heifers had an average weaning weight of 450 pounds at 7 months of age and you want the heifers to weigh 650 pounds at 13 months, then they must be fed to gain approximately 1.1 pounds per day. Heifers are amazingly tolerant of how and when they gain the weight as long as they do not get too thin or too fat. In this example, it does not matter if the heifers gain 1.1 pounds every day or if she gains 0.5 pounds per day for the first 100 days and then fed to gain 2.0 pounds per day for the next 75. This does make it important that a group of heifers be of uniform frame size if they are to be fed together. If there is great variation in frame size, either the small frame heifers get too fat or the large frame heifers are not heavy enough to begin cycling at 13 months.

When heifers are approximately 12 months of age they should be evaluated for weight, frame, pelvic size, and maturity of reproduction tract. Producers that want to select for growth should be weighing all heifers at this time because yearling weight measurements are the best indicators of growth. This program involves selecting heifers for breeding by size and type, obtaining pelvic measurements, palpating for ovarian development (puberty), and vaccinating for reproductive diseases, all during one processing through the chute. At this time cull heifers can be placed in the feedlot and finished at a relatively young age.

Breeding to Calving

Just having the first calf heifer bred as a yearling does not mean the job is completed. It is extremely important that this heifer continue to grow from breeding to calving. In fact, heifers that weigh 600 to 650 pounds at breeding should gain another 200 to 250 pounds or more before calving. This means that these heifers will have to gain 3/4 to 1 pound per day from breeding to calving.

Generally with spring calving cow herds, these bred replacement heifers will remain on summer grass from breeding until fall. If the quantity and quality of grass is adequate, they should easily achieve a gain of from 1 to 1 1/2 pounds per day. Then in the fall of the year, they would be fed harvested or stored feed until calving, possibly in some cases using the stored feed as a supplement to native grass. During this period of time, it is important to remember what nutrients the bred heifer really needs. Protein is important as the heifer is continuing to gain weight, however, protein is not nearly as important as energy. The following table of work done at the North Platte Experiment Station in Nebraska vividly illustrates the fact that energy is the real key nutrient during this period of time. Heifers that were fed an inadequate level of energy required nearly three times as long a period from calving to first estrus and likewise had a markedly reduced conception rate because the heifers were not cycling. As can be noted, however, the ideal combination to use was adequate protein and energy in which the heifers gained nearly 3/4 pounds per day, produced the heaviest calves at birth, had the shortest interval to first estrus, and had the highest conception rates at first service.

EFFECT OF ENERGY AND PROTEIN LEVEL DURING GESTATION ON PERFORMANCE OF BRED BEEF HEIFERS (Nebraska Data)

	Low Protein Low Energy	Low Protein High Energy	High Protein Low Energy	High Protein High Energy
Winter Weight Change (12/9-4/27)	-11 Lbs.	62 Lbs.	10 Lbs.	117 Lbs.
Calf Weaning Weight (180 Days of Age)	295 Lbs.	308 Lbs.	323 Lbs.	293 Lbs.
Rebreeding Data				
Calving to 1st estrus	142 days	54 days	148 days	51 days
% lst service conception	67%	38%	50%	83%
% Final conception	38%	75%	29%	86%

Rebreeding the First-Calf Heifer

The first lactation is probably the most critical phase of a beef cow's productive life. This heifer is still growing, producing milk for the calf, and the uterus is preparing for the next pregnancy. Each of these require extra feed and it is very difficult to manage the first-calf heifer if she is with the mature cows. Therefore it is important to separate the heifers from the mature cows for extra management. Again it is important to feed both extra protein and energy, however, the extra energy is more important. An extra 3-5 pounds of corn to the first-calf heifer can go a long way toward getting her rebred by 90-120 days postpartum. Remember that if the heifer calves 30 days before the mature cows we have an extra 30 days to get her rebred.

The critical aspect of feeding the beef cow to rebreed while keeping costs down is to feed to meet the cow's requirements. For example, a 1000 pound two-year old heifer nursing a calf requires 13 pounds of TDN (energy) and 2.1 pounds of crude protein. If you are feeding this heifer good quality hay (15% crude protein) she is probably consuming approximately 20 pounds of dry matter. Therefore she is receiving 3 pounds of crude protein and 11 pounds of TDN. In other words, she is getting too much protein and too little energy. This heifer is now in a negative energy balance and will be more difficult to rebreed.

Conclusion

The biggest single factor affecting beef cow reproduction performance is nutrition. The young heifer calf needs adequate skeletal and muscle development, but rapid growth will negatively affect milk production. On the other hand the yearling heifer needs more energy to reach an optimum weight in order to reach puberty by 12 months of age. Clearly, the most critical point in the production cycle is the 2-year old heifer that is nursing a calf while still growing and preparing for rebreeding. This is the stage that requires careful management.

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1991 - 1992

ANIMAL SCIENCES
University of Illinois

Agriculture Experiment Station

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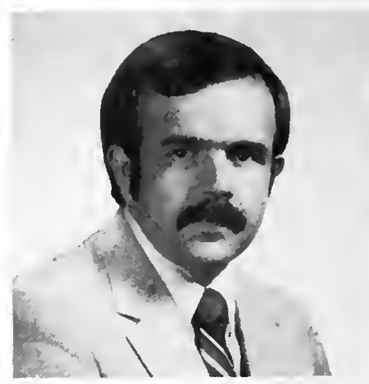
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CONTENTS

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THE DEPARTMENT OF ANIMAL SCIENCES
UNIVERSITY OF ILLINOIS

Dennis R. Campion, Head of Department

On behalf of the Department of Animal Sciences, I am pleased to introduce the 1990 Beef Cattle Research Report.

The Report contains new research findings, many of which are directly applicable to the beef industry today. Other projects such as the adrogenization of beef calves (which makes heifer calves grow similar to steer calves) will require assessment at a future date when the technology has been more fully developed. Our goal is to secure both the near-term and long-term profitability of beef cattle production through research.

The success of the beef cattle program can be contributed to outstanding faculty, staff, and students. While we are proud of everyone involved for their outstanding contributions, several faculty received particular recognition during 1990-91. Dr. George Fahey received the American Feed Ingredients Association-Nutrition Research Award at the national meeting of the American Society of Animal Science (ASAS). Dr. Dan Faulkner was the recipient of Outstanding Young Extension-Industry Specialist Award given at the Midwest Section ASAS meetings. Dr. Doug Parrett received this award the previous year. And, Dr. Larry Berger received the Funk Recognition Award for Excellence which is the highest award given in the College of Agriculture. Our hats are off to these faculty and to all the rest dedicated to making the beef industry more profitable in Illinois and beyond its borders.

UNIVERSITY OF ILLINOIS PUREBRED ANGUS HERD

D. F. Parrett, Extension Specialist, Beef

The University of Illinois maintains 60 spring calving purebred Angus cattle. In addition, ten to fifteen replacement heifers are retained each year. The cattle are used in research and teaching. Teaching uses include: beef production, livestock judging and evaluation courses, and special learning classes for undergraduate student research projects. The students gain experience in performance record keeping, animal selection, hands-on laboratory experience, heat-detection, calving and general beef cow herd management.

Most of the research conducted using the cattle is related to applied nutrition and new management techniques. Recent work has concentrated on previous androgenization effects of beef calves, limited creep feeding, various estrous synchronization techniques for beef cows and gene mapping of purebred lines of cattle.

Many clinics, workshops, and judging activities also make use of the purebred cattle. The herd also serves as a catalyst for interaction between the Department of animal Sciences staff members and the Illinois purebred cattle industry. Performance tested bulls are sold each year through the Illinois Performance Tested Bull Sale. Bulls are also raised and used as herd sires for the commercial cow herds at the Dixon Springs and Orr Research Centers. By raising our own herd sires, we can provide predictable performance and uniformity in the cattle raised for research trials. Of particular importance is the development of a calving ease herd within the Angus herd. These cattle are bred specifically for low birth weight EPD's. This group will become an increasingly important segment of our targeted purebred production program. EPD's (expected progeny differences) are used extensively in designing the breeding programs, with a goal of optimum performance for our environment (table 1). Many breeders have supported our Angus program and we appreciate their efforts to enhance our program.

Cow Herd - Average EPD's		EPD's			
	n	Birth	Weaning	Milk	Yearling
Yearling	24	3.5	32	10	52
2 yr. olds	6	3.0	31	8	53
3-4 yr. olds	13	4.1	26	6	42
5-6 yr. olds	18	4.4	24	7	37
> 6 yr. olds	7	2.7	19	10	32

1991 Angus A.I. Sires to Produce 1992 Calves	Birth	Weaning	Milk	Yearling
• Hoff Hi Spade	4.1	45	7	79
• GDAR Executive 727	4.3	47	18	76
• TC Stockman	3.3	38	18	64
• DHD Travelor 6807	+ .1	30	10	60
• SS Rito 0715 OH3	-4.3	19	7	33

ENERGY VALUE OF WET CORN GLUTEN FEED IN A RESTRICTED FEEDING PROGRAM FOR FEEDLOT CATTLE

Larry L. Berger and Cliff L. Willms
Animal Sciences Department
University of Illinois

SUMMARY

The purpose of this study was to determine the relative energy value of wet corn gluten feed and corn when fed at restricted intake to feedlot heifers. Growing heifers (560 lb initial weight) were fed diets containing 0, 25 or 50% wet corn gluten feed so that the diet without gluten feed was projected to provide 2.5 lb/day gain. Corn gluten fed replaced corn on an equal dry matter basis. Heifers fed 25% wet gluten gained as rapidly and as efficiently as those fed the control diet during both restricted (days 1-84) and when fed ad libitum (days 85-170). Rate of gain and feed efficiency was reduced approximately 5% when the high level of gluten was substituted for corn.

INTRODUCTION

Previous research at the University of Illinois has shown that wet corn gluten feed has approximately 93% the energy value of corn when fed at ad libitum intake. With the reduced supply of yearling cattle and the fact that corn is often the cheapest source of net energy, feeding growing calves restricted intakes of high-energy diets has become more popular. Much of the energy in corn gluten feed is in the form of fiber which is more slowly digested in the rumen than the starch in corn. Consequently, it was hypothesized that feeding it at restricted intake may increase its energy value because of a slower rate of passage through the rumen. In addition, restricted intakes often result in increased fluctuations in rumen pH due to the consumption of one or two major meals per day. Because the rapid consumption of corn gluten feed is likely to have less of a pH depressing affect than the consumption of an equal amount of processed corn, substituting gluten for corn may increase digestibility of the fiber from other dietary sources such as corn silage. This could increase the net energy of the total diet.

PROCEDURE

One hundred-eight crossbred heifer calves with an initial weight of 560 lb were randomly assigned to 18 pens. Heifers were purchased approximately a month before the start of the experiment and were vaccinated for IBR, PI_3, blackleg, malignant edema and Hemophilus. They were dewormed, treated for grubs and lice and implanted with Synovex H.

All heifers were started on a diet containing 55% corn silage on a dry matter basis. At 4-day intervals, corn and/or wet gluten replaced 10 percentage units of corn silage so that by day 17 all heifers were being fed a diet containing 15% silage (dry matter basis). Diet compositions are shown in table 1. The control diet was balanced to contain 14% crude protein. This level of protein is greater than the NRC requirement to achieve 2.5 lb/day gain, but was fed so that the high protein level on the 50% gluten diet would not confound the interpretation of the results. Additional calcium was added to the high gluten diet to maintain approximately a 2:1 calcium:phosphorus ratio. Monensin was included in the supplement to provide 25 grams/ton of diet. Cattle were fed once per day, in the morning, in a fence-line bunk that provide two linear feet per heifer.

Shrunk weights were taken at the start and just prior to slaughter. The 84-day weight was taken when intakes were restricted so that fill should be relatively uniform across treatments. Beginning on day 85, heifers were fed ad libitum the same diets as when they were on restricted intake to determine whether there was any treatment differences in how the heifers adjusted to ad libitum feeding.

RESULTS

Heifers fed 25% wet gluten gained faster (P<.05) than those fed 50% gluten, with the corn diet being intermediate (Table 2). During the period of restricted intakes feed conversions were excellent for all treatments. Feed:gain ratios were 4.85, 5.03 and 5.29 for the 25% gluten, corn and 50% gluten diets, respectively (Table 2). As with daily gains, the only significant difference (P<.05) was between the low and high gluten diets.

There were no compensatory gains for heifers fed the 50% gluten diet during the ad libitum feeding period. For the total trial (170 days), heifers fed the 25% gluten diet gained as fast as were slightly more efficient than those fed corn. The overall performance demonstrated the potential of restricting intakes of a high energy diet during the growing phase in that the heifers averaged 3.0 lbs per day and required less that 5.5 lbs feed per lb of gain (Table 2).

Two possible reasons why wet gluten was equal to corn in energy when fed at restricted intake are: 1) slower rates of passage through the digestive tract resulting from restricting the intake may have allowed more of the fiber in the gluten to be digested and 2) substituting wet gluten for corn at up to 25% of the diet may moderated fluctuations in rumen pH so that more of the corn silage fiber was digested. Comparing these data with previous trials, suggest that restricting the intake of diets containing wet gluten improves the energy value of the total diet compared to the restricted feeding of an equal amount of corn.

Table 1. Final Diet Composition on Dry Matter Basis.

Item	Corn	25% WCGF[a]	50% WCGF
	Diets		
Corn silage	15.00	15.00	15.00
Dry corn	26.55	26.99	27.42
High-moisture corn	55.00	30.00	5.00
Wet corn gluten feed	--	25.00	50.00
Soybean meal	1.60	.80	--
Limestone	.90	1.54	2.19
Urea	.56	.28	--
Trace-mineral salt	.36	.36	.36
Monensin	.02	.02	.02
Vitamin mix	.01	.01	.01

Table 2. Performance of Feedlot Heifers fed Wet Corn Gluten Feed (WCGF) or Corn at Restricted Intakes for 84 Days.

Item	Corn	25% WCGF	50% WCGF
	Diets		
Day 1-84[a]			
Daily gain, lb	2.85[b,c]	2.95[b]	2.71[c]
Intake, lb	14.30	14.26	14.28
Feed:gain	5.03[b,c]	4.85[b]	5.29[c]
Day 1-170			
Daily gain, lb	3.00[b]	3.02[b]	2.80[c]
Intake, lb	16.41	16.12	15.93
Feed:gain	5.49[b,c]	5.35[b]	5.68[c]

[a]Intakes were restricted on days 1-84 and fed ad libitum days 85-170.
[b,c]Means in the same row with different superscripts differ (P<.05).

COW-CALF PERFORMANCE WHILE GRAZING ALFALFA-ORCHARDGRASS OR RED CLOVER-TALL FESCUE ON A CONTINUOUS OR ROTATIONAL SYSTEM

D. D. Buskirk, D. B. Faulkner and J. W. Castree

SUMMARY

A 2 x 2 factorial experiment was used to evaluate midsummer legume-grass pastures and grazing systems. The two forage types evaluated were Alfalfa-Orchardgrass (A-O) and Red Clover-Tall Fescue (R-F). Within each of these forage types grazing systems evaluated were continuous (CONT) and rotational (ROT; 6 days on, 30 d off). The experiment was conducted at the Orr Research Center, Baylis, IL in years 1990 and 1991. Seventy-two cow-calf pairs were utilized in the first year and forty-six pairs were used in the second year. Put-and-take cow-calf pairs were used to maintain equivalent forage availability among treatments. Cow and calf performance was affected by interactions of forage type, grazing system and year. Cow and calf daily gains were greater ($P < .05$) for A-O than R-F regardless of grazing system. Cow daily gain was greater ($P < .05$) on A-O compared to R-F for both years of the trial. In 1991, cow gain/acre was lowest ($P < .01$) on R-F, but calf gain/acre was highest ($P < .05$) on R-F. Stocking rates were higher ($P < .01$) on ROT in 1990, but were lower ($P < .01$) on ROT in 1991 compared to CONT. Calf gain/acre was highest in 1991 on R-F CONT. Different grazing management practices and forage combinations yielded the greatest beef production in different years.

INTRODUCTION

Productivity of a pasture depends largely on the species of forage and the grazing management used. This is especially true in the midsummer period when cool-season grasses are growing slowly. Forage type and grazing method must be matched in order to optimize animal performance. Therefore, the objectives of this study were to evaluate the influence of pasture forage type and grazing system on cow and calf weight gains during midsummer.

PROCEDURES

A 2 x 2 factorial experiment was used to evaluate midsummer legume-grass pastures and grazing systems. The two forage types evaluated were Alfalfa-Orchardgrass (A-O) and Red Clover-Tall Fescue (R-F). Within each of these forage types grazing systems evaluated were continuous (CONT) and rotational (ROT). Rotationally grazed pastures were divided into 6 paddocks, with each paddock being grazed for 6 days and rested for 30 days. The experiment was replicated twice and repeated over two years. Seventy-two cow-calf pairs were utilized in the first year (July 12 to Sept. 20, 1990) and forty-six pairs were used in the second year (July 9 to Sept 20, 1991). Put-and-take cow-calf pairs were used to maintain equivalent forage availability among treatments. Put-and-take animals were included in computations of stocking rate, but were not included in animal gain determinations. All calves were given access to creep feed during the trial. The study was conducted at the Orr Research Center, Baylis, IL.

Statistical analysis was conducted using the GLM procedure of SAS. Variables included in the fixed model were forage type, grazing system, year, and their two-way interactions. Pasture was used as the experimental unit. Treatment mean differences were separated using the F-test for least significant difference.

RESULTS

There were significant ($P < .05$) two-way interactions for forage type, grazing system, and year for cow and calf daily gain, gain/acre and stocking rate.

Cow daily gain was greater ($P < .05$) on A-O than R-F (Table 1.). Cows gained one lb/d more on ROT and .5 lb/d more on CONT when grazing A-O compared to R-F. Similarly, calves gained more ($P < .01$) when grazing A-O. Calves gained .34 lb/d more on ROT and .45 lb/d more on CONT when grazing A-O compared to R-F. Stocking rates were lower ($P < .01$) on A-O than R-F with either grazing system. Even though stocking rates were lower for A-O, cow daily gain was improved enough to produce the most cow gain/acre for A-O ROT ($P < .01$). In contrast, calf gain/acre was 75 lb greater ($P < .01$) for R-F CONT than for A-O ROT.

Table 2. shows the effects of year on the two forage types. As a result of cows beginning the trial in thinner body condition in 1990, cows gained more weight in 1990 than in 1991 ($P < .01$). In both years, cows exhibited greater ($P < .01$) daily gains on A-O pastures. Stocking rates were greater ($P < .05$) on R-F, but were less ($P < .05$) for A-O in 1991 than the previous year. Cow gain/acre was similar among forage types ($P < .05$) in 1990, however, in 1991 cow gain/acre was greater ($P < .05$) for A-O compared to R-F (27.1 vs -43.0 lbs.). Calf gain/acre was similar ($P < .05$) within forage type between years. In 1991, calves gained 63 lbs. more on R-F compared to A-O pastures.

No differences ($P > .05$) were found for cow or calf daily gain due to grazing system alone (Table 3.). Rotationally grazed pastures in 1990 and CONT in 1991 had the greatest ($P < .01$) stocking rates. Cow gain/acre was greater ($P < .01$) in 1990 than 1991 for both grazing systems. Cow gain per acre was increased by 24% on ROT over CONT grazing in 1990. Calf gain/acre was greatest ($P < .05$) for CONT system in 1991. Different grazing management practices and forage combinations yielded the greatest beef production in different years.

TABLE 1. PASTURE PRODUCTIVITY OF ALFALFA-ORCHARDGRASS AND RED CLOVER-TALL FESCUE GRAZED CONTINUOUSLY OR ROTATIONALLY (6 DAYS ON, 30 DAYS OFF)

	Alfalfa-Orchardgrass		Red Clover-Tall Fescue	
	Rotational	Continuous	Rotational	Continuous
Cow gain, lb/d	1.62^{a}	1.31^{b}	$.64^{c}$	$.80^{c}$
Calf gain, lb/d	2.79^{d}	3.04^{d}	2.45^{e}	2.59^{e}
Stocking rate, prs/A	$.76^{d}$	$.82^{d}$	1.15^{e}	1.21^{e}
Cow gain/A, lb	99.7^{d}	67.5^{e}	49.2^{e}	52.6^{e}
Calf gain/A, lb	147.6^{d}	181.5^{de}	199.5^{de}	222.9^{e}

^{abc}LS means in a row with different superscripts differ ($P<.05$).
^{de}LS means in a row with different superscripts differ ($P<.01$).

TABLE 2. PASTURE PRODUCTIVITY OF ALFALFA-ORCHARDGRASS AND RED CLOVER-TALL FESCUE FOR YEARS 1990 AND 1991

	1990		1991	
	Alfalfa-Orchardgrass	Red Clover-Tall Fescue	Alfalfa-Orchardgrass	Red Clover-Tall Fescue
Cow gain, lb/d	2.36^{a}	1.92^{b}	$.57^{c}$	$-.48^{d}$
Calf gain, lb/d	2.64^{ef}	2.47^{e}	3.18^{f}	2.57^{ef}
Stocking rate, prs/A	$.86^{e}$	1.10^{f}	$.73^{g}$	1.26^{h}
Cow gain/A, lb	140.1^{a}	144.8^{a}	27.1^{b}	-43.0^{c}
Calf gain/A, lb	155.9^{e}	186.4^{efg}	173.2^{ef}	236.1^{g}

^{abcd}LS means in a row with different superscripts differ ($P<.01$).
^{efgh}LS means in a row with different superscripts differ ($P<.05$).

TABLE 3. PASTURE PRODUCTIVITY GRAZED CONTINUOUSLY OR ROTATIONALLY (6 DAYS ON, 30 DAYS OFF) FOR YEARS 1990 AND 1991

	1990		1991	
	Rotational	Continuous	Rotational	Continuous
Cow gain, lb/d	2.15^{a}	2.13^{a}	$.11^{b}$	$-.01^{b}$
Calf gain, lb/d	2.52	2.60	2.72	3.03
Stocking rate, prs/A	1.08^{a}	$.88^{b}$	$.84^{b}$	1.15^{a}
Cow gain/A, lb	158.0^{a}	127.0^{b}	-9.1^{c}	-6.8^{c}
Calf gain/A, lb	186.3^{d}	156.1^{d}	160.1^{d}	248.4^{e}

^{abc}LS means in a row with different superscripts differ ($P<.01$).
^{de}LS means in a row with different superscripts differ ($P<.05$).

GRAZING CALVES ON BIRDSFOOT TREFOIL- TALL FESCUE, TALL FESCUE, AND TALL FESCUE FERTILIZED WITH NITROGEN

D. B. Faulkner, C. J. Kaiser, F. A. Ireland and D. D. Buskirk

SUMMARY

Two grazing studies were conducted to evaluate three management strategies for spring grazing of tall fescue (tall fescue, tall fescue fertilized with 100 lb of N per acre and tall fescue-birdsfoot trefoil). Birdsfoot trefoil in fescue improved stocking rate slightly over fescue alone but no differences were observed in animal performance. Nitrogen supplementation doubled stocking rate on fescue but animal performance was reduced. The magnitude of this reduction was year dependent. Gain per acre favored different management strategies in different years.

INTRODUCTION

Animal performance on tall fescue during the early spring appears to be similar to other cool season grasses. Spring is also the time when much of the growth take place in tall fescue. Spring grazing of steers and selling them in June takes advantage of the high quality and large quantity of tall fescue. It also keeps steers off the tall fescue in the summer when the endophytic fungus is a problem and allows the steers to be sold on a traditionally strong market. Therefore, management strategies to utilize tall fescue in the spring need to be evaluated. The objective of this study was to evaluate the performance, carrying capacity and gain per acre of yearling steers grazing birdsfoot trefoil-tall fescue, tall fescue and tall fescue fertilized with nitrogen.

PROCEDURE

Eighteen seven acre pastures were utilized in year 1 and twelve seven acre pastures were utilized in year 2 to evaluate spring grazing (April 4 to May 30, 1989 and April 3 to May 29, 1991) of tall fescue. In both years, yearling calves were placed on birdsfoot trefoil-tall fescue, tall fescue, and tall fescue with nitrogen (100 lbs N per acre). Ten tester animals per pasture were used to evaluate animal performance. Put and take animals were utilized to maintain sword height between 3 and 6 inches and to evaluate stocking rate. Steers were weighed after 16 hour removal from feed and water at the beginning and end of the studies.

RESULTS

There was a significant year by treatment interaction ($P<.05$) for gain and gain/acre so data are presented for both years (Table 1). In both years, birdsfoot trefoil in fescue improved stocking rate and gain/acre slightly over fescue alone but no differences were observed in animal performance. Nitrogen supplementation doubled stocking rate on fescue but animal performance was reduced. The magnitude of this reduction was year dependent. In year 1, the gain per acre favored the fescue supplemented with nitrogen despite the reduced performance, but in year 2, gain per acre was similar for all the treatments. Year 2 was an exceptionally wet year, with over 10 inches of rainfall in May alone. This resulted in more grass (indicated by an increased stocking rate) with a corresponding decrease in grass quality (indicated by steer performance). Gain per acre favored different management strategies in different years.

TABLE 1. PERFORMANCE OF STEERS ON THREE FORAGE SYSTEMS

	Fescue	Fescue-N	Fescue-BT	SE
Year 1				
Pastures, no.	6	6	6	
Initial wt, lb	564	566	558	5
Final wt, lb	647[a]	624[b]	640[a]	6
Daily Gain, lb.	1.34[a]	.95[b]	1.32[a]	.08
Stocking Rate, hd/acre	1.55[a]	3.45[b]	1.88[c]	.12
Gain/Acre, lb.	128[a]	206[b]	154[a]	19
Year 2				
Pastures, no	4	4	4	
Initial wt, lb	460	466	455	7
Final wt, lb	511[a]	482[b]	510[a]	8
Daily Gain, lb.	.92[a]	.30[b]	1.00[a]	.11
Stocking Rate, hd/acre	1.94[a]	3.76[b]	2.10[a]	.12
Gain/Acre, lb.	99	70	117	25

[abc]Values in a row not having a common superscript differ (P<.01)

CATTLE PERFORMANCE AS INFLUENCED BY GRAZING MANAGEMENT SYSTEMS

B. S. Bertelsen, D. B. Faulkner, J. W. Castree and D. D. Buskirk

SUMMARY

Yearling crossbred heifers were used to compare continuous grazing and rotational grazing at two levels of intensity. Treatments were continuous (CONT), 6 paddock rotational (6-PADD) and 11 paddock rotational (11-PADD) grazing systems. Paddocks in the 6-PADD pastures were grazed 6 d and rested 30 d while 11-PADD paddocks were grazed 3 d and rested for 30 d. The trial was conducted at the Orr Beef Research Center, Baylis, IL and was repeated over two years. Heifer gain, stocking rate and gain per acre were measured during the summer grazing period of mid-May through mid September of 1990 and 1991. Grazing system did not affect heifer average daily gain ($P > .58$). Stocking rate for CONT was less ($P < .03$) than both rotational treatments. Gain per acre was 40% greater ($P < .04$) for 6-PADD compared to CONT. There were no significant advantages in 11-PADD over 6-PADD. Rotational grazing did not affect heifer daily gain, but substantially increased stocking rate which resulted in more beef produced per acre.

INTRODUCTION

Rotational grazing can allow producers to generate more beef per acre of land (a fixed unit of input) through a higher stocking rate (animals per acre). Controlling the grazing of the beef herd will limit selectivity and force the animals to consume more of the forage available. This in turn, can greatly improve the efficiency of forage utilization. However, if grazing pressure exceeds forage availability, individual animal performance may be decreased. Therefore, the objectives of this experiment were to examine the effects of rotational grazing management at two levels of intensity versus a continuous grazing system on daily gain, stocking rate and gain per acre.

PROCEDURES

Sixty-five yearling crossbred heifers were utilized during the grazing season from mid-May through mid-September, 1990. Heifers were blocked by weight and randomly allotted to six pastures. Three treatments were assigned to six pastures with two replications per treatment. Treatments were CONT, 6-PADD and 11-PADD grazing. Rotational pastures were divided into equal-area, rectangular paddocks by electrified polywire with a common area along one end of the paddocks for water and free choice mineral access. Paddocks in the 6-PADD pastures were grazed for six days and rested for 30 d. Each paddock in the 11-PADD pastures was grazed for three days and rested 30 d. Pasture forage for all treatments consisted of 50% alfalfa, 40% tall fescue and 10% orchardgrass by visual estimate. Eighteen of the heifers originally allotted were used as put-and-take animals to measure carrying capacity of the pastures. Stocking rate was adjusted at each rotation to maintain an equal amount of forage remaining after grazing a paddock. A rising-plate meter was used to measure density of forage remaining after grazing to determine a need for adjustment in stocking rate.

The experiment was repeated in 1991. Ninety-seven yearling heifers were utilized during the second year. Heifers were randomly allotted and the same treatments were assigned to the same six pastures as in the first year. Twenty-nine of the heifers were used as put-and-take animals and stocking rate was maintained as in 1990.

During both years average daily gain, stocking rate and gain per acre were measured. Put-and-take animals were not included in daily gain calculations.

Statistical analysis was conducted using the GLM procedure of SAS with pasture as the experimental unit. Treatment mean differences were separated using the F-test for least significant differences.

RESULTS

There were no significant (P > .16) interactions between treatment and year on daily gain, stocking rate and gain per acre. Therefore, only main effects are reported.

Average daily gain was not significantly different (P > .58) between treatments (Table 1). This indicates that intake and diet quality were not substantially limited in any treatments. Stocking rates for 6-PADD and 11-PADD pastures were 52 and 32% higher (P < .03) than CONT, respectively. Stocking rates were similar between 6-PADD and 11-PADD (P > .09). Six paddock pastures produced 48 lbs/ac more than CONT (P < .04). Gain per acre tended to be higher (P = .06) on 11-PADD than CONT. Carryover effects of treatment on pasture forage production were limited since stocking rates were 18% higher (P < .05) in 1991 than the first year and there was little difference in gain per acre (P > .84) or daily gain (P > .28) between years (Table 2). In conclusion, rotational grazing did not affect heifer average daily gain, but substantially increased stocking rate resulting in more pounds of beef produced per acre. There were no significant advantages in 11-PADD over 6-PADD.

TABLE 1. EFFECT OF GRAZING MANAGEMENT SYSTEM ON ANIMAL PERFORMANCE AND PASTURE PRODUCTIVITY

	Treatment			
Item	Continuous	6 Paddock	11 Paddock	SEM
Daily gain, lbs/d	.805	.741	.809	.084
Stocking rate, hd/ac	1.227[a]	1.871[b]	1.617[b]	.094
Gain per acre, lbs/ac	118.9[c]	166.6[d]	159.7[c,d]	12.997

[a,b] Least square means in a row with different superscripts differ (P < .03).
[c,d] Least square means in a row with different superscripts differ (P < .04).

TABLE 2. EFFECT OF YEAR ON ANIMAL PERFORMANCE AND PASTURE PRODUCTIVITY

	Year		
Item	1990	1991	SEM
Daily gain, lbs/d	.841	.730	.068
Stocking rate, hd/ac	1.441[a]	1.702[b]	.077
Gain per acre, lbs/ac	149.9	146.9	10.612

[a,b] Least square means in a row with different superscripts differ (P < .05).

During both years average daily gain, stocking rate and gain per acre were measured. Put-and-take animals were not included in daily gain calculations.

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FACTORS INFLUENCING THE SALE PRICE OF BULLS

D. B. Faulkner, D. D. Buskirk and D. F. Parrett

SUMMARY

Angus (49 head) and Simmental (101 head) bulls ranging in age from 10.5 mo to 2.2 years were sold at the Performance Tested Bull Sale in Springfield, Illinois on February 20, 1991. The bulls had complete performance information including: birth weight EPD, weaning weight EPD, yearling weight EPD, combined EPD index, frame (1-9 scale), weight, daily gain (WDA), age, muscle (1-5 scale from 4 evaluators), and scrotal circumference. Bull buyers prefer older, heavier bulls. They also want light birth weight EPD and muscling in the bulls. Frame is only important in the Angus breed where bulls under a frame 6.5 were discounted. In the Simmental breed there was a preference for the bulls to be black and polled. No other factors were important in predicting the sale price of bulls.

INTRODUCTION

Purebred producers often speculate about the factors that influence the sale price of bulls. It is important that these factors be identified so breeders can produce bulls that are in demand for their customers. Therefore, we decided to evaluate factors that influenced sale price in the Illinois Performance Tested Bull Sale.

PROCEDURE

Angus (49 head) and Simmental (101 head) bulls ranging in age from 10.5 mo to 2.2 years were sold at the Performance Tested Bull Sale in Springfield, Illinois on February 20, 1991. Complete performance information, weights and measures were available on each bull. An example of the information follows:

LOT 64
OWNER: CURT RINCKER, SHELBYVILLE
BULL: RS BIG WHEELS Z21 POLLED
BORN: 02/18/90 TAT.: Z21
SIRE: RBR PAPILLON
MGS: LOUADA AMBASSADOR

(SIM)	WT	EPD	ACC	RANK
BIRTH	91	+ 1.0	.34	C
WEAN	659	+ 7.0	.32	B
YEAR		+15.0	.16	B
MILK		- 5.0	.16	D

SCROT CIRC cm	PELVIC AREA cm^2	FRAME SCORE	SALE WT lb	SALE WDA	COMB EPD RATIO	SALE DAY ORDER
38.5	160.5	8.2	1326	3.61	97.8	72

The cattle contained a range of values for birth weight EPD, weaning weight EPD, yearling weight EPD, combined EPD ratio (Appendix A), frame (1-9 scale), weight, daily gain (WDA), age, muscle (1-5 scale where 1 = light muscling and 5 = heavy muscling based on 4 independent evaluations), and scrotal circumference. Tables 1 and 2 shows the means, standard deviations and minimum and maximum values for these variables. These values and their squares were used as independent variables in a stepwise multiple regression procedures (maximum R^2) (SAS, 1985), to develop the simplest equations that would adequately predict sale price. Simple correlations were calculated among all the measurements (SAS, 1985).

RESULTS

The range in the two sets of bulls represents producers' top bulls that have been selected for growth. The simple linear correlation of age and weight was .85 (Tables 3 and 4). This indicates that age or weight could be used interchangeably in developing the predictions. All other correlations of concern were relatively low.

There were some observations for Simmental bulls that could not be included in the prediction equations because they were an all or non trait. Polled bulls were worth $399 more than horned bulls and black or grey bulls were worth $220 more than red bulls. These factors were accounted for before the prediction equations were developed.

The prediction equations are shown below:

Angus Bulls: Sale price = $-9442 - 127(\text{birth EPD}) + 2520(\text{frame}) - 157(\text{frame})^2 + .71(\text{weight}) + 105.5(\text{gain})^2 + 32.9(\text{muscle})^2$

Simmental Bulls: Sale price = $-1255 - 53.9(\text{birth EPD}) + 5.02(\text{weight}) - .0012(\text{weight})^2 - 2032(\text{muscle}) + 388(\text{muscle})^2 + .11(\text{index})$

The Angus equation explains about 63% of the variation and the Simmental equation explains about 67%. This is quite good when we consider that the equations cannot take into account factors like conformation, soundness, breeder reputation, pigmentation, color, and fitting.

These equations are difficult to evaluate particularly when there is a squared term (which means a curve). Therefore, we have taken the average value for all of the other measurements and graphed each measurement individually (see graphs).

For the Angus bulls, there is over a $750 spread in value due to weight. The average value per pound is $.71/lb over the range in these bulls. There is over a $900 spread in the value due to birth weight EPD. For each pound increase in birth weight EPD there is a decrease in value of $128. Muscle score resulted in over a $400 spread in value and gain (WDA) resulted in over a $900 spread in value. Bulls under a frame score of 6.5 received a severe discount of up to $750, but no advantage was observed for cattle above 6.5 frame. No other factors were important in developing prediction equations for the value of these bulls. It is important to remember that age could be substituted for weight in this equation.

For the Simmental bulls, there is over a $1500 spread in the value due to weight, with most of the difference being between 900 and 1700 lbs. Muscle score accounts for over $600 in value, with the difference being all in favor of the heavily muscled bulls. No differences were observed between the light muscled and average muscled bulls. The combined EPD ratio accounted for over a $600 spread in sale price. In addition, birth weight EPD accounted for over $400 in price spread. This difference was in addition to the birth weight EPD being part of the combined ratio. The $54 decrease in value per pound of birth weight EPD increase would be similar to the value for Angus bulls if the effect of birth weight EPD in the ratio was also considered.

Bull buyers appear to want older, heavier bulls as their first priority. Of secondary importance is birth weight and muscling of the bulls. Frame is only important in the Angus breed for bulls under a 6.5 frame score. In the Simmental breed there was a preference for the bulls to be black and polled. No other factors were important in predicting the sale price of the bulls.

APPENDIX A

This ratio is derived from the bull's birth, weaning, and maternal milk EPD as follows (Bryant and Lemenager, 1988):

> Birth weight EPD * -2.43. This takes into account a decrease in calf survival, an increase in calf dystocia, a longer postpartum anestrous interval and lower conception rate that result from an increase in birth weight.
>
> Weaning weight EPD * .75. This is considered to be an average long term feed calf value per pound due to increasing weight.
>
> Maternal milk EPD * .75. This assumes; 1) the long term feeder calf value discussed above of .75, 2) 50% retention of heifer calves for replacements (25% of calf crop), and 3) that the average cow will produce 4 calves in her lifetime. Weight factor of .75 * 25% replacement rate * 4 calves = .75.

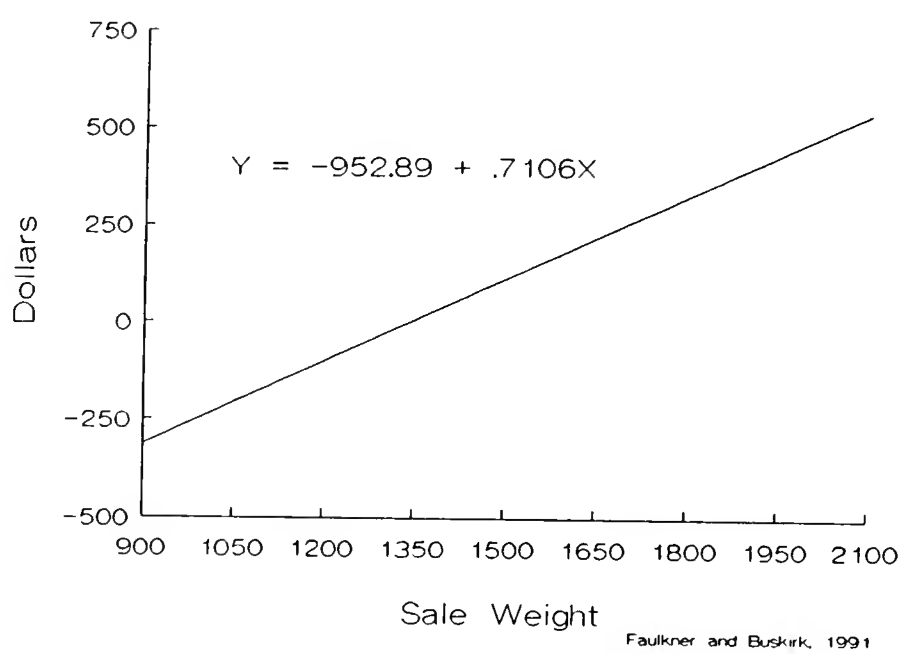
These factors are totaled to determine the economic value of each bull. the economic value of the average bull of the breed is also calculated and set at an ratio of 100. The bulls in the sale are then compared to the average of the breed.

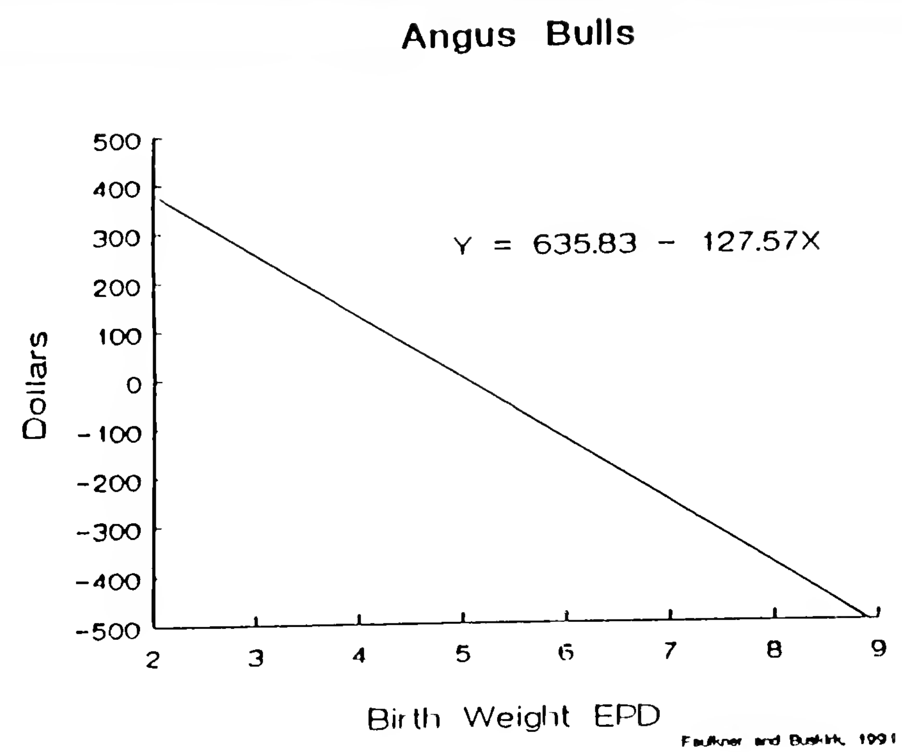
REFERENCE

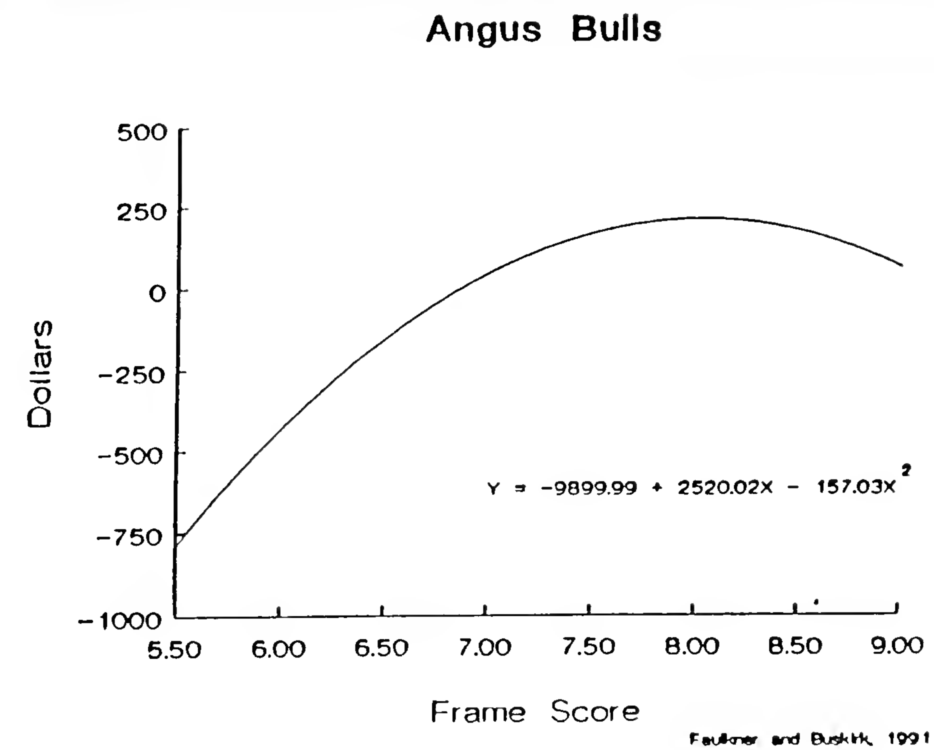
SAS. 1985. SAS User's Guide: Statistics. SAS Inst., Inc., Cary, NC.

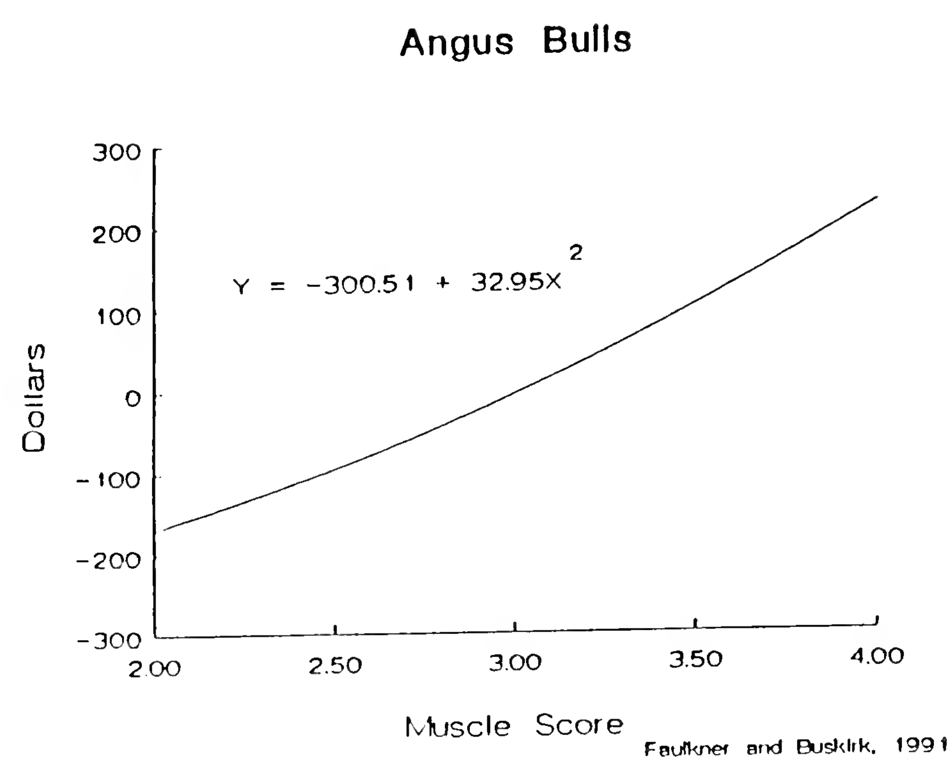
Bryant, D. E. and R. P. Lemenager. 1988. A computer program designed to assist producers in making bull selection and mating decisions. Beef Day Proceedings, Purdue University, September 2, 1988.

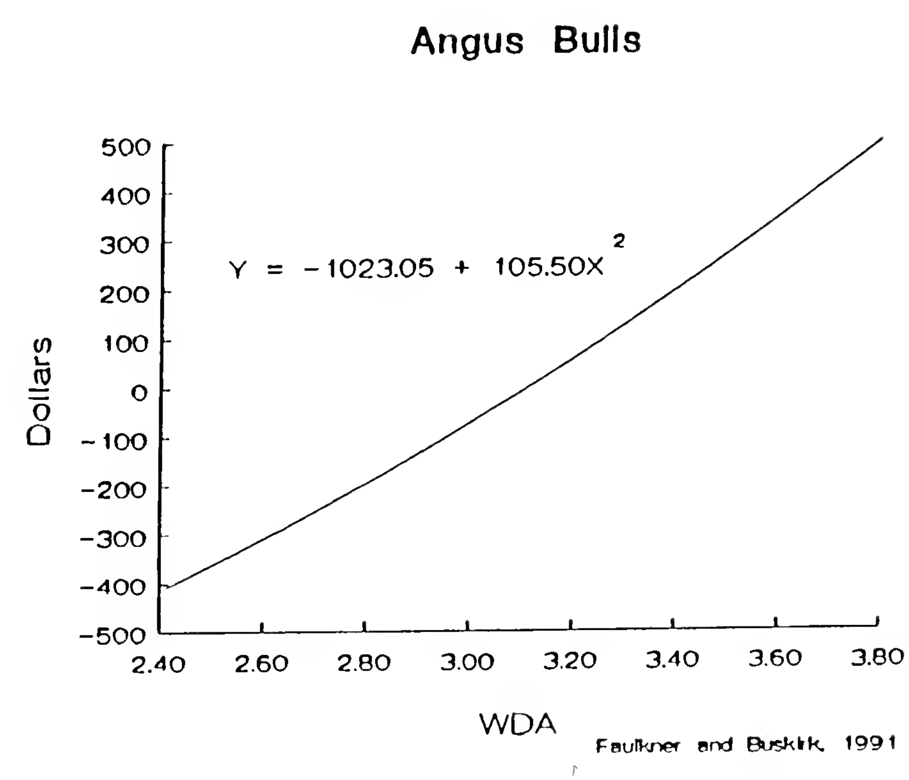
Angus Bulls



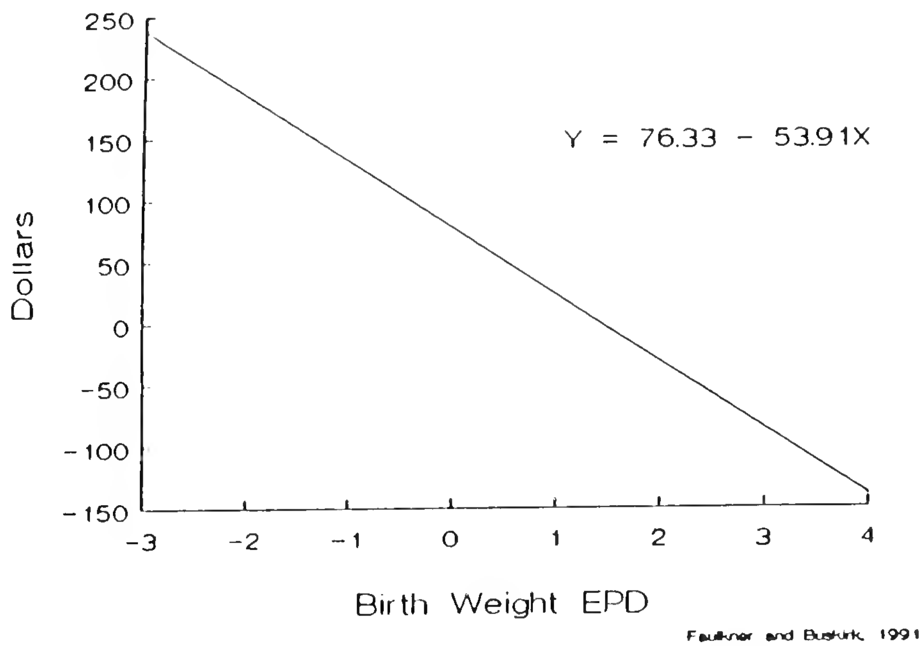

Angus Bulls
Y = 635.83 - 127.57X
Dollars
500
400
300
200
100
0
-100
-200
-300
-400
-500
2
3
4
5
6
7
8
9
Birth Weight EPD
Faulkner and Buskirk, 1991


Angus Bulls
Y = -9899.99 + 2520.02X - 157.03X 2
Dollars
500
250
0
-250
-500
-750
-1000
5.50
6.00
6.50
7.00
7.50
8.00
8.50
9.00
Frame Score
Faulkner and Buskirk, 1991

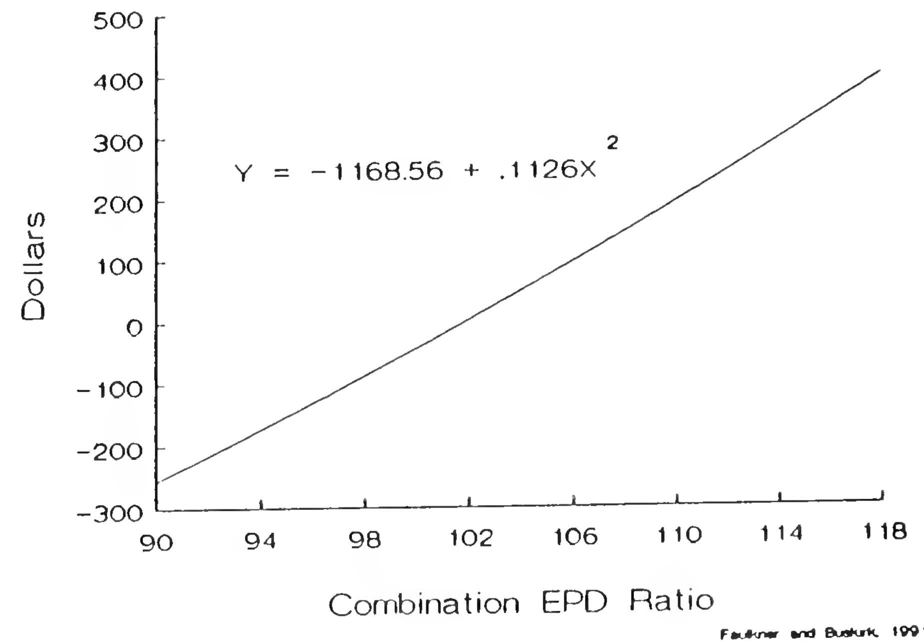

Angus Bulls
Y = -300.51 + 32.95X 2
Dollars
300
200
100
0
-100
-200
-300
2.00
2.50
3.00
3.50
4.00
Muscle Score
Faulkner and Buskirk, 1991


Angus Bulls
Y = -1023.05 + 105.50X 2
Dollars
500
400
300
200
100
0
-100
-200
-300
-400
-500
2.40
2.60
2.80
3.00
3.20
3.40
3.60
3.80
WDA
Faulkner and Buskirk, 1991

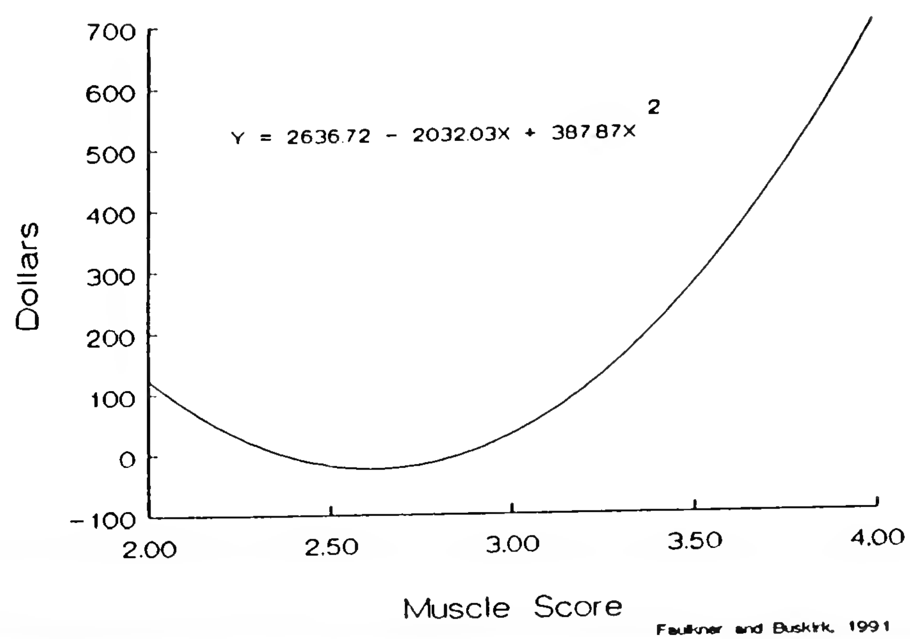
Simmental Bulls



Simmental Bulls



Simmental Bulls



Simmental Bulls

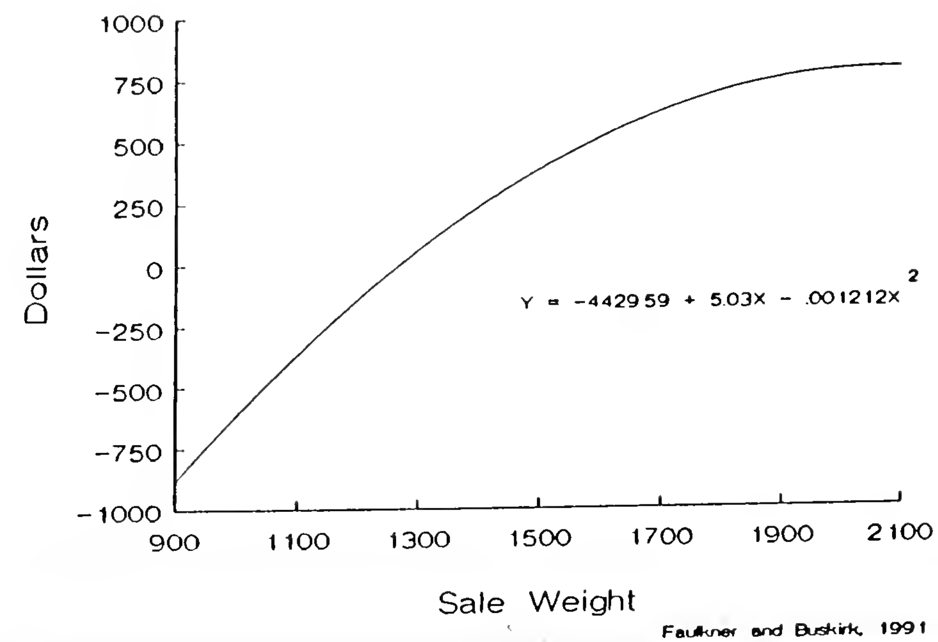


TABLE 1. ANGUS MEASUREMENTS

	Mean	Standard Deviation	Minimum Value	Maximum Value
Birth EPD, lb.	5.0	1.7	1.8	8.4
Weaning EPD, lb.	30.5	6.7	15.0	48.0
Milk EPD, lb.	10.6	3.9	0.0	17.0
EPD Index	105.0	5.4	93.6	116.9
Frame[a]	6.9	0.9	5.4	9.0
Weight, lb	1341	328	934	2147
Gain, lb/d	3.1	0.3	2.4	3.7
Age, d	437.0	132.8	327.0	743.0
Muscle[b]	3.0	0.5	2.0	4.0
Scrotal, cm	39.4	3.5	33.0	45.5

[a]On a 1-9 scale according to Beef Improvement Federation Standards.
[b]On a least to most scale from 1-5.

TABLE 2. SIMMENTAL MEASUREMENTS

	Mean	Standard Deviation	Minimum Value	Maximum Value
Birth EPD, lb.	1.4	1.6	-3.0	4.0
Weaning EPD, lb.	10.7	7.5	-6.0	32.0
Milk EPD, lb.	-1.9	5.1	-11.0	9.0
EPD Index	101.9	5.2	90.1	117.8
Frame[a]	7.9	0.8	6.0	10.0
Weight, lb	1270	239	914	2106
Gain, lb/d	3.3	0.3	2.6	3.9
Age, d	389.3	86.7	299.0	706.0
Muscle[b]	2.9	0.6	1.5	4.0
Scrotal	38.1	2.9	31.0	45.0

[a]On a 1-9 scale according to Beef Improvement Federation Standards.
[b]On a least to most scale from 1-5.

TABLE 3. SIMPLE CORRELATIONS FOR ANGUS BULLS

	Birth EPD	Weaning EPD	Milk EPD	EPD Index	Frame	Weight, lb.	Gain lb/d	Age	Muscle
Weaning EPD, lb.	.57[a]								
Milk EPD, lb.	-.04	.04							
EPD Index	-.24	.52[a]	.61[a]						
Frame	.36	.46[a]	-.17	.06					
Weight, lb.	-.08	.05	-.02	.10	.49[a]				
Gain, lb/d	.45[a]	.36[a]	.21	.11	.14	-.30[b]			
Age, d	-.21	-.05	-.12	.04	.37[a]	.94[a]	-.61[a]		
Muscle	.12	.21	.22	.23	.17	.25	.18	.16	
Scrotal, cm	-.09	-.10	-.23	-.16	.33[a]	.74[a]	-.33[a]	.73[a]	-.01

[a](P<.01).
[b](P<.05).

TABLE 4. SIMPLE CORRELATIONS FOR SIMMENTAL BULLS

	Birth EPD	Weaning EPD	Milk EPD	EPD Index	Frame	Weight, lb.	Gain lb/d	Age	Muscle
Weaning EPD, lb.	.43[a]								
Milk EPD, lb.	-.12	-.45[a]							
EPD Index	-.36[a]	.43[a]	.34[a]						
Frame	.28[a]	.16	.11	-.07					
Weight, lb.	.33[a]	.29[a]	-.04	.04	.48[a]				
Gain, lb/d	.16	.04	-.01	-.08	.39[a]	-.01			
Age, d	.23[b]	.25[b]	-.02	.09	.31[a]	.92[a]	-.39[a]		
Muscle	-.02	.14	-.09	.10	.11	.35[a]	.25[b]	.22[b]	
Scrotal, cm	.40[a]	.18	.01	-.09	.32[a]	.62[a]	.08	.53[a]	.21[b]

[a](P<.01).
[b](P<.05).

RANKING BULLS BY EPD INDEX - A STEP ABOVE THE REST

by

David Seibert
Area Livestock Adviser
University of Illinois

Bull selection has been continuously plagued by selection for single traits and maximums. With the desire to increase the growth and size of beef cattle, considerable emphasis has been placed on the traits of weights and frame. However, this has resulted in calving difficulties due to increased birth weight and continual escalation of mature cow size.

Most tests evaluate post weaning traits of growth rate and feed efficiency, while visual appraisal, like shows, emphasize size, composition, and structural soundness as major criteria. However, the relative economic value of the various traits indicates that reproductive traits (a live calf each year) are five times more important than productive traits (growth and feed efficiency) and ten times more important than the product traits (carcass quality and composition).

In our Illinois Performance Tested (IBPT) Bull Sale, held during the Illinois Winter Beef Expo, we have sold between 140 and 195 bulls during the past four years. In developing the ranking system of these bulls, we have continually changed the index. Different emphasis was placed on the traits of "average daily gain, weight per day of age, yearling weight, frame, and backfat." Each of the indexes emphasized the post-weaning traits and neglected the very important traits of birth weight and milking ability of bulls' offspring females.

In order to consign to the IBPT Bull Sale, the consignors are required to be on their breed's performance program. With this requirement and the availability of expected progeny differences (EPDs), we felt these could be incorporated into an index that would provide us with the most accurate ranking of bulls based on genetic merit. Research has shown that EPDs are far superior to actual and/or adjusted weights in bull selection. This is especially true in the IBPT Bull Sale, since bulls come from at least 70 plus different environments and a broad range of feeding regimens.

DEVELOPMENT AND USE OF EPD INDEX

Purdue University researchers D. E. Bryant and R. P. Lemenager developed a computer program entitled "Beef Cattle Sire Summary Analysis" (1) that utilizes EPDs from a breed's performance program and calculates an economic index.

With this program, producers have the option of utilizing EPDs for the traits of birth weight, weaning weight, yearling weight, maternal milk, and combined weaning weight. However, for the IBPT Bull Sale, we only utilize EPDs for birth weight, weaning weight, and maternal milk. Weaning weight EPD and yearling weight EPD both measure growth and are highly related. However, we chose weaning weight for the IBPT Bull Sale since some breeds consigned to the sale could not provide yearling weight EPDs prior to their being taken and turned in to the breed association.

In order to arrive at an index, certain economic values must be established in order to weigh each trait in the index (i.e., birth, weaning, and milk). Also, the emphasis placed on each trait will determine in what type of breeding situation the bull should be used. Indexes could be developed to select bulls for use on first calf heifers (calving ease bulls) or bulls to be used on mature cows with all offspring going to the feedlot (terminal sires). However, for the IBPT Bull Sale, we selected the "General Index" developed by the Purdue researchers, since it provided a balance of traits (birth, weaning and milk) that are most appropriate for the majority of the bull buyers at our sale.

The index is calculated in the following manner based on economic data from beef cattle operations.

** Birth Weight EPD x -2.43. This takes into account a decrease in calf survival, an increase in dystocia, a longer post-partum anestrus interval, and a lower conception rate that results from an increase in birth weight.

** Weaning EPD x .75. This is considered to be an average long-term feeder calf value or slaughter cattle price per pound due to increased weight.

** Maternal Milk EPD x .75. This assumes: 1) the long-term feeder calf value discussed above of .75; 2) that a producer would keep 50% of the heifer crop (25% of the total calf crop) for herd replacements; and 3) that the average cow will produce 4 calves in her lifetime. The final economic value equation for maternal milk looks like this: .75 x 25% replacement rate x 4 calves = .75.

Table 1

Calculating "General EPD Index" for 1992 IBPT Bull Sale:

* Birth Wt. EPD.........	______	x -2.43=	______
* Weaning Wt. EPD....	______		
Maternal Milk EPD.+	______		
WEAN & MILK ==	______	x + .75=	______
TOTAL VALUE====			______
* Minus "BREED ADJUSTEMENT"(a)			- 13.5
* PLUS 100..			+100.00
** GENERAL EPD INDEX =======			______

(a) Each breed different.

ADJUSTING THE BULLS TO BREED AVERAGE

After commercial bull buyers have decided which breed or breeds they plan to buy, then how the bulls being offered in a sale COMPARE TO THE BREED AVERAGE in the economic EPD traits is of major importance. Purchasing the best bull in any sale does not mean anything unless that bull is compared to the breed's contemporaries born that year. If not compared to the breed average, the top indexing bull in a sale could be near the top, bottom, or just in the middle for EPDs within a breed.

Thus, we implemented a concept of "adjusting the bull's EPD index to breed average" for bull calves born during the same year. This is done by calculating the economic value of the average bull of a breed and setting it at an index of 100. The bulls in the sale would then be compared to the average of the breed. For the Angus breed, Table 2 would be utilized to establish the breed adjustment with the 50% EPDs for birth weight (+3.4), weaning weight (+21), and maternal milk (+8) being used.

Table 2

June 1991 Angus EPD Breakdown
1990 Non-Parent Bulls and Cows

Birth EPD		Wean EPD		Milk EPD		Year EPD	
Top Pct.	= to or less	Top Pct.	= to or More	Top Pct.	= to or More	Top Pct.	= to or More
5%	0.1	5%	35.0	5%	16.0	5%	57.0
10%	0.8	10%	32.0	10%	14.0	10%	52.0
15%	1.3	15%	30.0	15%	13.0	15%	48.0
20%	1.7	20%	28.0	20%	12.0	20%	46.0
25%	2.0	25%	27.0	25%	11.0	25%	44.0
30%	2.3	30%	25.0	30%	11.0	30%	42.0
35%	2.6	35%	24.0	35%	10.0	35%	40.0
40%	2.8	40%	23.0	40%	9.0	40%	38.0
45%	3.1	45%	22.0	45%	9.0	45%	37.0
50%	3.4	50%	21.0	50%	8.0	50%	35.0
55%	3.6	55%	20.0	55%	7.0	55%	34.0
60%	3.9	60%	19.0	60%	7.0	60%	32.0
65%	4.1	65%	18.0	65%	6.0	65%	31.0
70%	4.4	70%	17.0	70%	5.0	70%	29.0
75%	4.7	75%	16.0	75%	4.0	75%	27.0
80%	5.0	80%	15.0	80%	4.0	80%	25.0
85%	5.4	85%	13.0	85%	3.0	85%	22.0
90%	5.8	90%	11.0	90%	1.0	90%	19.0
95%	6.6	95%	8.0	95%	-1.0	95%	14.0
100%	11.4	100%	-28.0	100%	-14.0	100%	-21.0
Total Animals	69,253		73,356		73,365		37,314

Using Table 1 for calculating and plugging in the 50% EPDs for birth weight, weaning weight, and maternal milk for Angus calves born in 1990 would result in a breed adjustment of +13.5. This adjustment is deducted from the bull's individual EPD Index in order to compare him with the average of the breed.

EPD INDEXING EXAMPLES

To acquaint you with how EPD Indexing works, I will use four examples similar to what we have experienced in the IBPT Bull Sale. These examples will use Angus EPDs which you find throughout the breed. The four examples are as follows:

Bull No.	Birth Weight EPD	Weaning Weight EPD	Maternal Milk EPD
A	+ 3.4	+ 21	+ 8
B	+ 0.8	+ 18	+ 9
C	+ 2.0	+ 33	+ 12
D	+ 7.3	+ 40	- 8

Using Table 1 to calculate the General EPD Index for the four bulls, we would come up with the following EPD Index:

Bull A	==	100
Bull B	==	105
Bull C	==	115
Bull D	==	93

For a commercial producer who wishes to purchase a bull with balanced trait EPDs (General Index), the order of economic value to his herd would be as follows: Bulls C, B, A and D. Bull A is the average of the breed so his index came out to exactly 100.

Bull C excels in the General Index and exceeds the average calf processed through the 1990 Angus AHIR Performance Program by +15 index points. Bulls B and D are still very acceptable bulls but should be used in another breeding program besides balanced trait. Bull B could possibly be used on first calf heifers, while Bull D could be used as a terminal sire on large frame mature cows where birth weight and milk are of no concern.

EPD GROUP RANKING

As explained above, the top indexing bull can work in many situations and provides for a balance of traits. However, he may not be the best bull for all production situations. Thus, each bull buyer will have special needs for calving ease (birth weight EPDs), growth (weaning & yearling weight EPDs), and level of milk production (maternal milk EPDs). In each of these situations, he will need to supplement the EPD Index with individual EPDs for the various traits and select the bull that is best for his ranching situation and environment.

SUMMARY

EPDs are an extremely powerful and predictable tool for genetic selection of beef cattle. Commercial producers who understand EPDs and how to apply them to their ranching environment will be those who will remain in production and be competitive in the future. The use of a General EPD Index allows economic values to be placed on multiple traits (birth, weaning and maternal milk EPDs) and the bulls to be ranked according to a specific selection scenario.

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"Management Practices That Improve Profitability of Cow-Calf Operations"

Richard K. Knipe

INTRODUCTION

For the past ten years, you have been told to run your cattle operation like a business, yet seldom given ideas on how or where to start. As Americans, we think in terms of maximums and therefore like to talk about our high weaning weights or conception rates. But to maximize profits, we need to study all aspects of the operation and not overemphasize a certain area.

When we study beef cow business records, (Strohbehn 1990) (Rasby & Frasier 1990), we clearly see that the high profit herds have lower production costs than low profit herds. Therefore, in a commercial cow-calf operation it seems logical to work to reduce costs while maintaining or even increasing per cow production.

This paper will attempt to discuss management practices that will either reduce costs at a given level of production or increase production without increased costs. Please keep in mind that this discussion assumes that we are working with herds that wean at least a 90% calf crop. If your herd is below 90%, then improving reproductive efficiency has to be top priority. Remember, that the low profit herds from the I.S.U. Cow Herd Records averaged over a 90% calf crop weaned in 1990.

BREAKDOWN OF COW COSTS

Regardless of year, the two biggest expenses in a cow-calf operation are feed and interest. Feed costs will make up 45-50% of total costs (Table 1) and show the most variability between high profit and low profit herds. Therefore, reducing feed costs will be a major portion of this discussion and should be the first area that you work on to reduce costs. Interest or capital costs generally makeup 25% of the total cost of a cow herd. The past 5 years have been profitable for the cow-calf industry and it is important that producers reduce debt load as we move into more uncertain years.

Cash operating expenses make up 10-12% of the total cow expense. Although there is less opportunity for savings in this area, it is important to evaluate where the money is being spent and what the return is on that investment. For example, if health costs are inflating this figure, one needs to work on a preventative health program.

Table 1. Comparison of high and low profit producers for costs and returns from 1982 thru 1989 (Strohbehn 1990).

Item	Lower profit one-third	Higher profit one-third
Costs:	---------------------------$/cow-----------------	
Feed and pasture	191.8	141.8
Cash operating	48.7	34.6
Depreciation, tax & insurance on bldgs. & equip.	30.5	14.5
Family & operator labor	53.2	37.0
Capital charge on fixed & oper. funds	98.8	73.7
TOTAL	$423.0	$301.6
Income:		
Gross returns	$312.4	$416.8
Return to capital, labor and management	32.1	221.6
Return to labor & management	-65.0	147.4
Net profit	-110.6	115.2

REDUCING FEED COSTS

As was mentioned earlier, feed costs are always the single biggest expense in a cow herd and usually the area with the most opportunity for cost reduction. Tables 2 and 3 illustrate the difference in how "low-cost" and "high-cost" producers feed their cows. If you study the numbers, you will find that the low-cost producers allow cows to do more of the feed harvesting. A combination of 12 extra days on pasture and 26 extra days on corn stalks significantly reduces feed costs.

The other area where low-cost producers excel is in use of stored feeds. When you calculate total pounds of stored feed fed in Table 2, you find that the high-cost producers fed over 6,400 pounds of feed compared to less than 3,300 pounds fed by the low-cost group. Further analysis shows that very little of the difference is due to cow size, since the high cost producer's cows only weighed 26 pounds more than the low-cost producer's cows.

It becomes evident that the high-cost producer must reduce feed wastage and reduce the use of expensive high energy feeds, such as corn, corn silage, and supplements (Table 3). All Illinois cow-calf producers could profit from the use of more corn stover, balancing rations to meet the needs of the cow, and using grain on a more timely basis and use less expensive supplements.

Table 2. **A 3 year average comparison of feed costs for producers 15% above and 15% below the yearly average for total cost per cow from 1987 through 1989. (Strohbehn 1990)**

Item	Producers 15% above average total cost	Producers 15% below average total cost
Pasture grazing:		
days	169.4	181.5
cost per day	$.383	$.292
total cost	$64.88	$53.00
Corn stalk grazing:		
days	67.7	93.6
cost per day	$0.58	$.030
total cost	$3.93	$2.81
Stored feeding program		
days	127.9	89.9
feed fed per day, lb.	50.3	36.4
cost per day	$.871	$.477
total cost	$111.40	$42.88

Table 3. **A 3 year average comparison of feeds used for producers 15% above and 15% below the yearly average for total cost per cow from 1987 through 1989. (Strohbehn 1990)**

Item	Producers 15% below average total cost	Producers 15% above average total cost
	--------------% of total--------------	
Hay	74	55
Corn stover	5	1
Corn silage	16	35
#2 corn	3	6
Supplements	2	3

SHORTER CALVING SEASON

Increasing the average calf weaning weight generally results in more gross income and if you do not increase costs, obviously more net income. However, it appears that the high profit producers improve average weaning weights with a shorter calving season, rather than growth genetics. Reducing the length of your calving season results in a higher average weaning weight and a more uniform group of calves, which are more attractive to the cattle feeder. The newly released Illinois Beef Performance Testing Program will analyze the calving season data for you, which can show the areas that could be improved.

MAINTAIN A UNIFORM MODERATE CROSSBRED COW HERD

Over the past 20 years, there has been a great deal of discussion about cow size. From an economic efficiency standpoint, we need the smallest cow that will produce calves that will fit "the box". If we can assume that the preferred carcass weights are in the 600-800 pound range, that implies a live weight of 1,000 to 1,300 pounds when they reach the Choice Grade.

If calves are placed on feed at weaning and fed to finish at 14 to 16 months, cows should be in the 4-6 frame score range. The Illinois commercial cow-calf industry does not have a place for a commercial cow in excess of a frame score 6.

If feeder cattle are to be backgrounded, or grown on lower energy feeds after weaning and prior to the finishing phase, the frame score range should be reduced by one frame score. Therefore, the ideal frame score cows for this scenario would be 3 to 5. The important point to remember is that we want uniformity, and you do not find uniformity by selecting replacements from the extremes.

Everyone knows that hybrid vigor results in an increased growth rate from crossing different breeds. However, using a crossbred cow results in an increase in reproductive performance that is economically more important. As I visit the commercial cow herds of Illinois, I see entirely too many purebred cows.

MARKETING THE PRODUCT

Every year at weaning time it is necessary to take a look at the marketing options. If your lender is willing, retained ownership should always be considered an option. Each year it is important to run projections to determine if you should sell the calves at weaning, background the calves before selling to the feeders, or retain ownership all the way to slaughter. Although the last 2 years have not been good years for retained ownership, it has to be considered every year. If you have invested in growth genetics, it is even more critical, since the cattle feeder will realize more benefit from your investment than you will.

When considering retained ownership, remember that cattle feeding is a very specialized and competitive business. If you do not have the knowledge or experience in feeding cattle you might want to consider placing them in a custom feedlot. We have several excellent custom cattle feeders in Illinois.

Another marketing area to be considered is the cull cows. Traditionally, the recommendation has been to pregnancy check the cows at weaning and cull all open cows. In spring calving cow herds, the result is that you are selling your cull cows in the fall when cow prices are the lowest. One idea to consider is to keep the thin open cows and give them extra feed which results in relatively cheap gain. Then sell the cows in March when cows are most valuable.

SUMMARY

Improving cow-calf profits will result from weaning a high-percentage calf crop while reducing costs. Feed costs make up about 50% of total costs and there is tremendous opportunity for improvement in that area. Reducing mechanical harvesting and utilizing corn stalks and corn stover will greatly reduce feed costs. The purebred and commercial cow-calf industries must work together to produce uniform and predictable genetics.

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INTENSIVE ROTATIONAL GRAZING
A Study of Local Farms

By Tom Saxe/Area Livestock Adviser

Improved grazing management may be an input whose time has come since low input sustainable agriculture (long practiced by successful farmers) seems to be the current catch phrase of politicians and educators.

Intensive Grazing Management (IGM) is a process of planned rotational grazing which affords maximum satisfaction to the requirements of both forage and animal. IGM is implemented by a short grazing period (e.g., 3 days) followed by a longer rest period (e.g., 30 days) on a given area of pasture. It utilizes a large number of paddocks (e.g., a pasture divided into 11 smaller units) so the animal has access to grazeable forage at all times during the grazing season. This grazing concept maximizes the quantity of forage harvested by reducing trampling losses. This improves beef production efficiency by spreading fixed costs over more pounds of production.

In late 1987, University of Illinois Extension employees Jim Kaiser, Tom Saxe, Jim Ahrenholz, Bob Frank, and Mike Plumer designed a three year project to investigate and demonstrate IGM technology. A project proposal was written and program support was solicited. Co-sponsors providing multi-year cash grants were: Illinois Beef Council; Illinois Forage and Grassland Council; and Egyptian Livestock Association. Supporting sponsors supplying animal health products, fencing materials and other beef related supplies were: IMC/Ralgro; MSD/AgVet; American Cyanamid; Syntex Corporation; and Gallagher Power Fencing.

PROJECT OBJECTIVES

A broad ranging list of objectives was formulated by the committee.

1. to demonstrate advantages of IGM
2. to teach the concepts involved in IGM
3. to teach producers and educators the agronomic and animal husbandry technology to enhance a successful IGM experience
4. to measure and document results of IGM demonstrations
5. to develop, duplicate and distribute IGM management guidelines
6. to conduct IGM field days and seminars for producer orientation
7. to develop cow path soil erosion control methodology through IGM practices

DEMONSTRATION COOPERATORS

Seven cooperator farmers initiated demonstrations in 1988. Four utilized stocker animals. They were Curt & Bruce Dean at Ava, Lester Saxe at Thompsonville, Keith Glasco at Cobden, and Ed Billingsley from Goreville. Three cow/calf demonstrations were conducted by Joe Hayes at Marion, Walter Bollmann at Ava, and Carl Woods from Anna.

New cooperators for 1989 were: Warren Dannehold at Waterloo, Ernie Duckworth at Benton, Duane Smith at Allendale, David & Edgar Bremer at Metropolis, David and Clarence Allbritton at Belknap, and John Rueter from St. Libory.

Cooperators conducting demonstrations for the first time in 1990 were: Greg Wells at Annapolis, Larry Ruhl at Fairfield, John Woodcock at Valmeyer, and Keith Ellis from Dongola.

COOPERATOR TESTIMONIALS

These general observations have been made by IGM cooperators and academia involved with the Illinois IGM project:

- thrifty, but thin fleshed cattle gain better
- stocker cattle offer the potential for more gain and profit per acre than do cow/calf
- IGM requires closer observation of cattle which minimizes problems
- higher stocking rates are possible with IGM
- increased stocking rate reduces individual animal performances, but to a point increases pounds of beef per acre
- pregnancy rates were increased
- cost per pound of production is lowered
- better distribution of recycled soil nutrients
- cattle adapt readily to electric fence and the system of rotation from paddock to paddock
- IGM helps control weeds
- land is utilized more efficiently and effectively
- IGM is better management for maintaining legumes in pasture
- land use is intensified, thereby optimizing resources
- provides better nutrition for animals
- cost to establish paddock divisions is minimal
- single strand electric fence is adequate
- cow path erosion is easier to control
- square shaped paddocks reduce animal trampling of forages

ANIMAL PERFORMANCE

Animal Performance parameters are summarized in a written and tabular form that follows. Further information regarding economic and forage analysis can be obtained by contacting Dr. Jim Ahrenholz (618/439-7263) or Dr. Jim Kaiser (217/333-4424) respectively.

'88 IGM
ANIMAL PERFORMANCE SUMMARIES

The **ED BILLINGSLEY** demonstration produced 204 lbs. of beef per acre for 35 days. There is no reason it could not have continued to support that level of performance for another month. The project was terminated because of market considerations. Average Daily Gain at 1.34 lbs. was suppressed due to a high stocking rate, but the 5.8 lbs. of adjusted beef/acre/day was tops amongst stocker demonstrations.

DEAN FARM had the highest yield of beef attributed to grazed forage at 768 lbs. of adjusted beef per acre. Their 101 head of stocker heifers was the largest demonstration in terms of animal numbers and total production of 17,361 lbs. of beef gain. They were tops amongst the stocker demonstrations with 258 adjusted Animal Unit Days supported/acre.

SAXE FARM dramatized the value and/or lack of value of fescue pasture. Their 7.25 inches of rainfall was lowest for demonstrations with 100 or more grazing days. They were drouthed out of their legume:grass mixed project pasture for 31 days from June 25 to July 26 during which time project heifers grazed a fescue backup pasture and lost .04 lbs. per head per day. When the project was terminated September 17, heifers were placed on the same backup fescue pastures and gained 1.54 lbs. per head per day for 57 days. The legume: grass demonstration pasture supported 1.86 lbs. average daily gain during the 107 days on test.

TRIPE G RANCH had an interesting demonstration in that it always appeared there wasn't anything for the cattle to eat, and yet their stocker bull gain was tops at 1.91 lbs per head per day. On close examination of the pasture there was low growing, leafy, vegetative and obviously high quality smooth bromegrass and summer annual grasses in the paddocks providing adequate nutrition for this very acceptable level of performance, albeit at the very low stocking rate of 1 Animal Unit per acre per day.

BOLLMANN FARM grazed first parturition cow/calf pairs. They achieved their goal of improving breeding efficiency of first calf heifers. Their 92% pregnant rate following the intensively grazed alfalfa in 1988 compares to 60% in 1986 and 54% in 1987 under their conventional continuous grazing on mostly grass with some legume pastures.

Adjusted 205 day weaning weights also favored the intensive grazing management by 100 pounds per calf.

JOE HAYES had the longest grazing season with 180 days. He fed considerable supplemental feed, but his 635 pounds of adjusted beef gain per acre was highest of the cow/calf demonstrations. Adjusted beef is gain produced by grazed forage with gain supported by supplemental feed mathematically removed. Similarly, this demonstration supported 426 adjusted Animal Unit Days per acre, tops amongst all demonstrations, indicating the value of a longer grazing season.

CARL WOODS' demonstration was short duration due to drouth and the cool season growth habit of fescue. However, his 94% pregnant rate was tops amongst cow/calf demonstrations and his 3.2 lbs. of adjusted beef per acre per day was a very acceptable level of performance. Additionally, the 1.26 lbs. ADG on yearling replacement heifers being bred for the first time is considered a very good rate of growth and development.

'89 IGM
ANIMAL PERFORMANCE SUMMARIES

The 41 acre **BILLINGSLEY** demonstration was largest in terms of acreage. This cow/calf program measured production from stock-piled Fescue:Lespedeza from September 18 through December 24. It yielded a low of 260 pounds of adjusted beef per acre. But, during the short 96 day fall grazing season produced a very respectable 2.7 pounds of adjusted beef per acre per day.

BREMER BROTHERS had a mixture of winter born cow/calf pairs and yearling stockers. They effectively reduced stocking rate by removal of the cows at mid season. This demonstration started earliest on April 6. An early start is one key to increasing pounds of beef per acre as well as keeping growth of cool season grasses under control. Early season animal performance was good but tailed off the last half, e.g. yearling steers gained 1.4 from April 6 to July 6, then slipped to .99 pounds per head per day from July 6 to October 10.

The **BOLLMANN** demonstration was basically cow/calf. Animal performance increased over the preceding year whereas most repeat cooperators realized reduced individual gains. Adjusted beef per acre was up 189 pounds. Cows gained .67 pounds per day faster. Calves ADG was .11 greater in '89 as compared to '88. And, pinkeye was not a problem this season. The latter observation may have contributed to the greater gains. The alleviation of the pinkeye problem was felt to be due to eliminating barn access where ammonia buildup irritated eyes in '88. Bollmann's 637 pounds of adjusted beef per acre was highest amongst cow/calf demonstrations.

DEAN FARM was a second year cooperator whose 653 pounds of adjusted beef per acre with stocker heifers was good but below the 768 recorded in 1988. ADG was also reduced .24 pounds from '88. Dean's project was apparently hampered by wild animals which stampeded the cattle on several occasions presenting management problems of regrouping cattle and reconstruction of fences.

WARREN DANNEHOLD had a 111 day grazing season. The new o-till seeding of alfalfa was beleaguered by alfalfa weevils and weed pressure. Dannehold's fleshy 648 pound stockers only gained 1.13 pounds per day but still produced a very respectable 503 pounds of adjusted beef per acre. Plans are to start earlier in 1990.

The **DUCKWORTH** demonstration shows excellent results during the first half of the grazing season. A new seeding, dry weather and drouthy soils took their toil in the last half of the summer. Duckworth was the only cooperator who exercised daily rotation and demonstrated that the animals could harvest almost 100% of the forage produced. Utilization to this extent reduced animal performance and indicated the need to reduce stocking rate and/or offer additional supplemental feed during periods of drouth.

JOHN RUETER demonstrated a sequential grazing concept in addition to Intensive Grazing Management. He rotationally grazed Fescue:Ladino from April 16 to June 12. He sequentially moved to Sudax:Alfalfa from June 12 to September 28. Then he sequentially moved back to the Fescue:Ladino from September 28 to November 10. The respective ADG's for the three periods (Spring, Summer, Fall) were 2.02, 1.23 and 1.65 lbs. The sum of the Fescue:Ladino yielded 495 pounds of beef per acre with 100 days of grazing. The mid season 108 days on Alfalfa:Sudax produced 640 pounds of gain per acre. The cattle showed a taste preference for Sudax as indicated by grazing habit.

SAXE FARM was a second year cooperator. Their adjusted beef per acre increased form 306 in 1988 to 719 pounds in 1989. This occurred as a result of 14.8 inches of rainfall in '89 compared to 7.25 inches in '88. Saxe Farm effectively reduces stocking rate per acre during the dry part of the summer by enlarging paddock size by about 100%. The paddocks are simply extended onto areas of the pasture where hay was harvested earlier in the season. The harvested hay accounted for 306 pound of the adjusted beef per acre equivalent.

SUGARTREE RANCH was tops this year with 959 pounds of adjusted beef produced per acre. The 16 acre demonstration carried 101 stockers during 131 days of grazing. Rainfall totaled 23.9 inches during the season with 8.1 and 5.9 respectively coming in the critical July and August periods. This enhanced forage production which garnered 7.3 pounds of adjusted beef per acre per day. Average daily gain was 1.29 pounds on steers averaging 508 pounds.

The **CARL WOODS** project improved over last year. It supported 122 days of grazing in 1989 compared to 73 in 1988. Increased carrying capacity was due mostly to an overseeding of Lespedeza into the Fescue pasture. Adjusted beef per acre was higher by 131 pounds at a respectable 398 pounds per acre for the cow/calf demonstration. Individual animal performance was lower this year as it was for most second year demonstrations. But, Woods' 463 adjusted Animal Unit Days per acre was tops amongst all 1989 cooperators.

'90 IGM
ANIMAL PERFORMANCE SUMMARIES

The **ALLBRITTEN** farm grazed a sudan:sorghum grass hybrid for 70 days. They started with 181 stockers on the 23.1 acre demonstration beginning July 17. After 16 days stocking level was reduced to 70 head with 21 added back on day 31. This demonstration illustrated the need of adjusting stocking rate and the flexible management necessary for IGM. It had the highest ADG for stockers at 2.02 pounds but was grain supplemented at 3 pounds per head per day for the first 16 days. Their 591 pounds of beef per acre attributed to grazed forage is excellent considering an additional potential gain per acre of 460 pounds was in the form of wheatlage harvested in May.

The three year **BILLINGSLEY** project has produced more beef per acre each year corresponding to an increasing number of grazing days. The pasture quality has also increased by incorporation of legumes. It produced 390 pounds of beef per acre and supported the second most adjusted animal unit days per acre (378), which is a very important parameter amongst cow/calf production systems. Cow ADG at .56 was highest of the '90 demonstrations.

BOLLMANN'S were a third year cooperator with 17 stocker steers on 7.4 acres of a thinning alfalfa hay field. Their previous IGM experience was with cow/calf. ADG was 1.71 pounds. They put on 244 pounds of gain per steer and yielded 561 pounds of beef per acre in a 143 day grazing season. Stocking rate was conservative at 2.3 head per acre for the whole season.

Second year cooperators, the **BREMER'S** again used a combination of cow/calf and stocker animals. They reduced stocking rate at mid summer by removing the cows nursing fall calves. Seasonal variation has a big effect on results. With fewer animals Bremers experienced lower animal performance and a lower yield of adjusted beef per acre, 229 pounds in 1990 vs. 598 during 1989.

WARREN DANNEHOLD was a second year cooperator with only slightly variable 1989 and 1990 results. ADG on stockers was up .2 pound probably because of lower condition on the cattle at the beginning of the project. Pounds of adjusted beef per acre (477 in 1990) was 26 pounds below 1989 in spite of a 42 day longer grazing season.

The **ERNIE DUCKWORTH** demonstration had the second longest grazing season at 208 days utilizing a sequential:intensive management concept. His pasture resource was fescue:clover:alfalfa:orchardgrass in varying percentages on different locations in the pasture cell. Duckworth rotated to fresh forage daily. He showed better individual animal performance in 1990 as compared to 1989 and produced slightly more animal gain per acre at 332 pounds.

KEITH ELLIS was a young man with an FFA & 4-H beef project. His 3.7 acre demonstration on fescue with grain supplementation produced 701 lbs. of beef per acre with 570 pounds attributed to grazed forage.

The **JOHN RUETER** demonstration continued with a sequential grazing concept in addition to the intensive grazing management. He utilized a fescue:clover pasture beginning March 30; then sequentially moved to Sudax on July 13; back to fescue:clover from October 2 to November 2 to average daily gains of 1.3, .72, and 2.1 respectfully for the three time segments with 1.24 overall. Adjusted gain per acre was 479 pounds.

Drouth in Wayne County shortened **LARRY RUHL'S** number of grazing days. Five yearling heifers gained a very acceptable 1.58 pounds per day. Ruhl produced 170 pounds of beef per acre in his 84 day demonstration. It was fescue and bromegrass.

SAXE FARM had a shortened grazing season due to wet soil conditions in the spring. Cattle had to be removed from the demonstration pasture 17 of the first 60 days. This thwarts the grazing cycle thus allowing for more growth and maturity of forage, much of which is tramped into the mud by the grazing animal. It also reduced yield of beef per acre to 480 pounds for 1990, compared to 719 adjusted beef equivalent in 1989. ADG was the lowest for the three year demonstration at 1.28 pounds.

SUGARTREE RANCH'S beef production and performance level was reduced compared to 1989. Shipping fever required much treatment and reduced animal gain. ADG was .97 pounds, but beef per acre was still a respectable 569 pounds for the 166 day demonstration.

GREG WELLS had two separate demonstrations as a first year cooperator. His unique projects were on Bermuda Grass pasture. Both topped the 1990 results with 845 and 705 pounds of beef per acre attributed to grazed forage. ADG on his 117 and 76 head of stocker steers was 1.2 and 1.58 pounds respectively. The Wells:Weber project supported a whopping 411 adjusted animal unit days per acre for 137 days. This is the equivalent of 6 head of five hundred pound stocker animals.

The longest demonstration was **JOHN WOODCOCKS** cow/calf on fescue. Efforts are being made to incorporate legumes in the stand. The 228 day project yielded 428 pounds of adjusted beef per acre and supported 366 adjusted animal unit days per acre.

CARL WOODS has had a demonstration each of the three years of the IGM project. His number of days has increased each year. This is due to starting earlier and establishing some legume in the fescue. The Woods' soil resource is very drought susceptible, but did yield 333 pounds of beef per acre in 1990 with his cow/calf project.

1988 IGM Cattle Performance

Cooperator	Acres	Days	No. Head	ADG	Adj. Beef/Acre
Billingsley	7.7	35	38 steers	1.34	204
Bollmann	6.9	119	12 cows	.11	448
			12 calves	1.94	
			1 bull	1.62	
			1 dry cow	1.77	
Dean	15.0	145	101 stockers	1.47	768
Hayes	8.5	180	15 cows	.30	635
			15 calves	2.34	
Saxe	16.9	107	25 heifers	1.86	306
Triple G	15.0	115	23 bulls	1.91	309
Woods	7.0	73	11 cows	-.22	267
			11 calves	1.75	
			1 bull	-1.37	
			5 heifers	1.26	

1989 IGM Cattle Performance

Cooperator	Acres	Days	No. Head	ADG	Adj. Beef/Acre
Billingsley	41.0	96	68 cows	.73	260
			62 calves	1.37	
			3 heifers	1.20	
Bollmann	6.9	164	10 cows w/calf	.78	637
			10 calves	1.74	
			1 bull	1.94	
			2 cows	2.05	
			1 steer	1.97	
Bremer	21.0	187	19 cows w/calf	.49	598
			19 calves	2.10	
			30 steers	1.17	
			12 heifers	.96	
			15 calves	.98	
Dannehold	3.5	111	16 stockers	1.13	503
Dean	15.0	136	90 stockers	1.23	653
Duckworth	8.0	161	12 cows	.06	324
			12 calves	1.45	
			1 bull	-.92	
Rueter	14.2	208	34 stockers	1.54	626
Saxe	12.0	152	30 stockers	1.37	719
Sugartree	16.0	131	101 stockers	1.29	959
Woods	7	122	14 cows w/calves	-.51	398
			14 calves	1.37	
			4 cows w/o calves	.92	
			1 bull	-.56	
			2 stockers	.92	

1990 IGM Cattle Performance

Cooperator	Acres	Days	No. Head	ADG	Adj. Beef/Acre
Allbritten	23.1	70	181 stockers	2.02	591
Billingsley	41.0	191	65 cows	.56	390
			8 heifers	.63	
			59 calves	1.36	
			1 bull	-.57	
Bollmann	7.4	143	17 steers	1.71	561
Bremer	31.0	163	16 cows	-.14	229
			16 calves	1.44	
			34 stockers	.79	
Dannehold	6.1	153	18 stockers	1.33	477
Duckworth	20.5	219	26 calves	1.85	332
			17 cows	.31	
			1 bull	.73	
Ellis	3.7	161	1 cow	1.18	570
			1 calf		
			13 stockers		
Rueter	18.2	208	38 stockers	1.24	479
Ruhl	24	84	43 cows	-.20	170
			32 calves	1.39	
			5 yrlgs.	1.58	
Saxe	12.0	163	42 stockers	1.28	480
Sugartree	16	166	155 stockers	.97	569
Wells:Gulf	23.3	126	76 steers	1.58	705
Wells:Weber	23.1	137	117 steers	1.20	845
Woodcock	10.0	228	14 cows	.27	428
			14 calves	2.30	
			5 yrlgs.	.66	
Woods	16	196	18 cows	-.31	333
			18 calves	1.87	

STRATEGIES FOR INCREASED GRAZING OF COWS

Dan B. Faulkner

Several record keeping systems have shown that the high profit beef producers graze cattle for more days and feed less harvested feed than other producers. This is the primary factor influencing their profitability since over 40% of annual cow costs are feed costs. Feeding less harvested feed also reduces machinery and energy costs for the producer.

The first step in developing a grazing program for a cow herd is to evaluate the quantity and quality of forage available throughout the year on a given farm. Cow numbers should be matched to the low point of forage production in an average year. Excess forage at other times of the year can be harvested and used for supplemental feed in a dry year and/or for winter feed.

Most farms should have some area that contains only a sod forming grass (fescue, brome, etc) for early spring, fall and winter grazing. These pastures should usually be split into a least 3 pastures to allow some rotation. They will provide a clean dry area to winter and calve the cows. this area should generally be from 30 to 60% of the total pasture area. The exact area needed will depend upon the length of time cows can graze corn stalks and the availability of summer pasture. If more spring grass is desired for grazing or harvest 100 lb of N will about double production (see "Grazing Calves on Birdsfoot Trefoil-Tall Fescue, Tall Fescue and Tall Fescue Fertilized with Nitrogen" in this publication).

One method to increase the grazing season on these pastures is to fertilize them with nitrogen (N) in August to stimulate fall growth. Morrow et al (1988) found an increase of 60 winter grazing days per acre with 40 lbs on N in midsummer and 99 days with 80 lbs of N on fescue. This represents a substantial increase in the length of the grazing season. This study was conducted in northern Missouri and should apply to much of Illinois.

Summer grazing can be done with grass-legume combinations or potentially with warm season grasses. Grass-legume combinations have the advantage of lower cost establishment, easier establishment, no nitrogen fertilization and higher quality. The grass-legume pastures need to be rotated to maintain the legumes in the pasture. At least 6 divisions are needed to ensure legume maintenance. These pastures can be hayed in the spring while the cattle are on the sod forming grass pastures and part of them hayed a second time to establish the rotation. The rest period is critical for legume sustainability. We found that cattle can graze up to 6 days at a time on a grass-legume pasture and not reduce legume sustainability as long as the pastures were then rested for 30 days (see "Cattle Performance as Influenced by Grazing Management Systems" in this publication). More than 6 pasture would allow the flexibility of skipping a pasture and harvesting excess forage if the rest period is going to exceed 30 days. The cattle should be rotated out of the pasture when the forage height is about 3 inches or animal performance will be reduced. The grass pastures and hay can be used as a buffer if forage quantity becomes limiting.

Corn stalk grazing is another excellent method of increasing the grazing season. Generally, grazed corn residues are good energy sources, but they may be slightly deficient in protein (Russell, 1990). Therefore, if cows are thin it is recommended that they be supplemented with protein while grazing cornstalks. Decreasing the stocking rate from .5 to 2 ac./cow/mo. increased gain from 10.1 to 71.3 lbs over 56 days (Russell, 1990). If cornstalk acreage is limited to .5 ac./cow/mo., then strip grazing to allow a new area ever 2 weeks increased gain from 20 to 40 lbs over 56 days (Russell, 1990). The best strategy for grazing cornstalks is dependent upon the availability of cornstalks and condition of the cows.

Developing a forage program that maximizes grazing takes some thought and planning. Once the program is developed it is important to match the calving season to the quality of forage throughout the year. The cows should calve and be bred when forage quality is highest. Two good methods of increasing the grazing season for Illinois cattle are grazing cornstalks and grazing stockpiled cool season grasses. Both of these practices require some management to get optimum cow performance.

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LOW COST ESTABLISHMENT OF SPRING SEEDED ALFALFA
A PRELIMINARY REPORT

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INTRODUCTION

Alfalfa is commonly seeded with a companion crop. Spring oats has been used most often in Northern Illinois and Winter Wheat in Southern Illinois. Alfalfa plant populations after harvesting the companion crops for grain have often been disappointingly small, and occasionally a complete failure to establish any alfalfa plants. Seeding alfalfa without a companion crop became possible with the introduction of selective herbicides in the 1950's which would reduce broadleaved or grass populations with little or not damage to alfalfa seedlings. Herbicides in addition to those developed in the 1950's have been released.

Companion crops have been used to establish alfalfa to control weeds, reduce soil erosion during the establishment period, and to provide additional income as cash grain or harvested forage during the seeding year. Companion crops harvested for forage at the early heading stage has resulted in greater populations of alfalfa plants than when the companion crops have been harvested for grain.

The use of methods where alfalfa is seeded without a companion crop has slowly increased since the late 1950's. Some estimates have been made to indicate that about 20% of spring seeded alfalfa in Illinois is seeded without a companion crop. The no-companion crop method of seeding alfalfa, utilizing herbicides, is considered by most research people at universities and private research institutes to be more sure of establishing a highly productive stand of alfalfa than the companion crop method.

The seeding rate of spring oats for use as a companion crop is suggested to be 1.5 bushel/acre, about 1 bushel/acre less than for grain production. There has been no recent research to verify this rate with the shorter, lodging resistant varieties of spring oats or winter wheat. The suggested seeding rate for winter wheat has been 1.5 bushel/acre, the same as for grain production. Winter wheat seeded in the spring does not head out, remains vegetative, provides a lush growth that provides excellent weed control, which may also limit the establishment of alfalfa.

PROCEDURES

Alfalfa was seeded at 3 locations in Illinois during April of 1988, 1989 and 1990. The locations were at Monmouth (Northwestern Illinois), Perry (Westcentral Illinois) and Urbana (Eastcentral Illinois). The seedings were made on clean, prepared seedbeds with a seeder having a corrugated roller and press wheels. Alfalfa was seeded at 18 pounds/acre for all comparisons. Sixteen comparisons (treatments) were included. Spring oats and winter wheat were seeded at 1, 2, and 3 bushel/a. Three preemergence herbicides were used: Eptam @ 3 lb. a.i./a; Balan @ 1.5 lb. a.i./a; and Treflan @ 1.3 lb. a.i./a. Three post-emergence broadleaved weed herbicides were used: 2,4-DB @ 1 lb.

a.i./a; Buctril @ 0.5 lb. a.i./a; and Basagran @ 0.75 lb. a.i./a. Each of these broadleave herbicides were also combined individually with a post emergence grass inhibiting herbicide, Poast @ 0.19 lb. a.i./a. The sixteenth treatment was the "check" which received no herbicides nor companion crop.

The trials were harvested during the seeding year at 65-70 days following seeding (oats were 50%-100% headed) and at 30-35 day intervals until September 1. Harvests were made or are planned to be made for 3 harvest seasons after the seeding year. The harvest schedule during full production years was planned to have the first harvest about May 25 and subsequent harvests at 32-35 day intervals, concluding about September 10.

RESULTS

Good stands of all species were obtained at all locations and all years. Weeds were variable within locations and between locations. Weed population notes were taken, but will not be reported here. The "check" treatment had the highest population of weeds at the first harvest after seeding. The "full production year" combined yields of the 3 locations during 1989 and 90, the cost to establish, and the cost per ton of harvested crop projected over a 3 year production cycle are shown in the following table.

YIELD AND COSTS OF DIFFERENT METHODS OF SPRING SEEDING ALFALFA OVER 3 LOCATIONS IN ILLINOIS - MONMOUTH, PERRY AND URBANA, 1989-90

Alfalfa and other Species or Herbicides	Tons Dry Matter/Acre/Yr	Cost/Acre to Establish	Establishment Cost/Ton of 3 Yrs. Production
Oats @ 1 bu.	5.42	$ 116	$ 7.13
Oats @ 2 bu.	5.57	$ 119	$ 7.12
Oats @ 3 bu.	5.53	$ 122	$ 7.36
W. Wheat @ 1 bu.	5.94	$ 118	$ 7.03
W. Wheat @ 2 bu.	5.47	$ 123	$ 7.50
W. Wheat @ 3 bu.	5.55	$ 128	$ 7.69
Eptam @ 3 lb.	5.75	$ 126.25	$ 7.31
Balan @ 1.5 lb.	5.56	$ 126.25	$ 7.57
Treflan @ 1.3 lb.	5.41	$ 119.25	$ 7.35
2,4-DB @ 1 lb.	5.50	$ 124.25	$ 7.52
Buctril @ 0.5 lb.	5.49	$ 122.25	$ 7.42
Basagran @ 0.75 lb.	5.48	$ 122.25	$ 7.43
2-4-DB+Poast @ 0.19 lb.	5.50	$ 136.25	$ 8.26

Buctril+Poast @ 0.19 lb.	5.76	$ 132.25	$ 7.65
Basagran+Poast @ 0.19 lb.	5.47	$ 132.25	$ 8.07
"Check"	5.41	$ 113	$ 6.96
Average	5.55	$ 123.77	$ 7.46

The highest yielding method of spring seeding alfalfa over these three locations appears to be winter wheat seeded in the spring at 1 bushel per acre. This method had the 2nd lowest "establishment cost" per ton of 3 year's production. The lowest "establishment cost" method appears to be the "check". Two bushel of oat seeding rate appeared to result in larger alfalfa yields than either 1 or 3 bushel of oats seeding rate. Alfalfa seeded with spring oats tended to be lower yielding than when seeded with winter wheat. Eptam and Balan methods of weed control at seeding appeared to result in greater alfalfa yields than did the Treflan method. The post emergence weed control methods for establishing alfalfa tended to be lower yielding than preemergence weed control methods or companion crop methods, except for Buctril+Poast, which had the 2nd highest yield, but one of the higher establishment costs per ton of production.

SUMMARY

The seeding of alfalfa alone in the spring without companion crop or herbicide in the northern half of Illinois can be a successful method of establishment, and at low cost. The crop (weedy in most cases) needs to be harvested at 65-70 days after seeding and at 32-35 day intervals during the establishment year. This method of seeding alfalfa is acceptable if a weedy first crop can be used. Weeds are normally most prevalent in the first harvest after seeding. The weed composition of alfalfa established by the different methods studied here was similar with all establishment methods after the first harvest following seeding.

Winter wheat at 1 bushel per acre appears to be a suitable method to establish high yielding alfalfa, quite weed free at first harvest but containing a high percentage of lush, vegetative wheat, and at a low establishment cost per ton of production. Eptam, a preemergence herbicide, appears to enable establishment of higher yielding alfalfa than Balan or Treflan and at lower cost per ton of alfalfa produced. The post emergence herbicide methods of establishing alfalfa resulted in lower yields and higher costs than most other methods, except the Buctril+Poast method which had a high yield of alfalfa but also a high cost per ton of alfalfa production.

FERTILITY REQUIREMENTS FOR PERMANENT PASTURES

C. J. Kaiser, T. R. Peck, and T. D. Saxe[1]

Nutrients taken up by pasture plants, consumed by cattle, and re-cycled back onto the pasture field by fecal and urine excretions can be a major source of nutrients for maintaining pasture land.

Sixteen different elements (C, H, O, N, P, K, Ca, Mg, S, Fe, Mn, Zn, B, Cu, Cl, Mo) have been identified as essential for plant growth. Nitrogen, phosphorus, and potassium (macronutrients) are needed in large amounts. These nutrients cycle into and out of forage-livestock systems in several ways. Nutrients are removed whenever animals are marketed, or a hay crop is removed. Nutrients are also removed by leaching, runoff, and volatilization.

Nutrients are returned to the forage-livestock system by various methods; e.g., the breakdown of organic material, weathering of parent rock, particulate fallout in rainfall, nitrogen additions in thunderstorms, nitrogen assimilation from the atmosphere by legumes, run-off drainage water, and the application of fertilizers. Nutrients are also added to a pasture system by the feeding of mineral supplements, and feeds (hay, silage, or grain) produced elsewhere and fed to livestock while on pasture. Most of the nitrogen and almost all the potassium are excreted through the urine, where phosphorus is excreted almost exclusively in the dung.

Nutrients are recycled within the forage-livestock system. Forage crops are consumed as pasture, hay, or silage. Nutrients in the form of animal manure containing the macronutrients, nitrogen, phosphorus, and potassium are returned to the land. On the average, a mature cow may be expected to defecate approximately 12 times and to urinate 8 times a day. The average daily area covered by defecation per cow is 148 square inches; the average daily area covered by urination per cow is 512 square inches. The total area covered per cow per year by defecation is 0.10 acres; by urination is 0.24 acres. The total land area covered by excretion (feces plus urine) per cow per year is 0.34 acres. This expression assumes no overlap of excreta. This, of course, is not true.

A 1,000 pound beef cow with calf to weaning (8 months) typically produces 60 pounds of manure per day, 88 percent (52.8 lbs) of which is water. The other 12 percent (7.2 lbs) is dry manure which contains 0.42 pounds of nitrogen, 0.27 pounds of phosphorus (P_2O_5) and 0.33 pounds of potassium (K_2O). This is equivalent to 153 pounds of nitrogen, 99 pounds of phosphorus (P_2O_5) and 120 pounds of potassium (K_2O) per year per cow-calf pair. Assuming that 3 acres will provide all the pasture and hay one cow-calf pair will need per year, approximately 51 pounds of nitrogen, 33 pounds of phosphorus (P_2O_5), and 40 pounds of potassium (K_2O) are recycled per acre.

At a stocking rate of 3 acres per cow-calf pair, 3 percent of the land area per year is covered by feces, and 8 percent is covered by urine (assuming no overlap). Approximately 11 percent of the 3-acre per cow-calf pair per year is covered by excreta (assuming no overlap) which is equivalent to 153 lbs of N,

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99 lbs of P_2C_5 and 120 lbs K_2O. In this example, approximately 10 years are needed to cover 100% of the pastured area.

TABLE 1. AVERAGE COMPOSITION (POUNDS N, (P_2O_5), AND (K_2O) OF BEEF CATTLE MANURE (FECES AND URINE) RECYCLED PER COW AND PER ACRE PER YEAR

	Nitrogen	Phosphorus	Potassium
Solid manure per ton (#)	14	4	11
Per pound (dry)	0.06	0.02	0.05
Per cow per day (dry)	0.42	0.12	0.33
Per cow per year (dry)	153	44	120
Per acre per year (dry) ##	51	15	40

Illinois Agronomy Handbook 1991-1992 (p. 58).
Assumed 3 acres per year per cow-calf pair.

TABLE 2. ESTIMATED ANNUAL LIVESTOCK SALES OF A 100-COW HERD (90% CALF CROP) MAINTAINED ON 300 ACRES OF PASTURE AND HAY

Livestock	Sold	Weight Per Head	Total weight
Steers calves	45	500	22500
Heifer calves	35	450	15750
Cull cows	10	1000	10000
Total	90		48250

TABLE 3. ESTIMATED ANNUAL NUTRIENT REMOVAL (#) BY LIVESTOCK OF A 100-COW HERD (90% CALF CROP) MAINTAINED ON 300 ACRES OF PASTURE AND HAY

Removal	Pounds Per Acre	Pounds Per Cow in the Herd	Total
Gain (Table 2)	160.83	483	48250
Nitrogen	4.12	12	1235
Phosphorus (P_2O_5)	1.08	3	324
Sulphur	0.62	3	187
Calcium	0.59	2	176
Potassium (K_2O)	0.27	1	80
Magnesium	0.20	1	60

Values calculated from: C. L. Pearson and R. L. Ison. Agronomy of Grassland Systems. (p. 73)

SOIL TEST GOAL

Buildup: The buildup is the amount of material required to increase the soil to the desired level (Table 4). Minimum soil-test levels required to produce optimum crop yields vary depending on the crop to be grown and the soil type (Illinois Agronomy Handbook, 1991-1992). Because phosphorus, and on most soils also potassium, will not be lost from the soil system other than through crop removal or soil erosion and because these are minimum values required for optimum yields, it is recommended that soil-test levels be built up to 40, 45, and 50 pounds per acre of phosphorus for soils in the high, medium, and low phosphorus-supplying regions of Illinois, respectively. Potassium soil-test level buildup recommendations are 260 and 300 pounds of exchangeable potassium per acre for soils in the low and high cation-exchange capacity regions, respectively.

TABLE 4. DESIRED BUILDUP VALUES (ILLINOIS AGRONOMY HANDBOOK, 1991-1992)

Phosphorus (P_2O_5) #			Potassium (K_2O) ##	
Low	Medium	High	Low	High
40	45	50	260	300

\# Nine (9) pounds of phosphorus (P_2 O_5) per acre is required to change P_1 soil test (1) one pound.

\## Four (4) pounds potassium (K_2 0) per acre is required to change the K test (1) one pound.

Maintenance: The maintenance addition is the amount required to replace the amount that will be removed by the crop to be grown. A 1,000 pound beef cow with calf to weaning (8 months) typically consumes 25 pounds of forage dry matter per day as hay and pasture. The annual consumption of a cow-calf pair is 9,125 pounds (4.56 tons). Total annual production of dry matter needed for a 100 cow herd is 456.25 tons. A forage yield of 1.52 tons per acre is required to maintain 300 cow-calf pairs on 300 acres. Since all hay and pasture produced on this 300 acres is consumed on the same 300 acres by the 100 cow-calf pairs, the removal by livestock sold of phosphorus (P_2O_5) and potassium (K_2O) is 3.60 [1.52 tons produced and consumed times 2.37 (Table 5) pounds per ton removed] and 7.62 [1.52 times 5.01 (Table 5)] pounds per acre, respectively.

TABLE 5. GAINS OR LOSSES (POUNDS) OF PLANT NUTRIENTS (#) PER TON OF FORAGE HARVESTED AS HAY OR GRAZED AS PASTURE

Forage	Nitrogen		Phosphorus (P_2O_5)		Potassium (K_2O)	
	Hay	Pasture	Hay	Pasture	Hay	Pasture
Alfalfa	-3.70	+39.00	-11.14	-2.23	-32.40	-3.24
Red clover	-2.20	+30.36	-9.74	-1.95	-35.28	-3.53
Redtop	-22.50	-5.62	-8.82	-1.67	-37.44	-3.74
Timothy	-23.20	-5.80	-7.89	-1.58	-28.32	-2.83
Average	-12.90	14.49	-9.40	-1.86	-33.36	-3.34
Alfalfa + Grass	-12.90	14.49	-12.00 ##	-2.37 ###	-50.00 ##	-5.01 ###

Illinois Extension Service, Planning the Farm Business
Illinois Agronomy Handbook, 1991-1992
Calculated as a ratio from the alfalfa, red clover, redtop, timothy average

TABLE 6. ESTIMATED ($P_2 0_5$) AND (K_2 0) OF THREE NUTRIENT RECYCLING CALCULATION METHODS, AVERAGE BALANCES PER ACRE, AND AVERAGE PER COW-CALF PAIR

	Calculation	($P_2 0_5$)	(K_2 0)
Animal gain (Table 3)	Method 1	-1.08	-0.27
Hay removed (1.52 tons)	Method 2	-18.25	-76.04
Manure returned (Table 1)	Method 2	+14.60	+40.15
Pasture (Table 5)	Method 3	-3.60	-7.62
Total per acre	Average	-2.78	-14.59
Per cow-calf pair per area grazed	Recommendation	-10	-50

ANNUAL FERTILIZER APPLICATION

An example of how to calculate the phosphorus and potassium fertilizer recommendations for pasture fields follows.

TABLE 7. SOIL-TEST RESULTS AND SOIL REGION, EXAMPLE

Soil-test Results	Soil Region
P_1 12	Low
K 180	Low
pH 5.8	Light-colored silty clay

TABLE 8. ANNUAL PHOSPHORUS (P_2O_5) FERTILIZER BUILDUP AND MAINTENANCE RECOMMENDATION, EXAMPLE

	Goal	Soil Test	Difference	Coefficient	Required
Buildup #	40	12	28	9	252
Maintenance ##					5
Total					257

\# From Table 4
\## See discussion

TABLE 9. ANNUAL POTASSIUM (K_2O) FERTILIZER BUILDUP AND MAINTENANCE RECOMMENDATION, EXAMPLE

	Goal	Soil test	Difference	Coefficient	Required
Buildup #	260	180	80	4	320
Maintenance ##					15
Total					335

\# From Table 4
\## See discussion

TABLE 10. POUNDS OF COMMERCIAL FERTILIZER NEEDED PER ACRE, EXAMPLE

Commercial Fertilizer	Calculated Needs	Product/Pound	Total Product Needed/Acre
0-46-0	257 #	.46	559
0-0-60	335 ##	.60	558

\# From Table 7
\## From Table 8

TABLE 11. TONS OF AGRICULTURAL LIMESTONE NEEDED PER ACRE, EXAMPLE

Limestone Location	Calculated Needs	Correction Factor (4 years)	Coefficient Number	Total Product Needed/Acre
Buncombe Johnson	5	1.39	0.3	2.09

\# Based on zero-tillage system adjustment, Illinois Agronomy Handbook, 1991-1992, page 51.

LIMESTONE NEEDS

Suggested pH goals for grass-legume pastures is a soil test pH of 6.5 to 7.0. Limestone (Calcium) should be applied based on the pH soil test value and the soil class (see the Illinois Agronomy Handbook, 1991-1992). The amount of agricultural limestone needed for soil test example (Table 7) and (Table 11) is 2 tons per acre (see Figure 10.5, Illinois Agronomy Handbook, 1991-1992 and Illinois Voluntary Limestone Program Producers Information - October 1991 Edition).

NITROGEN NEEDS

Soil tests are currently not recommended for determining nitrogen needs on pastures. It is recommended that all perennial grass pastures include a pasture legume as the nitrogen source. Nitrogen should not be applied to grass-legume mixtures when the legume is 30 percent or more of the mixture. Because the objective is to maintain the legume in the mixture, emphasis should be on applying phosphorus, potassium, and calcium to the soil test buildup and maintenance recommendations.

HOW TO SOIL SAMPLE A PASTURE FIELD

A soil tube is the best implement to use for taking a sample. Sample to a depth of 7 inches. Five soil cores taken with a soil tube at each sampling location form one composite sample. The composite sample should be taken from one square rod. One composite sample is suggested from each 2.5 acres. Late summer and fall (before September 30) are the best seasons for collecting soil samples from the field because potassium test results are most reliable during these times. Sampling frozen soil or within two weeks after the soil has thawed should be avoided.

SUMMARY RECOMMENDATIONS

1. Include and maintain a pasture legume in all pasture and hay fields.

2. Take soil tests in the fall annually.

3. Apply limestone, phosphate and potassium fertilizer to buildup recommendations.

4. Apply an additional 10 pounds of phosphate per acre per year for each ton of hay removed on hay lands.

5. Apply an additional 50 pounds of potassium per acre per year for each ton of hay removed on hay lands.

6. Apply an additional 10 pounds of phosphate per acre per year on pasture land used by one cow-calf pair.

7. Apply an additional 50 pounds of potassium per acre per year on pasture land used by one cow-calf pair.

RULE OF THUMB

Apply 10 pounds of phosphate and 50 pounds of potassium per acre per year for each ton of hay removed.

Apply 10 pounds of phosphate and 50 pounds of potassium per cow-calf pair per year on the total pasture acres used per pair.

VISUAL EVALUATION OF PERFORMANCE BEEF BULLS

D. F. Parrett, Extension Specialist, Beef

Expected Progeny Differences (EPD's) have allowed us to evaluate the genetic value of cattle with more accuracy than at any other time in history. By utilizing EPD information a producer can target his production objectives and breed to sires that will predictably and specifically change the important traits in his breeding program. Some producers use extremes for rapid change and others utilize bulls who have a balance of performance traits and try to optimize their animal production instead of changing single traits. Regardless of the goals, EPD's aid a producer in genetically describing the bulls to utilize in their breeding programs.

Once a producer identifies bulls that have acceptable EPD's that meet production objectives, he has to visually evaluate a bull to assess his ability to physically produce cattle with functional appeal. Beef cattle type is largely undefined. A wide variety of types can perform profitably but cattle that have a correct conformation should sire calves with greater demand. Three general areas are most often discussed when evaluating the visual traits of bulls. These are 1) structured soundness, 2) frame size, and 3) muscling and capacity. Of course reproductive soundness is most important and producers should always evaluate testicle size and development and other reproductive characteristics. We also consider characteristics of polled or horned, color and pigmentation, disposition and other traits. However this paper will discuss the previously identified areas of soundness, frame size, and muscling.

STRUCTURAL SOUNDNESS

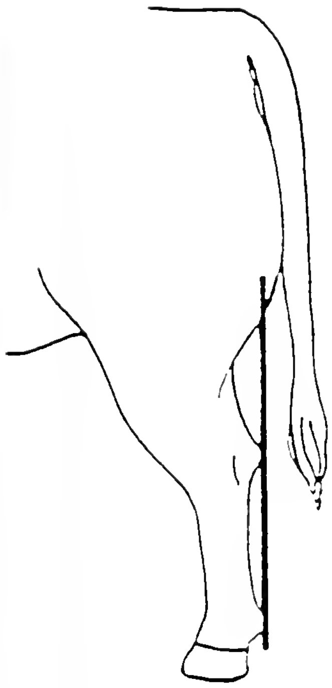
Proper skeletal structure is essential for all livestock. Whether an animal is intended for breeding or for market, it must be able to walk properly. To ensure longevity of breeding stock, animals must be structurally correct and able to walk freely to breed, graze, and reach water under pasture conditions. Structural defects can lead to impaired mobility, pain, and eventually to unsoundness.

Anyone involved in livestock selection must be able to identify correct structure, observe defects, and understand the seriousness of defects. The environment of animals can also play a factor in potential development of structural defects.

A correct beef animal will be sloping in his shoulder, straight and strong in his top, and level from hooks to pins. He will also stand squarely on his feet and legs, is strong in his pasterns, and have flexible movement in his legs.

When viewed from the front, the feet should point forward at the stance and when walking. The rear legs should be equally wide at the hocks and the pasterns, and toe out slightly from the pasterns to the ground. The animal should walk straight forward, flexing its hock rather than rolling at the hock. All joints should be well-defined and show no swelling or puffiness.

Some descriptions of structural defects are shown in figures 1-7 (adapted from "Structural Defects of Beef Cattle," 1988 Anderson and Ritchie and "Rear Leg Soundness of Bulls," R. S. Ott, D.V.M., University of Illinois).



gure 1 - Desirable conformation the rear legs as seen from the de.

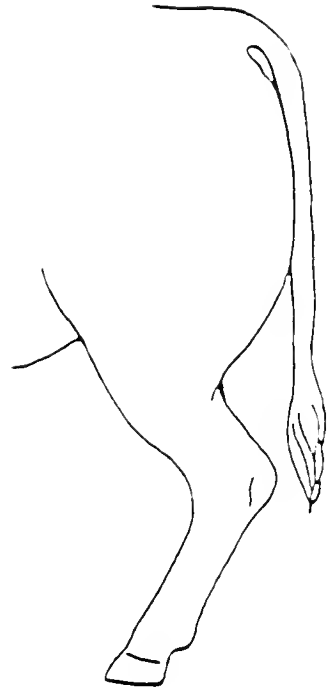


Figure 2 - Sickle-hock conformation.

Figure 3 - Post-leg.

Figure 4 - Camped behind.

Figure 5: Front view of knock-kneed, splay footed heifer

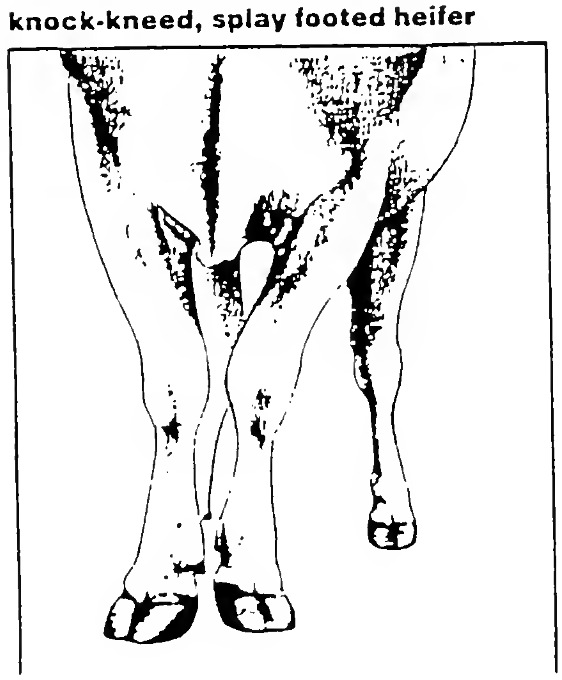


Figure 6: Front view of structurally sound steer

THE RELATIONSHIP BETWEEN STRUCTURE AND MOVEMENT

It is important to understand the relationship between structure and movement and function to evaluate livestock. The justification for selection of structurally correct livestock does not lie in aesthetics, but rather in the fact that correct animals are more able to perform the tasks that are required of them.

Now that you are aware of many structural defects, try to imagine how they will affect movement. Often, many problems will be related. The most serious complex of problems are those that arise from too little angulation of the skeleton. For example, a post-legged animal will usually be too straight in the shoulder and knee, as well as on both fore and rear pasterns. Cattle that are too straight may lift their loins when moving. All species with these problems will move very stiffly.

There are two reasons for this. First, these animals' structures will not allow a long, free stride. When the shoulder is too straight, the foreleg cannot reach far enough forward to take a long step. Neither the hock nor the knee will allow a long reach, and the straight pasterns will not allow a long follow-through. The result: a very short, choppy stride.

Secondly, movement is often painful for animals that are too straight. When the joints are too straight, they must absorb all of the stress of a step down. With proper angulation, stress is spread over bones, joints, tendons, and muscles. In the post-legged animal, stress on the joints can become tremendous. Even flexing joints will become painful, and the animal will take short, choppy strides to avoid flexing the joints any more than it has to. This is especially a problem for breeding males when the must mount a female.

The problem of too-straight structures is quite common in all species. Breeders of most breeds of beef cattle and sheep have placed a great deal of selection emphasis on frame size. Over recent years, many livestock producers have selected breeding stock with less than adequate angulation of the joints because these animals are taller than animals that have correct structure. If these producers would imaging straightening the should, hock, knee, and pasterns of a correct animal, they could easily see how the animal would stand an inch or two taller without any real change of size.

On the flip side, over-angulation of the joints (sickle-hocked, weak pasterns) may result in abnormal stance and hoof growth. However, the problems associated with this defect are seldom as severe as those related to a too-straight structure.

MUSCLING TRAITS

Muscle is a highly heritable trait in beef cattle. If a producer places selection emphasis on muscling, he can visually select for increased muscling and add it to his breeding program fairly rapidly. Emphasis on reproductive performance has resulted in many cattle being average or light muscled. Also, excessive muscling can lead to calving difficulty and decreased fertility in females. Muscling is important, but optimum levels are slightly above average and not excessive.

Many terms have been used to describe muscling. Muscling is not flat or smooth and cattle described with these terms are generally just light muscled. A short, bunchy muscle can lead to restricted movement by the animal.

One should also evaluate the fatness of bulls. Too often fat bulls initially appear thick or heavy muscled. Producers need to be able to tell the differences between fat and muscle.

Body capacity and natural spring of rib and width of body are important with muscling. Desirable bull types stand wide with adequate width of chest, depth and spring of rib, and uniform width from front to rear.

FRAME SCORES FOR CATTLE

In recent years, measurements for height have become a descriptive supplement to many herd testing programs. Adjusted weights and weight ratios accompanied by linear measurements for height have added another dimension to evaluating the fat-lean ratio of an individual animal in performance program.

Linear measurements are objective. They serve as supplemental information for comprehensive performance testing. How much emphasis breeders should place on linear measurement information should depend on their goals relative to shape and growth patterns, the extent to which certain shape relationships may be important to them, and any advantage these shape relationships give them in marketing the beef cattle.

A linear measurement should never be interpreted as a replacement for the weight of an animal at a give age. Instead, linear measurements should be used with growth information as a supplement for selection. No one frame size for an animal will be best for all feed resources, breeding systems, and feed costs. Reproductive efficiency and market weight will determine the optimum frame size range within a given set of feed resources, breeding systems, and production costs.

Frame score is a convenient way of describing the skeletal size of cattle. With adequate height growth curves, most animals should maintain the same frame score throughout their life while their actual height increases with age. This allows the one frame score value to be used regardless of when the animal was evaluated (within the range of available data). Environmental factors can alter the growth rate from an animal's genetic capacity. Nutrition level is a major factor. Cattle fed less than adequate nutrition will grow slower than the tables indicate while cattle fed extremely high levels will grow faster.

The recommended point for linear measurement for height is to a point directly over the hooks.

COW AND CALF PRODUCERS' USE OF FRAME SCORE

Ideally, cow and calf producers use frame scores as a guide to the meat market's preferences in cattle size. However, cow and calf producers also must match cow size to the production environment. the more limited the feed resources available, the smaller the cow must be to produce efficiently each year. Ideally, the frame size of the cow is determined by the production environment, while the frame size of the sire used is determined by market demands of fat cattle. Reproductive efficiency and market weight will determine the optimum frame size range within a given set of feed resources, breeding systems, and production costs.

Purebred breeders who are providing the seedstock for commercial operations should utilize frame scoring as part of a total performance package. The frames size measurements should be taken at weaning time and at yearling time. A linear measure should never be interpreted as a replacement for the weight of an animal.

FEEDLOT USE OF FRAME SCORES

In recent years the U.S. beef industry has shown a preference for 600- to 800-pound carcasses at or near the Choice grade. If this is true, steers with frame scores 1 and 7 are either too small or too large to fit these market requirements. In particular, cattle with frame score 1 are too small and fatten too quickly to fit an efficient beef production system. The extremely large steers yield carcasses and retail cuts too large for current meat market preferences. However, the ever-increasing fast food market and new processing technology could change the current preferences for carcasses lighter than 800 pounds.

The major objective of scoring feeder calves by frame is to allow the feedlot operator to sort incoming calves into pens of cattle that will be similar in their most desirable marketing traits. This helps prevent overfeeding of small-framed cattle or underfeeding of large-framed cattle, which can occur if the varying frame sizes are fed together. Also feeders can alter their feeding programs to market cattle at the most proper fat levels and weights. The small-framed cattle can be "grown" with lower energy diets to heavier weights, while large-framed cattle can be "pushed" with higher energy diets to finish at lighter weights.

SUMMARY

1. No one frame size is optimum for all production environments and market programs.

2. Frame scores or height measurements are objective, descriptive measures to be used with other performance measures.

3. Frame scores should be utilized to produce sizes of cattle that:

   A. Fit the feed resources, calving ease, rebreeding demands, and production costs of a cow or calf enterprise.

   B. Fit the weight and fat level demanded by the marketplace.

4. Frame scores are highly heritable, and breeders can make changes fairly rapidly.

5. Growth rate is best predicted by weaning and yearling EPD's; frame scores can help describe the maturity or fattening pattern of a given animal.

6. The emphasis breeders place on frame scores should depend on their goals relative to shape and growth patterns and any advantages these shape relationships give them in marketing cattle.

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