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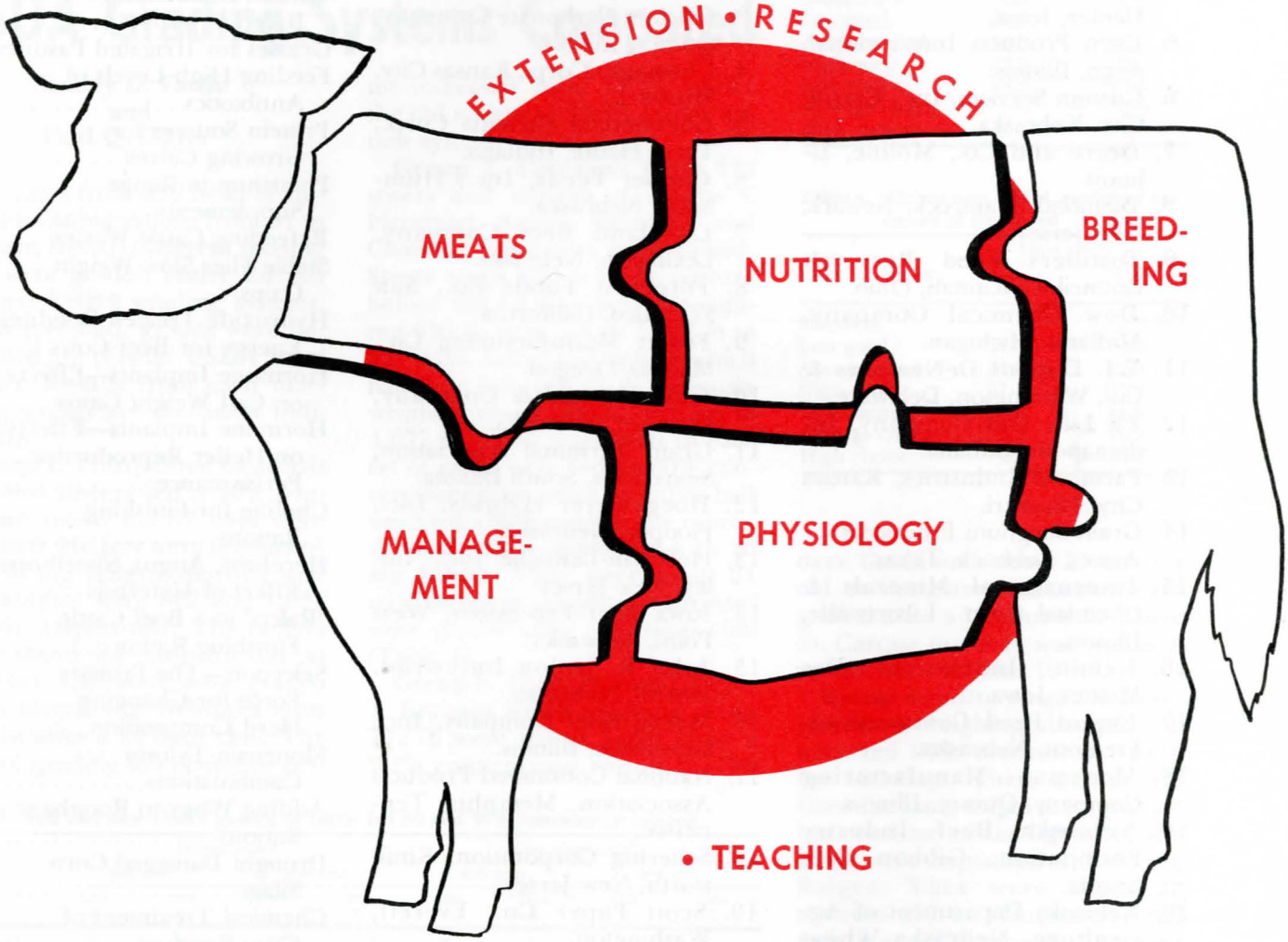
1976 NEBRASKA BEEF CATTLE REPORT



Prepared by the staff in Animal Science and cooperating Departments for use in the Extension and Teaching programs

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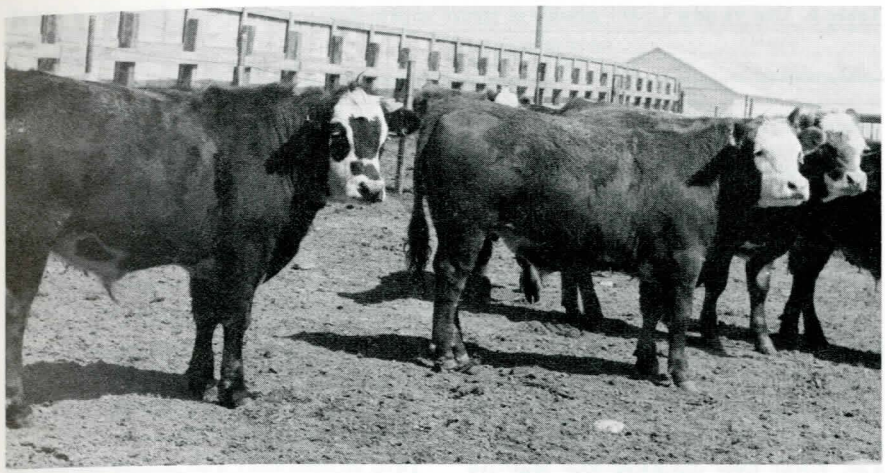


Crossbred steers used in test reported in Table 5.

USDA Grading Systems Compared

Stanley D. Farlin
and
Paul Q. Guyer[1]

Carcasses from 830 head of cattle fed finishing rations from 87 to 134 days, from 6 different feeding tests, were graded under the old and new USDA grading systems. Unless specified, grades were determined by official USDA meat graders. Results from each marketing group are discussed individually.

Group 1. Thirty-three Charolais crossbred heifers fed a 90% concentrate ration for 87 days were evaluated. Heifers were implanted with 36 mg Ralgro. Starting and final weights were 802 and 1,032 pounds, respectively. The heifers were about 24 months old at slaughter. Carcasses were graded by a University of Nebraska meat scientist after a 24 hour chill. The percent grading low choice or better increased from 12.1% under the old system to 33.3% under the new system.

Group 2. Carcasses from 222 steers and heifers of Angus X Hereford, Angus, Hereford and Charolais crossbreds were studied. Steers which had been on pasture before the feeding period weighing 656 lb were fed to 1,002 lb in 131 days. Steers and heifers which had been fed corn silage peviously weighing about 786 lb were fed to 1,077 lb in 117 days. Half of each set of cattle were fed an 80% concentrate ration while the other half were fed a 90% concentrate ration. All cattle were implanted with 36 mg Ralgro. They were about 24 months old at slaughter. Carcasses were graded after a 24 hour chill (Table 1).

Group 3. Three hundred Angus X Brangus steers weighing about 772 lb were fed to 1,020 lb on a 90% concentrate ration in 106 days. Cattle were about 21 months old at slaughter. Carcasses were graded after a 72 hour chill (Table 2). Carcass maturity was typical A except for 4 A$^+$ and 19 A$^-$.

Group 4. Forty Angus X Brangus steers weighing about 625 lb were fed 90% concentrate ration for 100 days. These steers were from the same origin as in group 3 but consisted of the lighter calves. They were implanted with 36 mg Ralgro. They were about 22 months old at slaughter. Final weight was 975 pounds. Carcasses were graded after a 72 hour chill (Table 3). Carcass maturity was typical A except for 4 A$^+$.

Group 5. One hundred fifty-five steers weighing 670 lb were fed to 1,087 lb on a 90% concentrate ration in 134 days. The cattle were

(continued on next page)

Table 1. Old and new USDA grades of cattle fed 80 and 90% concentrate rations.

USDA carcass grade	Pasture steers[a]				Corn silage cattle[b]			
	80% conc.		90% conc.		80% conc.		90% conc.	
	Old %	New %	Old %	New %	Old %	New %	Old %	New %
Standard	0	3.2	6.3	15.6	0	0	0	0
Good$^-$	0	1.6	3.1	1.6	0	0	0	0
Good^0	32.3	27.4	37.5	28.1	31.3	25.0	27.1	20.8
Good$^+$	22.6	3.2	20.3	7.8	22.9	14.6	27.1	12.5
Choice$^-$	32.3	51.6	17.2	31.3	25.0	37.5	22.9	43.8
Choice^0	12.9	12.9	10.9	10.9	10.4	12.5	8.3	8.3
Choice$^+$	0	0	4.7	4.7	8.3	8.3	8.3	6.3
Prime	–	–	–	–	2.1	2.1	6.3	8.4

[a] 656 steers fed to 1,002 lb in 131 days; 62 and 64 animals fed 80% and 90% rations, respectively.
[b] 786 lb steers and heifers fed to 1,077 lb in 117 days; 48 animals fed per ration group.

Table 2. Old vs new USDA grades of carcasses from steers fed 106 days.

USDA carcass grades	USDA grades	
	Old %	New %
Standard	0	0
Low good	1.3	1.3
Average good	1.3	1.3
High good	28.7	20.7
Low choice	42.3	12.7
Average choice	9.3	37.7
High choice	16.0	25.3
Prime	1.0	1.0

Table 3. Old vs new USDA grades of carcasses of steers fed 100 days.

USDA carcass grades	USDA grades	
	Old %	New %
Standard	2.5	12.5
Low good	10.0	0
Average good	40.0	40.0
High good	27.5	22.5
Low choice	12.5	17.5
Average choice	7.5	7.5
High choice	0	0

Table 4. Old vs new USDA grades of carcasses of steers fed 134 days.

USDA carcass grades	USDA grades	
	Old %	New %
Standard	.6	1.9
Low good	12.3	3.9
Average good	31.0	12.9
High good	27.7	25.8
Low choice	20.6	31.6
Average choice	5.2	19.4
High choice	2.6	4.5

Grading Systems

(continued from page 3)

about half Angus X Hereford steers with the rest being Hereford, Charolais crossbreds or Simmental crossbreds. All except 20 head of the steers were fed in confinement pens with about 20-22 ft^2 per head. Cattle were implanted with 30 mg DES. The steers were about 20 months of age at time of slaughter. The carcasses were graded after a 72 hour chill (Table 4). Except for 4 A^- and 29 A^+ carcass maturity was typical A.

Group 6. Grades of carcasses from crossbred steers (64 Hereford X Angus and 16 Angus-Hereford X Charolais) about 17 months of age were compared using both grading systems (Table 5). These steers were fed corn silage growing rations for 112 to 150 days followed by 66 to 114 days on finishing rations. Carcasses averaged 651 lb weight, .29 inch backfat and 50.8 cutability. Carcass maturity was borderline between A^- and A (37 A^- and 43 A).

Table 5. Old vs new USDA grades of steers approximately 17 months old.

USDA carcass grades	Hereford-Angus[a] cross		Hereford-Angus X[a] Charolais cross	
	Old %	New %	Old %	New %
Low good	–	–	–	6.2
Average good	6.2	10.9	12.5	31.2
High good	26.6	17.2	50.0	25.0
Low choice	60.9	64.1	37.5	37.5
Average choice	4.7	7.8	–	–
High choice	1.6	–	–	–

[a] 64 Hereford-Angus crosses and 16 Hereford-Angus-Charolais Crosses.

Summary. Carcasses from 830 head of cattle fed finishing rations from 87 to 134 days were graded under the old and new USDA grading systems. (Table 6). Average final live weights for the six trials ranged from 975 lb to 1,087 pounds. Carcass maturity ranged from borderline between A^- and A to essentially all A.

Beef steers and heifers yielded 13.8% more choice carcasses under the new USDA grading system adopted in 1975 than under the old grading system. Results were variable in the six groups marketed ranging from an increase of only 2.5% to 26%. Nearly 2% of the carcasses dropped to the standard grade and the number of good grades were 15.7% less.

Table 6. Summary of effect of proposed changes in USDA grading standards on beef carcass grade.[a]

USDA carcass grades	USDA grades	
	Old %	New %
Standard	.7	2.4
Low good	3.7	1.8
Average good	19.2	14.7
High good	27.7	18.4
Low choice	32.2	29.3
Average choice	8.0	21.2
High choice	7.7	11.2
Prime	.8	1.0

[a] Includes 6 trials and 830 head of cattle.

[1]Stanley D. Farlin is Associate Professor, Beef Nutrition. Paul Q. Guyer is Extension Beef Specialist.

Short Scrotum Bulls vs Bulls and Steers

M. K. Nielsen,
V. H. Arthaud[1]

Bulls have gained faster and more efficiently (less feed per pound of gain) than steers in studies at Nebraska and other experiment stations. Bulls slaughtered at the same young age as steers yield more lean and less fat but the average quality grade is lower.

Short scrotum animals were studied to determine whether they would possess the fast lean growth of bulls as well as the desirable carcass quality of steers. The short scrotum animal is produced by forcing the testes into the body cavity and applying an elastrator band around the scrotum to retain the testes in the body. This renders the animal sterile due to higher temperature environment for the testes.

The Experiment

Two hundred twenty-four male Angus calves born in 1969, 1970 and 1971 were studied. Calving season was March through early May, and the calves were reared through weaning at the University of Nebraska Dalbey-Halleck farm southeast of Beatrice.

Calves were assigned at random to sex condition (bull, steer and short scrotum) on May 31 each year. Each sex condition group was split randomly into creep (75% corn, 20% oats, 2.5% molasses and 2.5% soybean meal) and non-creep feeding groups on August 1 each year. Average consumption for animals on creep was 142, 154 and 128 lb for 1969, 1970 and 1971, respectively.

All calves were weaned in mid October and transported to Lincoln for feeding. There were about 12 to 13 animals in each sex condition-preweaning management group each year. In the total data, there were 75 bulls, 75 short scrotums and 74 steers.

Calves were started on a ration of brome-alfalfa hay and ground shelled corn. For the calves born in 1969, the concentrate percent of the ration was increased until all calves were on full feed in mid January. The animals were self-fed a complete ration (82% ground corn, 5% chopped hay, 5% corn cobs, 5% molasses plus other ingredients) until slaughter 162 days later.

The 1970 and 1971 bull and short scrotum calves were not fed the same as their contemporary steers. The 1970 bulls and short scrotums were brought onto full feed in mid December and self-fed (69% corn, 20% corn cobs, 5% molasses, 3% soybean meal plus other ingredients) until slaughter 181 days later. The 1970 steers were not brought up to full feed until mid March, then self-fed 141 days the same ration as their contemporaries until slaughter.

The 1971 calves were self-fed the same ration as the 1970 calves after being placed on full feed. The 1971 bulls and short scrotums were on full feed 213 days beginning in early December. The 1971 steers were on full feed 128 days from early March until slaughter.

Growth measures on the cattle

Table 1. Growth measures on bulls, short scrotums and steers.

	Bulls			Short Scrotums			Steers		
	Creep	No creep	Avg.	Creep	No creep	Avg.	Creep	No creep	Avg.
ADG during creep period, lb/day	2.01	1.74	1.87	1.96	1.68	1.83	1.87	1.65	1.76
Adjusted 205 day weight, lb.	478	463	470	474	459	467	465	459	463
ADG full feed, lb/day	2.47	2.56	2.51	2.42	2.47	2.45	2.38	2.18	2.27
Adjusted final weight, lb[a]	1045	1025	1034	1023	1001	1012	928	915	928

[a] Bulls and short scrotums were significantly different than steers.

Table 2. Carcass measures on bulls, short scrotums and steers.

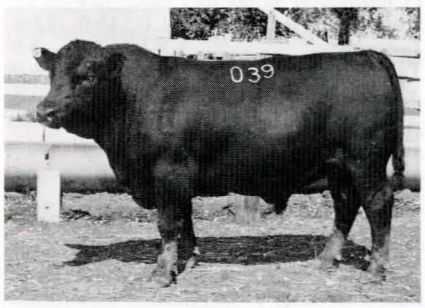
	Bulls	Short Scrotums	Steers
Carcass weight, lb.[a]	613	600	545
Kidney, heart and pelvic fat %[a]	2.5	2.7	3.3
Ribeye area, in.^{2}[a]	12.3	12.3	10.9
Fat thickness, in.[a]	.37	.38	.46
Cutability[a]	51.6	51.5	50.0

[a] Bulls and short scrotums significantly different than steers.

are given in Table 1. The sex condition-preweaning management averages are adjusted for year differences and interactions between years, sex conditions and preweaning managements. Sex condition averages presented in Tables 2 through 4 on carcass and eating quality data are adjusted for year and preweaning management differences as well as any interactions between years, sex conditions and preweaning managements.

During the preweaning period when some animals had access to creep and others did not, average daily gains (ADG) were not significantly different between the three sex conditions. The ADG's of the bulls and short scrotums were, however, a little higher than for the steers. Creep feeding did significantly increase gains in all three sex conditions. Adjusted 205-day weights (adjusted to a mature dam basis) showed the same results as the ADG during creep period data. Significant gain differences due to creep feeding carried through in the 205-day weights. The bull and short scrotum calves tended to be heavier (4-7 lb) at weaning than the steer calves, but the difference was not significant.

Average daily gain on full feed tended to be higher for the bulls and short scrotums than for the steers (2.51 and 2.45 vs 2.27). This difference was not significant though because there was an appreciable amount of variation among animals of the same sex condition.



Bull

The ADG data during the full feed period are not directly comparable due to the difference in feeding practices for the 1970–1971 calves. The steers of these two years were started on full feed at a later age and were on full feed a shorter number of days. If the steers had been fed the same as the bulls and short scrotums in the 1970–71 calves, perhaps their ADG would have been lower due to reaching heavier weights faster and then maintained until slaughter. ADG's for the 1969 calves were 2.51, 2.36 and 2.27 for bulls, short scrotums and steers, respectively.

Adjusted final weight (adjusted 205-day weight + gain weaning to final) averages are presented here only to indicate the average weights at which the cattle were slaughtered. Although a significant sex condition difference is detected, part is due to the shorter full feeding period for steers in 1970–1971. The bull and short scrotum averages can be compared directly since these groups were fed the same within years. The bulls tended to be heavier (1,034 vs 1,012) than short scrotums at slaughter at the same age.

Averages for carcass measures are shown in Table 2. Heavier carcass weights for bulls and short scrotums as compared to steers are explained by the differences in slaughter weights. Dressing percent averages were 59.3, 59.3 and 58.7 for bulls, short scrotums and steers, respectively. The ribeye area and outside fat thickness measurements at the 12th rib were adjusted to a common carcass weight. Thus, bulls and short scrotums of the same carcass weight as steers had larger ribeyes with less outside fat; the steers also had more internal fat as demonstrated by their higher kidney, heart and pelvic fat percent.

Cutability, the percent of lean meat from the chuck, rib, loin, rump and round, was about 51.5 for bulls and short scrotums and 50.0 for steers. This is a significant difference pointing out the higher percent lean, lower percent fat of bull and short scrotum cattle carcasses compared to steer carcasses when slaughtered at the same age.

Table 3 has the averages for the grades and grade factors. Maturity score measures the physiological age of the animal. There were no significant differences, but bulls and short scrotums tended to be older physiologically than steers when the chronological ages were the same. Degree of marbling was much higher for steers (modest) as compared to the bulls and short scrotums (small). The steer carcasses had finer texture of lean and thus were more desirable in that area. Color of lean was more desirable in the steers than the bulls and short scrotums; the bull and

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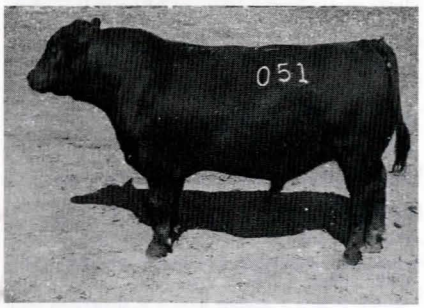


Short scrotum bull

Short Scrotums

(continued from page 5)

short scrotum carcasses had a darker color of lean.

Maturity, marbling, texture and firmness of lean all influence the quality grade. The steers (average choice) were more than ⅓ grade higher than the bulls and short scrotums (high good to low choice). Conformation grade reflected the differences in degree of muscling with bulls highest, steers lowest and short scrotums in between. Final grade, a combination of quality and conformation, showed the same results as the quality grade.

The degree of expression of the jump muscle, crest and pizzle eye in the carcass helps differentiate between bullock and ordinary steer beef USDA standards. The jump muscle is attached to the hip bone, the crest is the muscle development of the neck and the pizzle eye is the muscle which attaches the penis to the body. Lower scores in all three of these indicate more "maleness." Bulls and short scrotums had about the same average in each measure and were significantly different from steers. The short scrotums were not distinguished as different from bulls.

Rib samples from each animal were brought to Loeffel Meat Lab in Lincoln to obtain penetrometer value, shear value and taste panel evaluation data (Table 4). The penetrometer mechanically measures firmness by recording the distance a .75 inch steel ball presses into the meat in a given amount of time. The shear value is a mechanical measure of tenderness. Three one inch cores were cut in a steak. The average amount of force required to cut the cores was the shear value for each animal.

Table 3. Grade factors in bull, short scrotum and steer carcasses.

	Bulls	Short Scrotums	Steers
Maturity score[b]	14.3	14.4	14.9
Marbling score[a,c]	12.2	12.1	15.4
Texture of lean score[a,d]	4.5	4.9	6.3
Color of lean score[a,e]	4.9	5.1	7.0
Quality grade[a,f]	11.5	11.6	12.9
Conformation grade[f]	14.1	13.8	13.3
Final grade[a,f]	11.6	11.4	12.9
Jump muscle score[a,g]	4.6	4.6	5.9
Crest score[a,g]	3.4	3.5	5.9
Pizzle eye score[a,h]	3.8	3.9	6.6

[a] Bulls and short scrotums significantly different than steers.

[b] A = 14, A− = 15.

[c] Small = 12, Modest = 15.

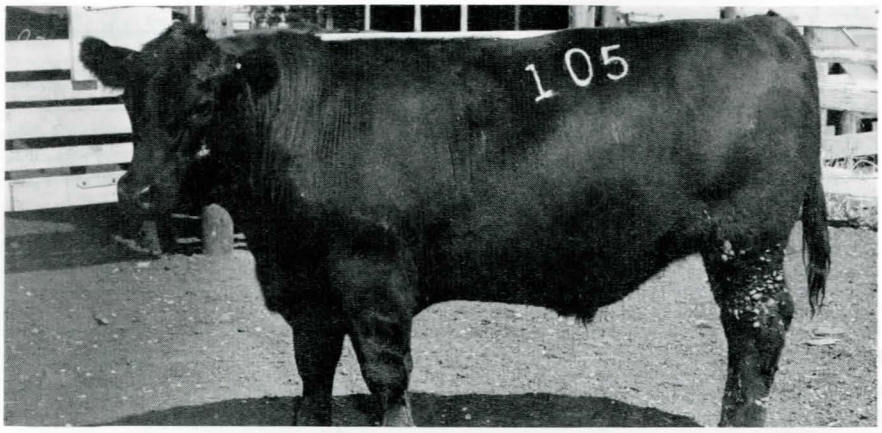
[d] Slightly coarse = 4, Slightly fine = 5, Moderately fine = 6.

[e] Slightly dark red = 5, Cherry red = 6, Light cherry red = 7.

[f] Good + = 11, Choice − = 12, Choice = 13, Choice + = 14.

[g] Moderately prominent = 3, Slightly prominent = 4, Barely evident = 5, None = 6.

[h] Slightly large = 4, Slightly small = 5, Moderately small = 6.



Steer

Penetrometer values indicated no differences between the three sex conditions. Shear values were not significantly different between the three sex conditions. Although the averages are not the same, variation among animals of the same sex condition was considerable compared to the differences between sex conditions. Steers did, however, have the lower shear values (more tender) as compared to bulls and short scrotums.

Taste panel evaluations were made on juiciness, tenderness and acceptability only for the 1969 and 1970 cattle. The average of nine tasters in 1969 and 10 tasters in 1970 sampling cooked portions of ribeye muscle were used. No significant differences were found between the three sex conditions for the three taste panel evaluations. Steers had the better scores and the short scrotums received the poorer scores. In acceptability, the three sex conditions were rated about the same by taste panel.

Summary

In this study, short scrotum animals do not appear to grow quite as fast as bulls, however they do appear to grow faster then steers. No differences were found between carcasses of bulls and short scrotums; cutability and its component factors plus quality grade and its factors were not different. Steers however had lower cutability and higher quality grade. Carcass indicators of sexual development showed bulls and short scrotums to be the same but different from steers. Eating quality indicators (mechanical plus taste panel) found no significant differences between the three sex conditions.

Any arguments for using short scrotums in beef production would be the same arguments for using young bulls. They both produce more pounds of lean at a given age than steers. When slaughtered at a young age, they produce meat which is acceptable to eat in relation to steer meat, but the quality grade is lower. Short scrotums will also be graded as bullocks under the present USDA system.

Table 4. Eating quality indicators of bull, short scrotum and steer steaks.

	Bulls	Short Scrotums	Steers
Penetrometer value, in.	.17	.17	.17
Shear value, lb.	14.1	15.0	13.0
Juiciness[a]	5.1	4.9	5.5
Tenderness[b]	5.5	5.0	5.9
Acceptability[c]	3.7	3.5	3.8

[a] Least juicy = 1, most juicy = 9.

[b] Least tender = 1, most tender = 9.

[c] Least acceptable = 1, most acceptable = 5.

[1]M. K. Nielsen is Assistant Professor, Beef Breeding. V. H. Arthaud is Associate Professor, Beef Production.

Carcass Evaluation Of Breed Groups

Crossbred steers used in carcass studies near beginning of the finishing period.

Robert M. Koch[1]

Because of the combinations of production resources and variations in market requirements in the beef industry, one type of cattle will not be most efficient in all production systems.

The wide spectrum of cattle types available in the world offers the opportunity of quickly matching genetic resources with production requirements.

Characterization of available genetic resources for economically important traits is necessary if we are to use this opportunity wisely. Initially, change in production characteristics can be made more rapidly using existing variation among breeds than by selecting within breeds. However, selection within breeds remains the primary method for continuing changes in average genetic merit.

In 1969 a germ plasm evaluation program was started at the U. S. Meat Animal Research Center. The primary objective of this program was to characterize biological and environmental relationships among traits relating to growth, efficiency of feed use, reproduction, maternal ability, and carcass and meat traits.

Breeds or breed crosses form an identifiable source of biological or genetic variation in production traits. The first cycle of breed crosses (Cycle I) resulted from artificial insemination of Hereford and Angus cows by Hereford, Angus, Jersey, South Devon, Limousin, Charolais and Simmental bulls. The Hereford and Angus cows were purchased as calves from commercial producers.

A large number of sires were used in the program: 32 Hereford, 35 Angus, 33 Jersey, 27 South Devon, 20 Limousin, 26 Charolais and 27 Simmental bulls. Hereford and Angus sires were sampled from those selected on individual performance as a basis of entry into the progeny testing program of artificial insemination (AI) organizations.

Jersey bulls were selected at random from two commercial AI organizations and the South Devon bulls were sampled from an importation made in 1969 by a commercial organization.

Charolais, Limousin and Simmental bulls were sampled from those available from commercial organizations and from the Canada Department of Agriculture for Limousin and Simmental. No progeny test results were available on any of the bulls at the time they were sampled for this program.

This report is concerned with carcass characteristics of the 14 breed groups in Cycle I of the germ plasm evaluation program. These breed groups, though not a random sample of the cattle population, are expected to indicate in a general way the genetic tendencies that would be found in a broad sample of cattle breeds and may offer insight to genetic variation within breeds.

Experimental Procedure

Steer carcasses from three years' calf crops were evaluated. Each year one-third of the steers were slaughtered at each of three slaughter dates spaced about one month apart. Slaughter at three dates provided a range in weight and degree of fatness for each of the breed groups. The average age at the start of the feeding period was 240 days and the average number of days on feed was 217.

Slaughter was carried out at a commercial packing plant. After a 24 hour chill, carcasses were evaluated for conformation, maturity, marbling, color, texture, firmness and U.S.D.A. quality and yield grades. The right side of each carcass was trucked to Kansas State University where it was processed to obtain detailed cutout information and taste panel evaluation.

The round, rib, loin and chuck were processed into closely trimmed boneless roasts (including steak meat) and lean trim, except for a small amount of bone left in short loin and rib roasts. Fat was trimmed to no more than 0.3 inch on any surface. Lean from the flank, plate, brisket and shank were added to the lean trim from the four major cuts. Chemical analysis of the lean trim in each carcass was used to adjust total lean trim to a 25% chemical fat basis. The sum of roasts and lean trim were called retail product.

A steak from the 12th rib of each carcass was used to determine intramuscular fat of the ribeye (*longissimus*) muscle. Steaks at the 10th and 11th ribs from four representative carcasses of each breed group at each slaughter date were frozen and later used in a taste panel evaluation of tenderness, flavor, juiciness and overall acceptability.

Genetic merit of animals in each breed-slaughter group was expected to be similar except for sampling variation. Therefore, change in carcass composition of the breed group average from one slaughter date to the next provided a method of adjusting breed

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Carcass Evaluation

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group means to three alternative situations for comparison, (1) constant age, (2) constant weight and (3) constant percentage of fat in the ribeye muscle.

The constant age used was 457 days (240 days average age at start + 217 days average on feed). The constant weight selected was a hot carcass weight of 635 lb which was close to the average of Hereford-Angus crosses and approximates the carcass weight expected from a 1,000 lb steer. The amount of fat in the ribeye muscle selected as a base of comparison was 5% since this approximated the marbling required for A maturity carcasses to grade U.S.D.A. Choice.

Each of the breed group means was adjusted by the linear change observed in the various traits during the last 60 days on feed relative to the change in the base trait of comparison, e.g., carcass weight, days on feed or fat in the ribeye muscle. This method of adjustment estimates values that would be obtained if all animals in a breed group had been fed for fewer or more days until the average of the breed group reached the base selected.

Table 1. Carcass composition when breed group means were adjusted to a starting age of 240 days and 217 days on feed.

	Breed group[a]							
Trait	HH AA	AH HA	JH JA	SDH SDA	LH LA	CH CA	SH SA	Avg.
Number of animals	69	97	53	44	82	78	87	510
	85	113	81	50	95	99	88	611
Slaughter weight, lb.	971	1003	958	1012	1009	1092	1080	1018
	968	999	945	1037	1019	1082	1065	1016
Avg.	970	1001	951	1024	1014	1087	1072	1017
Hot carcass weight, lb.	610	637	595	645	645	690	674	642
	619	637	592	667	659	692	673	648
Avg.	614	637	593	656	652	691	673	645
Bone, %[b]	12.7	12.1	12.7	12.6	12.7	13.3	13.8	12.9
	11.7	11.8	12.1	12.1	12.3	12.7	13.0	12.3
Avg.	12.2	12.0	12.4	12.3	12.5	13.0	13.4	12.6
Retail product, %[b]	67.4	66.1	65.1	66.9	71.9	71.9	71.0	68.7
	65.6	65.0	64.7	67.2	71.4	70.4	69.4	67.8
Avg.	66.5	65.5	64.9	67.0	71.7	71.2	70.2	68.2
Fat trim, %[b]	19.9	21.8	22.2	20.6	15.4	14.8	15.3	18.4
	22.7	23.2	23.2	20.7	16.2	16.9	17.6	20.0
Avg.	21.3	22.5	22.7	20.6	15.8	15.8	16.4	19.2
Kidney and pelvic fat, %[b]	3.1	3.7	5.7	4.3	3.7	3.7	3.6	3.9
	3.8	3.4	5.7	4.4	4.0	4.0	4.2	4.2
Avg.	3.5	3.5	5.7	4.3	3.8	3.8	3.9	4.1
Fat thickness, at 12th rib, in	.52	.63	.42	.46	.40	.35	.37	.45
	.66	.67	.51	.52	.43	.43	.43	.52
Avg.	.59	.65	.46	.49	.41	.39	.40	.48
Ribeye area, in^2	10.7	11.2	10.6	11.4	12.7	12.5	12.2	11.6
	11.0	11.1	10.7	11.8	12.9	13.0	12.2	11.8
Avg.	10.8	11.1	10.6	11.6	12.8	12.7	12.2	11.7
Yield grade	3.1	3.3	3.4	3.1	2.4	2.4	2.5	2.9
	3.4	3.4	3.4	3.1	2.5	2.6	2.7	3.0
Avg.	3.2	3.4	3.4	3.1	2.4	2.5	2.6	3.0
Ribeye fat, %	5.0	6.2	6.0	5.2	3.6	4.3	4.4	5.0
(longissimus m.)	6.9	5.7	7.4	5.9	4.3	5.1	5.1	5.8
Avg.	6.0	6.0	6.7	5.6	3.9	4.7	4.8	5.4

[a] H = Hereford; A = Angus; J = Jersey; SD = South Devon; L = Limousin; C = Charolais; S = Simmental. Breed of sire is first and breed of dam is second.

[b] Percentage of total retail product, fat trim and bone.

Results

Breed group means for composition traits are compared at a common age (457 days) in Table 1, at a common carcass weight (635 lb) in Table 2, and at 5% fat in ribeye muscle in Table 3. Adjusted weights for retail product, fat trim and bone were expressed as percentages for convenient comparison. *Comparisons of Hereford and Angus sires with other sire breeds should be based on the Hereford-Angus crossbred groups and not the straightbreds.* Significant heterosis is expected in growth traits of all breed crosses although composition did not seem to exhibit heterosis in Hereford-Angus contrasts.

Slaughter and Hot Carcass Weight. Slaughter weight was based on weight out of the feedlot on feed and water with a 4% shrink. Differences in slaughter and carcass weights at a constant age (Table 1) indicate significant differences in average growth rate. Charolais crosses were significantly higher and Jersey crosses lower than other breed groups. Carcass weight multiplied by the percentage of carcass that is retail product, fat trim or bone indicates significant differences in growth rate of these tissues.

Dressing percentage (Table 2) did not differ significantly even though hide weight and fatness did differ significantly among breed groups.

Bone. Bone included bone, major tendons and excised ligaments. The fraction of total bone left in the short loin and the partially boneless rib was estimated as .157. Therefore total bone can be approximated by dividing bone values in the tables by .843 and the corresponding change deducted from retail product to obtain boneless retail product.

Differences in percentage of bone were small on a weight constant basis (Table 2). There was a tendency for the larger breeds to have a higher proportion of bone.

Retail Product. If retail product percentages in Tables 1, 2 and 3 are plotted against hot carcass weight several points become evident (Figure 1). First, as cattle in each breed group are fed to higher weights, the percentage of retail product declines. Counter to this environmental trend is a genetic trend associated with the breed group means. The change associated with the age constant means, Table 1 and plotted in Figure 1, suggests a strong genetic tendency for groups that grow more rapidly to have a higher percentage of retail product than slower growing types.

Differences in composition were greatest when comparisons of breed groups were made at a

common carcass weight and smallest at a constant percentage of fat in ribeye muscle. Charolais, Limousin and Simmental crosses were significantly higher in retail product percentage and Jersey crosses were the lowest. South Devon crosses were intermediate.

Fat Characteristics. Fat trim included the kidney knob and pelvic fat. Since variation in bone was relatively small, differences in percentage of fat trim is essentially the opposite picture observed for retail product. Fat trim percentage increased in all breeds as weight due to feeding increased. The genetic trend based on breed group means at a constant age was downward, i.e., faster growing breed groups had lower fat percentages. Jersey crosses and Hereford and Angus straightbreds and crossbreds had the highest while Charolais, Limousin and Simmental crosses had the lowest fat trim percentages. South Devon crosses again were intermediate. Fat trim is the major variable influencing composition that can be affected by producers through breeding, feeding or management practices.

Kidney and pelvic fat was highest in Jersey crosses and lowest in Hereford-Angus types than other breed groups at all bases of comparison.

Fat thickness was closely related to amount of fat trim among the breed group means when all were adjusted to the same carcass weight, although Jersey crosses had a lower fat thickness than might be expected from the total amount of fat trim.

Ribeye Area. Ribeye area has often been used as an indicator of lean muscle. Because it does not increase proportionately with total carcass weight, comparisons should be made at a common carcass weight as in Table 2. Breed groups with larger ribeye areas had higher percentages of retail product. Limousin cross carcasses had the largest area, exceeding Charolais crosses even though retail product percentage was similar for the two breed groups.

Yield Grade. Yield grade was calculated from the formula prescribed by U.S.D.A. (1965) beef grading standards. Yield grade means were inversely related to percentage of retail product.

Ribeye Fat Percentage. Intramuscular fat in the ribeye (marbling) is of considerable economic importance because it is the most important factor in determining the

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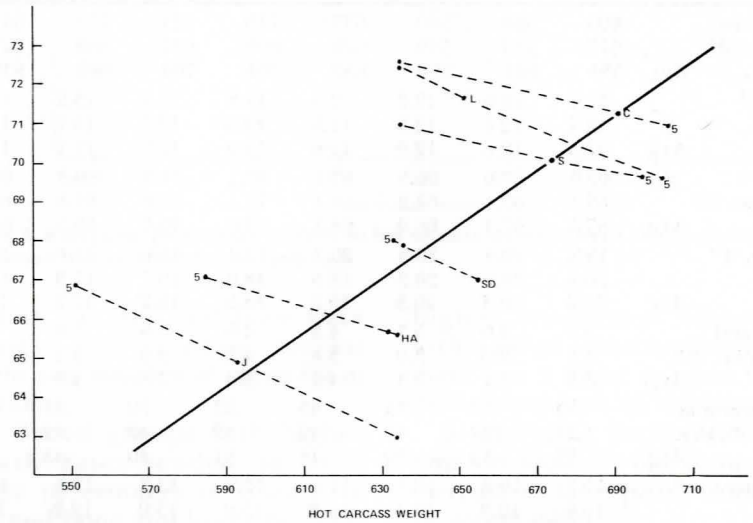

Figure 1. Retail product percentage relative to hot carcass weight when breed groups are fed varying lengths of time to reach (1) a hot carcass weight of 635 lb; (2) a constant age of 457 days (marked by initial of sire breed); and (3) 5% fat in the ribeye (marked 5). Solid line is trend associated with age constant breed group means and dotted lines are trends associated with time on feed.

Table 2. Carcass composition when breed group means were adjusted to a hot carcass weight of 635 lb.

	Breed group[a]							
Trait	HH AA	AH HA	JH JA	SDH SDA	LH LA	CH CA	SH SA	Avg.
Hide, % of	8.9	8.0	7.2	7.8	7.9	7.8	8.7	8.0
slaughter	7.4	8.2	6.5	7.3	7.4	7.6	8.0	7.5
weight Avg.	8.2	8.1	6.9	7.5	7.7	7.7	8.3	7.8
Dressed yield, %	63.0	63.5	62.8	63.5	64.0	63.0	61.8	63.1
	64.2	63.7	62.5	64.1	64.4	63.3	63.0	63.6
Avg.	63.6	63.6	62.7	63.8	64.2	63.1	62.4	63.4
Bone, %[b]	12.3	12.1	12.3	12.7	12.9	13.8	14.2	12.9
	11.5	11.8	11.8	12.5	12.7	13.3	13.3	12.4
Avg.	11.9	12.0	12.0	12.6	12.8	13.6	13.8	12.6
Retail	66.5	66.1	63.6	67.1	72.4	73.1	71.8	68.6
product, %[b]	64.9	65.0	63.0	68.7	72.4	71.9	70.2	68.0
Avg.	65.7	65.6	63.3	67.9	72.4	72.5	71.0	68.3
Fat trim, %[b]	21.2	21.8	24.2	20.2	14.8	13.1	14.0	18.5
	23.7	23.1	25.2	18.8	15.0	14.8	16.5	19.6
Avg.	22.5	22.4	24.7	19.5	14.9	13.9	15.2	19.0
Kidney and	3.3	3.7	5.8	4.3	3.5	3.4	3.5	3.9
pelvic fat, %[b]	3.9	3.4	6.2	4.0	3.9	3.6	4.0	4.1
Avg.	3.6	3.6	6.0	4.1	3.7	3.5	3.7	4.0
Fat thickness at	.56	.62	.52	.45	.38	.28	.32	.45
12th rib, in	.69	.66	.56	.44	.39	.32	.39	.49
Avg.	.63	.64	.54	.44	.38	.30	.36	.47
Ribeye area, in^2	10.8	11.1	10.6	11.4	12.6	12.1	12.0	11.5
	11.0	11.1	10.9	11.8	12.8	12.5	12.1	11.8
Avg.	10.9	11.1	10.8	11.6	12.7	12.3	12.0	11.6
Yield grade	3.2	3.3	3.6	3.1	2.3	2.2	2.3	2.9
	3.5	3.4	3.7	2.8	2.4	2.3	2.5	2.9
Avg.	3.4	3.4	3.7	3.0	2.3	2.2	2.4	2.9
Ribeye fat, %	5.5	6.2	7.1	5.0	3.4	3.1	4.0	4.9
	7.6	5.7	9.3	5.2	3.8	4.1	4.6	5.8
Avg.	6.6	6.0	8.2	5.1	3.6	3.6	4.3	5.3

[a] H = Hereford; A = Angus; J = Jersey; SD = South Devon; L = Limousin; C = Charolais; S = Simmental. Breed of sire is first and breed of dam is second.

[b] Percentage of total retail product, fat trim and bone.

Table 3. Carcass composition based on breed group means adjusted to 5% fat in the ribeye muscle.

Trait	Breed group[a] HH AA	AH HA	JH JA	SDH SDA	LH LA	CH CA	SH SA	Avg.
Hot carcass weight, lb	609	584	560	637	713	721	735	651
	577	583	539	628	696	687	663	625
Avg.	593	584	550	632	704	704	699	638
Bone, %[b]	12.7	12.6	13.2	12.6	11.8	13.1	13.2	12.8
	12.4	12.6	12.5	12.6	11.9	12.7	13.1	12.7
Avg.	12.5	12.6	12.9	12.6	11.9	12.9	13.1	12.8
Retail product, %[b]	67.5	67.0	66.5	67.1	69.1	71.3	69.8	68.6
	67.5	67.1	67.2	69.1	70.1	70.6	69.6	69.0
Avg.	67.5	67.1	66.9	68.1	69.6	70.9	69.7	68.8
Fat trim, %[b]	19.8	20.4	20.3	20.3	19.1	15.6	17.0	18.5
	20.6	20.2	20.3	18.3	18.0	16.7	17.3	18.4
Avg.	20.2	20.3	20.3	19.2	18.5	16.2	17.2	18.4
Kidney and pelvic fat, %[b]	3.1	3.6	5.7	4.3	4.6	3.8	3.8	3.9
	3.5	2.9	5.0	3.8	4.3	3.9	4.2	3.9
Avg.	3.3	3.2	5.3	4.1	4.4	3.8	4.0	3.9
Fat thickness at 12th rib, in	.52	.54	.33	.45	.53	.39	.43	.45
	.58	.54	.45	.42	.49	.42	.42	.46
Avg.	.55	.54	.39	.44	.51	.40	.43	.46
Ribeye area, in^2	10.7	10.8	10.5	11.4	12.9	12.7	12.5	11.6
	10.6	10.8	10.4	11.8	13.0	13.0	12.2	11.6
Avg.	10.7	10.8	10.4	11.6	13.0	12.8	12.3	11.6
Yield grade	3.1	3.1	3.1	3.1	3.0	2.6	2.8	2.9
	3.2	3.1	3.1	2.8	2.8	2.5	2.7	2.8
Avg.	3.2	3.1	3.1	2.9	2.9	2.6	2.7	2.9

[a] H = Hereford; A = Angus; J = Jersey; SD = South Devon; L = Limousin; C = Charolais; S = Simmental. Breed of sire is first and breed of dam is second.

[b] Percentage of total retail product, fat trim and bone.

Table 4. Quality and palatability for breed group means adjusted to a starting age of 240 days and 217 days on feed.

Trait	Breed group[a] HH AA	AH HA	JH JA	SDH SDA	LH LA	CH CA	SH SA	Avg.
Quality grade[b]	9.2	10.0	9.6	9.6	8.6	9.0	9.0	9.3
	10.4	9.7	10.3	10.2	9.0	9.8	9.4	9.8
Avg.	9.8	9.9	9.9	9.9	8.8	9.4	9.2	9.6
Marbling score[c]	10.1	12.2	13.0	11.2	8.9	10.0	9.8	10.8
	13.1	11.5	14.6	12.5	10.0	11.6	11.1	12.0
Avg.	11.6	11.9	13.8	11.8	9.5	10.8	10.4	11.4
Conformation[b]	11.1	11.7	9.1	11.0	11.9	11.9	11.4	11.2
	12.0	11.8	9.5	11.4	12.4	12.6	11.7	11.6
Avg.	11.6	11.7	9.3	11.2	12.2	12.5	11.6	11.4
Taste panel evaluation								
Tenderness[d]	7.3	7.5	7.6	7.3	6.8	7.2	6.6	7.2
	7.3	7.3	7.4	7.6	7.2	7.5	7.2	7.4
Avg.	7.3	7.4	7.5	7.5	7.0	7.4	6.9	7.3
Flavor[d]	7.4	7.5	7.6	7.5	7.6	7.5	7.4	7.5
	7.5	7.4	7.6	7.5	7.5	7.6	7.6	7.5
Avg.	7.5	7.5	7.6	7.5	7.5	7.6	7.5	7.5
Juiciness[d]	7.0	7.1	7.3	7.1	7.1	7.1	6.9	7.1
	7.1	7.1	7.4	7.3	7.0	7.1	7.3	7.2
Avg.	7.0	7.1	7.3	7.2	7.1	7.1	7.1	7.1
Acceptability[d]	7.3	7.3	7.5	7.3	7.0	7.3	6.9	7.2
	7.3	7.3	7.4	7.4	7.2	7.4	7.3	7.3
Avg.	7.3	7.3	7.5	7.4	7.1	7.3	7.1	7.3

[a] H = Hereford; A = Angus; J = Jersey; SD = South Devon; L = Limousin; C = Charolais; S = Simmental. Breed of sire is first and breed of dam is second.

[b] Prime = 15, 14, 13; Choice = 12, 11, 10; Good = 9, 8, 7; Standard = 6, 5, 4.

[c] Abundant = 27, 26, 25; Moderately abundant = 24, 23, 22; Slightly abundant = 21, 20, 19; Moderate = 18, 17, 16; Modest = 15, 14, 13; Small = 12, 11, 10; Slight = 9, 8, 7; Traces = 6, 5, 4; Practically devoid = 3, 2, 1.

[d] Extremely desirable = 9; Desirable = 8; Moderately desirable = 7; Slightly desirable = 6; Acceptable = 5; Slightly undesirable = 4; Moderately undesirable = 3; Undesirable = 2; Extremely undesirable = 1.

Carcass Evaluation

(continued from page 9)

U.S.D.A. quality grade. Breed crosses differed significantly in percentage of intramuscular fat when compared at a common age or weight. Jersey crosses were significantly higher than other breed crosses and were followed in rank by Hereford-Angus, South Devon, Simmental, Charolais or Limousin, respectively. If percentage of ribeye fat is plotted against hot carcass weight (Figure 2) we note that breed crosses differed by 150 lb in the average carcass weight at which they reached 5% fat in the ribeye. Interestingly, Charolais, Limousin and Simmental were quite similar in the average carcass weight at which they had 5% fat in the ribeye.

If percentage of fat trim is considered in relation to ribeye fat (Figure 3) it is also evident that increased intramuscular fat was associated with an increased percentage of total fat trim. The trend was strong and positive both from the environmental effect of feeding and the genetic trend of breed group means.

Quality Grade, Marbling Scores and Conformation. Quality grade (Table 4) was based on separate evaluation of conformation and on characteristics that indicate palatability, including marbling, maturity, color, texture and firmness of lean. All of these cattle were young and grade was determined primarily by marbling and conformation. Straightbred Angus and Angus crosses graded higher than other breed groups.

Conformation (thickness and fullness in relation to length) was significantly higher in straightbred Angus, Limousin and Charolais crosses and lower in Jersey crosses then the other breed groups.

Marbling scores were closely related to ribeye fat percentage and significantly higher in straightbred Angus and in Jersey crosses than in other breed groups. Limousin crosses had the lowest marbling scores. The lower quality grade relative to average marbling was due to adjustment for differences in conformation and to the differ-

ence in scaling of marbling and quality grade.

Palatability. Taste panel evaluation was made on a subset of 496 carcasses and samples scored on a desirability scale from 1 to 9. All breed group means (Table 4) were well above the minimum levels of acceptability. Differences among sire breed group means for taste panel tenderness and acceptability were small but statistically significant.

Jersey and South Devon crosses were more tender and Limousin and Simmental crosses were less tender than other breed crosses. Within breed groups, data from the three slaughter groups (not shown here) indicated there was essentially no change in average taste panel tenderness and acceptability scores. The average changes observed were −.0015 and −.0001 units per day, respectively. At the same time average marbling scores increased .025 per day.

Data adjusted for differences in age and time on feed indicated that taste panel tenderness scores increased .065 per marbling score which is comparable to an increase of one taste panel score per 15 units of marbling. Thus, among breed groups of similar age and time on feed those that had more marbling also had slightly higher taste panel scores while within breed groups the increased marbling due to time on feed seemed to just about compensate for decreased tenderness associated with increased age.

Flavor and juiciness scores did not differ significantly among the breed groups even though their marbling was significantly different.

Conclusions

1. There were significant differences among breed group means in growth rate of retail product, fat trim, bone, ribeye fat percentage, quality grade and taste panel tenderness.

2. When compared at age, weight, or ribeye fat constant bases the differences among breed groups in composition of retail product, fat trim and bone were greatest at a constant carcass weight and smallest at equal fat in the ribeye.

3. Breed groups with higher growth rates tended to have higher percentages of retail product and bone and lower percentages of fat trim.

4. Retail product percentage declined and fat trim percentage increased in all breed groups as time on feed advanced.

5. Breed groups with higher growth rates tended to have less fat in the ribeye muscle and reached choice grade at significantly different weights.

6. Average taste panel scores for all breed groups were well above the minimum levels of acceptability and differences were small.

7. Breed crosses with higher marbling scores had slightly higher tenderness scores and within breed and slaughter groups there was a slight increase in tenderness per unit of marbling.

8. Marbling increases due to time on feed did not result in an increase in taste panel tenderness or acceptability.

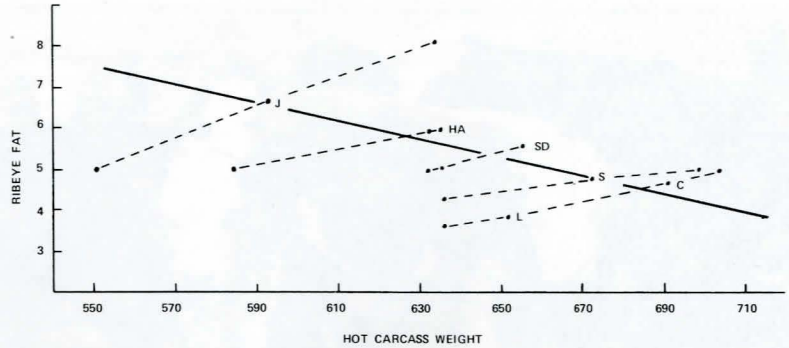

Figure 2. Ribeye fat percentage relative to hot carcass weight. (Solid line is genetic trend and dotted line is trend due to feeding.)

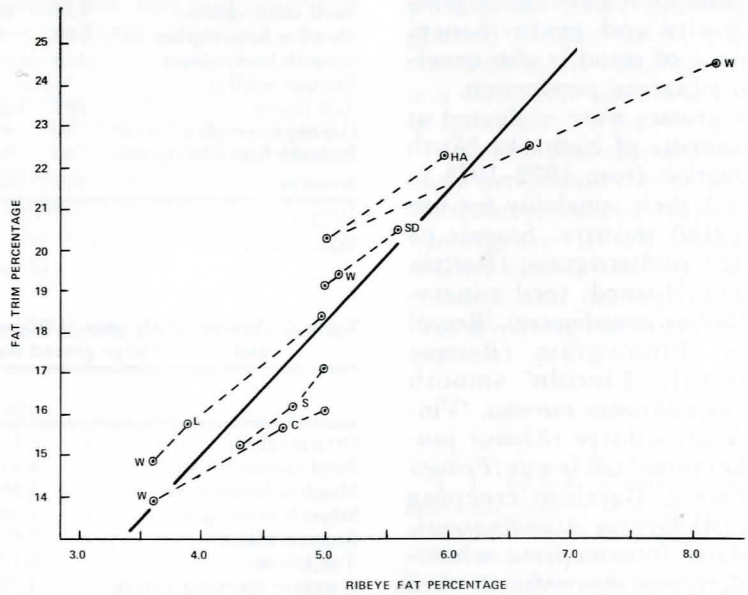

Figure 3. Change in fat trim percentage relative to ribeye fat percentage. (Solid line is genetic trend and dotted line is trend due to feeding.)

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Yearling steers on one of the eight pastures used for grass evaluation studies.

Grasses for Irrigated Pastures

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Different grasses have certain adaptations and characteristics that make them either desirable or undesirable for specific uses.

For use as irrigated pasture, grasses must be adapted to an intensively managed pasture program. This includes a favorable response to liberal use of fertilizer and irrigation water, plus adaptation to intensive grazing management. Desirable characteristics must include high dry matter production of acceptable quality forage to produce high livestock grazing capacity and performance. Persistence of stand is also necessary for sustained production.

Eight grasses were evaluated at the University of Nebraska North Platte Station from 1972–1975 to determine their suitability for use as irrigated pasture. Stands of 'Sterling'[2] orchardgrass, *(Dactylis glomerata)*, 'Ioreed' reed canarygrass *(Phalaris arundinacea)*, 'Regar' meadow bromegrass *(Bromus beibersteinii)*, 'Lincoln' smooth bromegrass *(Bromus inermis)*, 'Vinall' Russian wildrye *(Elymus junceus)*, 'Kenmont' tall fescue *(Festuca arundinacea)*, Garrison creeping foxtail *(Alopecurus arundinaceus)*, and 'Slate' intermediate wheatgrass *(Agropyron intermedium)*, were established as individual stands in the spring of 1972.

Pasture Management

Each grass was treated as a separate pasture management unit. The overall management procedure was to allow each grass to express its productive potential by subjecting it to as near optimum management and growing conditions as possible.

Yearling steers were grazed from May 1 to September 10. Weaned calves were grazed starting October 15 for at least 28 days. This provided a 35 day deferment for all grasses.

A rotation grazing system with five pastures was used for each grass. Each sub-pasture was grazed about 5–7 days allowing 20–28 days for recovery between uses. Grazing pressure was adjusted to the available forage by adding or removing animals as necessary to maintain a proper degree of forage utilization. A designated number of animals were retained on each grass during the entire grazing season for determining average daily gain over the entire grazing season.

All grasses were fertilized the same with an average over the three years of about 260 lb nitrogen, 50 lb of phosphate, 15 lb zinc and 10 lb of iron per acre per year.

Each grass was watered independently according to the soil-water status of each pasture to maintain near optimum growing conditions. This required an average of about 28 inches of irrigation water applied during each growing season. Precipitation received each year averaged about 16 inches.

Table 1. Grazing capacity of eight irrigated pasture grasses in animal-days per acre.

	1972		1973		1974		1975		3 yr. avg.	
	Yrlg[a] Days	Calf[b] Days	Yrlg Days	Calf Days	Yrlg Days	Calf Days	Yrlg Days	Calf Days	Yrlg Days	Calf Days
Orchardgrass	174	0	388	207	541	187	460	231	463	208
Reed canarygrass	157	46	374	162	445	99	389	144	402	135
Meadow bromegrass	166	0	424	168	483	126	436	139	447	144
Smooth bromegrass	115	0	360	144	436	126	396	174	397	148
Russian wildrye	31	0	377	144	385	72	354	126	372	114
Tall fescue	184	126	553	208	720	179	571	240	614	209
Garrison creeping foxtail	66	45	409	174	467	126	450	198	442	166
Intermediate wheatgrass	48	55	408	208	498	142	464	181	456	177
Average	117	34	412	177	497	132	440	179	449	163

[a] Grazed in spring and summer.
[b] Grazed in fall.

Table 2. Average daily gain (ADG) and gain per acre from eight irrigated pasture grasses and native range grazed during the spring and summer by yearling steers.

	1973		1974		1975		3-yr avg.	
	ADG	Gain/A	ADG	Gain/A	ADG	Gain/A	ADG	Gain/A
Orchardgrass	1.43	564	1.49	851	1.56	733	1.49	716
Reed canarygrass	1.41	552	1.72	785	1.63	633	1.58	666
Meadow bromegrass	1.46	648	1.84	945	1.63	718	1.64	770
Smooth bromegrass	1.49	541	1.93	876	1.73	700	1.71	705
Russian wildrye	1.61	603	1.74	694	1.76	627	1.70	641
Tall fescue	0.72	376	0.74	550	0.72	383	0.72	436
Garrison creeping foxtail	1.48	636	1.85	884	1.71	811	1.68	777
Intermediate wheatgrass	1.67	745	1.89	968	1.76	856	1.77	856
Native range	1.73	--	1.74	--	1.63	--	1.70	--

Results and Discussion

Limited use was made on all pastures in 1972, starting the first week of July following a spring seeding. Days of grazing for 1972 indicates the rate of grass establishment and ability to provide grazing during the first growing season (Table 1). Limited grazing of certain grasses was realized within 60 days after a spring seeding due to rapid stand development.

Forage quality of the eight grasses is expressed by the average daily gain (ADG) of the yearling steers during the summer months and calves during the fall. Tables 1 and 2 show relative comparisons among grasses. Summer gains were acceptable for all grasses, except those from tall fescue (Table 2). Poor forage quality reduced ADG from tall fescue to less than half those from other grasses when averaged over the three grazing seasons. Intermediate wheatgrass consistently ranked among the highest in ADG. Performance of yearling steers on native range was comparable to ADG of cattle grazing the better irrigated grasses.

Gain of weaned calves indicates that tall fescue and reed canarygrass are inferior to the other grasses in forage quality for fall grazing (Table 3). Reed canarygrass bleaches and loses quality readily after a hard freeze. Tall fescue retained the poor forage quality characteristics into the fall that were evident during summer grazing. An exception is the good performance of calves on tall fescue in the fall of 1975 which is not consistent with previous years.

Grazing capacity is a term that expresses the amount of forage produced by each grass. This is measured as yearling or calf-days of grazing. Differences among grasses in animal acceptance keeps this figure from estimating forage production accurately. However, the relative productivity among grasses with good ADG can be compared (Table 1) for both summer and fall grazing. Russian wildrye and Reed canarygrass rank the lowest with orchardgrass the highest when averaged over the three years. Poor animal acceptance of tall fescue increases the grazing capacity of this grass beyond what could be expected based on actual dry matter production.

Fall forage production is important for extending the green-feed period. Orchardgrass, Garrison creeping foxtail and intermediate wheatgrass are well suited for this purpose.

Gain per acre is a value that estimates the total production capability of each grass. Gain per acre is presented for summer and fall grazing in Tables 2 and 3. Total gain per acre for each grass indicates that five grasses, orchardgrass, meadow brome, smooth brome, Garrison creeping foxtail and intermediate wheatgrass were consistently high producers and have the highest 3-year average (Table 4).

Table 4. Total gain per acre from eight irrigated pasture grasses.

	1973	1974	1975	3-year average
Orchardgrass	731[a]	1021	1069	940
Reed canarygrass	641	811	729	727
Meadow bromegrass	753	1071	852	892
Smooth bromegrass	628	1004	895	842
Russian wildrye	693	766	727	728
Tall fescue	407	648	633	562
Garrison creeping foxtail	769	1041	1072	960
Intermediate wheatgrass	923	1100	1014	1012
Average	693	933	874	833

[a] All values are combined gain of yearling steers and weaned calves.

Table 3. Average daily gain (ADG) and gain per acre from eight irrigated pasture grasses grazed during the late fall by weaned calves.

	1973		1974		1975		3-yr avg.	
	ADG	Gain/A	ADG	Gain/A	ADG	Gain/A	ADG	Gain/A
Orchardgrass	0.81	167	0.91	170	1.45	336	1.05	224
Reed canarygrass	0.55	89	0.27	26	0.46	66	0.42	60
Meadow bromegrass	0.63	105	1.00	126	0.96	134	0.86	121
Smooth bromegrass	0.61	87	1.02	128	1.12	195	0.91	136
Russian wildrye	0.63	90	1.00	72	0.80	100	0.81	87
Tall fescue	0.15	31	0.55	98	1.04	250	0.58	126
Garrison creeping foxtail	0.77	133	1.25	157	1.32	261	1.11	183
Intermediate wheatgrass	0.86	178	0.93	132	0.87	158	0.88	156

Persistence of stand and ease of establishment are two other grass characteristics that are important. All eight grasses evaluated in this study can be readily established with accepted planting procedures. However, Garrison creeping foxtail has poor seedling vigor and establishment was slower. The stand of Russian wildrye was not persistent, indicating poor adaptation to irrigated pasture conditions. With the exception of Russian wildrye, all stands were acceptable at the end of four grazing seasons.

Summary

Considering all grass characteristics and animal performance data that were measured and observed in this study, five grasses that proved suitable for irrigated pasture production at North Platte were orchardgrass, meadow brome, smooth brome, Garrison creeping foxtail and intermediate wheatgrass. The remaining three grasses, Russian wildrye, tall fescue and Reed canarygrass were less desirable and are not well adapted for this use.

The five desirable grasses previously mentioned can be seeded as a mixture, except intermediate wheatgrass which should be seeded alone. Seeding mixtures, cultural and management practices are being developed for these grasses.

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[2]Single quotation marks designate variety.

Feeding High Levels of Antibiotics

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Low levels of antibiotics may help increase daily gains, improve feed efficiency and lower the incidence of liver abscesses in cattle fed high energy rations. This has led many feedlot operators to feed relatively low levels (70 mg) of antibiotics in the ration daily. Higher levels (350 mg) of antibiotics are also fed to calves for a short period of time (usually 28 days) after arrival in feedlots in an effort to control disease outbreaks.

Recent experiences and research indicate that disease control could be more effective if relatively high levels of antibiotics were fed. But what about feeding high levels of antibiotics over a long period of time? Will they affect the rumen microorganisms, and consequently lower feedlot performance?

The purpose of this trial was to determine the effects of 0, 250, 500, 750, 1,000, 1,250, and 1,500 mg of chlortetracycline (CTC-50) on animal gain, feed consumption, feed utilization, animal health, and the incidence of liver abscesses when added daily to the finishing ration of steers.

The trial was conducted at the Panhandle Experiment Station from May 30, 1974 to January 2, 1975. One hundred and seventy steers of mixed breeding, purchased from local auction markets were used. About half of the steers were purchased the previous fall, while the other half were purchased 10–20 days before the trial started. They were randomly sorted into 15 different pens, with 10 head allotted to 14 pens, and 30 head in one large pen. The large pen served as a comparison for health and the incidence of liver abscesses. Each treatment was repeated by feeding two pens the same supplement containing CTC-50 to supply either 250, 500, 750, 1,000, 1,250, or 1,500 mg per head daily. Two smaller pens and the large control pen did not receive any CTC-50.

Cattle were weighed at the start and the end of the trial after a 14 hour shrink without feed and water. Seven days before the trial, the cattle were vaccinated for IBR (infectious bovine rhinotracheitis), leptospirosis and enterotoxemia, and were branded. The cattle were slaughtered in three different groups over a 3-week period, when it was estimated that 80% of the cattle would grade choice.

The final finishing ration is shown in Table 1. Cattle were started on a full feed of ground alfalfa hay and 8 pounds of crimped corn per head per day, plus the prescribed amount of CTC-50 for each treatment. After feeding the starting ration for 20 days, the level of corn was increased daily at the rate of one pound per head until alfalfa comprised 5% of the final ration. In the finishing ration, 1.1 pound of a crude protein supplement (58%) was fed per head daily during the first half, and .55 pound daily the second half of the trial. The supplements were formulated so the level of daily feeding of CTC-50

Table 1. Composition of the finishing ration.

Ingredient		Ration % Days 0–108	109–217
Ground alfalfa hay		5	5
Cracked shelled corn		90	92.5
Protein supplement[a]		5.0	2.5
Soybean meal	(77.4%)[d]		
Urea	(8.0%)		
Limestone	(9.0%)		
Tri-Polyphosphate	(1.0%)		
Salt	(4.6%)		
Vitamin A[b]			
Chlortetracycline-50[c]			

[a] Supplement was formulated to contain 58% CP (DM basis) and was fed at the rate of 1.1 lb. and .55 lb. per head daily the first and second half of the trial, respectively.
[b] Added to supply 30,000 IU/head/day.
[c] Added to supply 0, 250, 500, 750, 1000, and 1500 mg of chlortetracycline/head/day for the respective treatment.
[d] Percent composition of supplement.

Table 2. The effect of various levels of chlortetracycline for finishing steers.

Item	Chlortetracyline (mg/hd/da.) 0[c]	250	500	750	1000	1250	1500	0[c]
No. of animals	20	20	20	20	20	20	20	30
Initial wt. (5-30-74), lb.	604	592	586	604	591	681	604	592
Final wt. (11-20-74), lb.	1045	1039	1008	1066	1059	1078	1072	991
Average daily gain, lb.	2.54	2.57	2.43	2.66	2.69	2.67	2.69	2.28
Daily feed intake, lb.	20.6	21.6	19.9	22.2	21.2	22.5	22.0	20.9
Feed/lb. of gain	8.13	8.39	8.32	8.37	7.87	8.41	8.18	9.16
Carcass:								
USDA Quality grade[a]	12.90	13.15	12.70	13.70	13.50	13.40	13.15	12.90
USDA Yield grade[b]	3.00	3.05	3.00	3.15	3.20	3.20	3.40	3.00

[a] Good = 10, Good + = 11, Choice − = 12, Choice = 13, Choice + = 14, Prime − = 15, Prime = 16, Prime + = 17.
[b] Official USDA Yield Grade 1-5.
[c] Large control lot

Table 3. The effect of chlortetracycline on liver condemnations of finished steers.

Medication chlortetracycline per day (mg.)	Number animals per group	Normal livers	Abscessed livers	Other condemnations
0	30	21	1	8
0	20	13	2	5
250	20	16	1	3
500	20	15	2	3
750	20	17		3
1000	20	16		4
1250	20	20		
1500	20	19		1
	170	137	6	27

was constant for each treatment throughout the trial.

Gains, feed intake, feed efficiency and carcass yield and quality grades are shown in Table 2. There was a trend for daily gain to increase as the level of CTC-50 increased up to 1,000 mg per head daily, although differences were not significant. Levels of CTC-50 above 1,000 mg per head daily did not appear to be of additional benefit in increasing daily gain. Feed intake and feed efficiency were not greatly influenced by levels of CTC-50, however they were slightly higher in treatments with the higher levels. Also, definitely more feed per pound of gain was required in the large control lot.

The high levels of CTC-50 had no apparent detrimental effects. This indicates the high levels did not harm beneficial rumen microorganisms. Also, feed intake of steers receiving CTC-50 was equal to or greater than the control cattle.

Steers fed the higher levels of CTC-50 (750 to 1,500 mg) appeared to have slightly higher quality grades and higher yield grades. The differences were not significant and may have been due to chance. No major disease problems were encountered in any of the cattle during the trial.

All animals on the experiment were followed through slaughter to determine the incidence of liver abscesses and other liver condemnations (Table 3). The incidence of liver abscesses was low even in the control groups, making an evaluation of the degree of control difficult. Groups on the higher levels of CTC-50 were free from abscesses. It appears that the incidence of liver abscesses was about constant up to and including the group that received 500 mg CTC-50 per head per day.

There were liver condemnations from other causes in the groups getting higher levels of CTC-50, but the level of CTC-50 apparently had no effect on these conditions.

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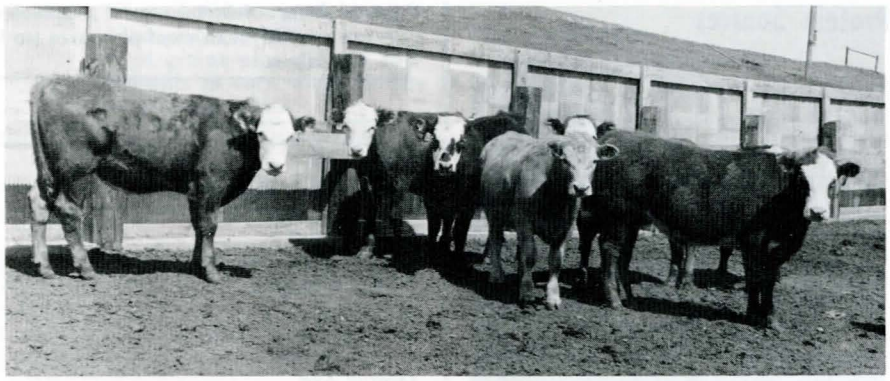

Steers used in study of nitrogen sources for growing cattle near the end of the growing period.

Protein Sources For Growing Calves

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A new concept in protein nutrition for beef cattle which determines the quantity of nonprotein nitrogen (NPN) and formed protein needed for cattle to make maximum gains has been proposed by Iowa State University. This concept takes into account degradation of plant protein by rumen microbes, synthesis of microbial protein from NPN, and the animal's protein requirements.

Under the proposed system, lightweight calves are said to require the largest percentage of plant protein in the ration. The reason is that not enough microbial protein is synthesized in the rumen to meet the calf's protein needs. Plant protein is needed to supplement microbial production to get optimum growth. As the calf grows, microbial protein synthesis more nearly meets the need. So increasing amounts of supplemental plant protein can be replaced with NPN. When heavier calf weights are reached, rumen microbes may supply enough protein to meet the calf's requirements if nonprotein nitrogen is supplied.

Evaluation

Degradation of plant proteins by rumen microbes may reduce utilization of proteins fed. The amount of ration protein that escapes degradation depends on the type of feed used. Trials were conducted at the Northeast, North Platte and Panhandle Stations to evaluate the effect of supplemental protein source and the new concept (metabolizable proteins) with corn silage for growing calves.

The test at the Panhandle Station involved 30 steer calves per treatment (averaging 425 pounds) in a trial that lasted 105 days. At North Platte, 10 steers and 12

(continued on next page)

Table 1. Effect of urea or soybean meal with corn silage for growing calves.

	No supplement	Urea supplement	Soybean meal supplement
Panhandle[a]			
Avg. daily gain, lb.	1.26	1.76	1.91
Dry feed/gain, lb.	10.07	8.04	7.48
North Platte[a]			
Avg. daily gain, lb.	.97	1.89	2.10
Dry feed/gain, lb.	12.69	8.25	7.55
Northeast[a]			
Avg. daily gain, lb.	1.06	1.41	1.64
Dry feed/gain, lb.	11.30	10.10	8.75
Overall Avg.			
Avg. daily gain, lb.	1.10	1.69	1.88
Dry feed/gain, lb.	11.35	8.80	7.93

[a] Percent protein and pounds natural protein fed/day in supplement for no supplement, urea and soybean meal supplement, respectively: Panhandle — 7.5, 0.12; 11.1, 0.13; 11.1, 0.59; North Platte — 7.3, 0.10; 10.9, 0.14; 10.6, 0.66; Northeast — 10.1, 0.00; 11.5, 005; 11.5, 0.67.

Protein Sources

(continued from page 15)

heifers per treatment (averaging 507 pounds) were fed 112 days. The test at the Northeast Station involved 28 calves per treatment (averaging 425 pounds) fed for 190 days.

Urea, soybean meal, cottonseed meal and brewer's dried grains were fed to provide the recommended percent protein or the recommended metabolizable protein (MP) in the ration. A negative control (no supplemental nitrogen) was included in each test. Performances of steers fed corn silage supplemented with no protein, urea, or soybean meal are shown in Table 1.

Using averages of all three trials, cattle fed soybean meal supplement had the highest average daily gain. These cattle also received the largest amount of supplemental natural protein (see footnote, Table 1).

Cattle fed urea supplement gained less than steers fed soybean meal. The urea supplement contained only a small amount of natural protein in the carrier. These lightweight calves did not receive enough protein through microbial synthesis and corn silage to produce gains equal to those of steers fed soybean meal.

Cattle fed no supplemental protein had the lowest daily gains. Protein levels in these rations were well below animal requirements, resulting in poor gains.

In all cases, urea additions to corn silage resulted in large gain responses. Corn silage did not contain enough nitrogen for optimum synthesis of microbial protein. Urea provided the nitrogen needed by rumen microorganisms.

Performances of cattle fed corn silage supplemented with urea to equal the urea fermentation potential (UFP) of corn silage, or with urea to raise the ration protein level to 11.1% are shown in Table 2.

Urea fermentation potential is the quantity of urea that rumen microbes can convert into microbial protein. Higher energy feeds have greater urea fermentation potential. High protein feeds generally have low urea fermentation potential.

Overall average daily gains for cattle fed urea to equal ration UFP were lower than for steers fed urea to 11.1% protein. This indicates that estimates of UFP values for corn silage rations are low, and lightweight calves are able to use more urea than is suggested by present UFP recommendations.

Performances of cattle fed corn silage with either soybean meal (11.1% protein), soybean meal to metabolizable protein (MP) or soybean meal plus urea (to UFP) to metabolizable protein are shown in Table 3.

Metabolizable protein is the protein which reaches the animal's tissues to be used for metabolic functions. The amount of metabolizable protein a feedstuff can supply depends on the amount of digestible protein undegraded by rumen microbes, and the amount of nitrogen converted into microbial protein.

Overall average daily gains of cattle fed either soybean meal (11.1% protein) or soybean meal to MP were not greatly different. The method of feeding soybean meal to MP appears to have no ad-

Table 2. Effect of urea to UFP or urea to 11.1% protein in corn silage rations for growing calves.

	Urea to urea fermentation potential (UFP)	Urea to 11.1% protein
Panhandle[a]		
Avg. daily gain, lb.	1.56	1.76
Dry feed/gain, lb.	8.68	8.04
North Platte[a]		
Avg. daily gain, lb.	1.50	1.89
Dry feed/gain, lb.	9.20	8.20
Northeast[a]		
Avg. daily gain, lb.	1.30	1.41
Dry feed/gain, lb.	10.70	10.10
Overall Avg.		
Avg. daily gain, lb.	1.45	1.69
Dry feed/gain, lb.	9.53	8.78

[a] Percent ration protein and pounds natural protein fed/day in supplement for urea to UFP and urea supplement: Panhandle — 8.30, 0.03; 11.1, 0.13; North Platte — 8.40, 0.01; 10.9, 0.14; Northeast — 11.30, 0.04; 11.5, 0.05.

Table 3. Effect of soybean meal supplement, soybean meal to metabolizable protein (MP) and soybean meal plus urea (to UFP) to MP in corn silage rations for growing calves.

	Soybean meal supplement	Soybean meal to MP	Soybean meal + urea (to UFP) to MP
Panhandle[a]			
Avg. daily gain, lb.	1.91	1.89	--
Dry feed/gain, lb.	7.48	7.38	--
North Platte[a]			
Avg. daily gain, lb.	2.10	2.10	1.91
Dry feed/gain	7.55	7.25	8.06
Northeast[a]			
Avg. daily gain, lb.	1.64	1.47	1.48
Dry feed/gain	8.75	9.53	9.52
Overall Avg.			
Avg. daily gain, lb.	1.88	1.82	--
Dry feed/gain	7.93	8.05	--

[a] Percent ration protein and pounds natural protein fed/day in supplement for soybean meal supplement, soybean meal to MP and soybean meal + urea (to UFP) to MP: Panhandle — 11.1, 0.59; 11.0, 0.59; North Platte — 10.6, 0.66; 10.9, 0.67; 10.1, 0.49; Northeast — 11.5, 0.67; 12.2, 0.38; 12.38, 0.33.

Table 4. Effect of soybean meal, solvent cottonseed meal, expeller cottonseed meal or expeller cottonseed meal plus urea in corn silage rations fed to growing calves.

	Soybean meal	CSM (sol.)	CSM (exp.)	CSM (exp.) + urea	CSM (sol.) + urea
Panhandle[a]					
Avg. daily gain, lb.	1.91	1.76	1.67	--	1.75
Dry feed/gain, lb.	7.48	8.08	8.10	--	7.10
North Platte[a]					
Avg. daily gain, lb.	2.10	--	2.10	1.74	--
Dry feed/gain, lb.	7.55	--	7.82	8.53	--
Overall Avg.					
Avg. daily gain, lb.	2.01	--	1.89	--	--
Avg. feed/gain, lb.	7.52	--	7.96	--	--

[a] Percent ration protein and pounds natural protein fed/day in supplement for soybean meal, CSM (sol.), CSM (exp.), CSM (exp.) + urea, and CSM (sol.) + urea: Panhandle — 11.1, 0.59; 11.03, 0.63; 9.43, 0.34; 0.00, 0.00; 9.90, 0.31; North Platte — 10.6, 0.66; 0.00, 0.00; 10.9, 0.74; 9.10, 0.25; 0.00, 0.00.

vantage over feeding soybean meal to balance the ration to 11.1% protein.

The amount of soybean meal fed in these treatments was not greatly different, however time of feeding did differ. Cattle fed soybean meal to MP received more soybean meal when cattle were lightweight. Later, when cattle reached heavier weights, those fed soybean meal to MP received less than cattle fed soybean meal supplement.

Cattle fed soybean meal-urea were fed urea only when cattle were heavy enough to permit the switch from soybean meal to urea. Calves at the Panhandle Station did not reach this weight before the trial ended. Average daily gains for cattle fed soybean meal-urea were less than for cattle fed the other two rations. Apparently, weights at which the change to urea was made were not heavy enough or perhaps cattle must go through urea adaptation whenever they are switched to urea.

Performance of steers fed corn silage supplemented with either soybean meal, cottonseed meal (solvent), cottonseed meal (expeller) or cottonseed meal (expeller) plus urea are shown in Table 4.

Expeller methods of removing oil from seeds result in considerable heat production. Heat has been shown to reduce degradation of protein in the rumen, resulting in more protein bypass. Reduced degradation could result in a deficiency of nitrogen in the rumen for microbial protein systhesis. Urea additions would overcome this problem.

Using overall averages, cattle fed soybean meal gained about 0.10 pound/day more than those fed cottonseed meal (exp.).

Cattle at the Panhandle Station fed either cottonseed meal (sol.) or cottonseed meal (sol.) + urea gained about the same. Cattle fed CSM (sol.) + urea received about half the natural protein of those fed cottonseed meal (sol.). Urea replaced the natural protein without reducing cattle gains. Apparently, enough natural protein was supplied by the solvent cottonseed meal + urea to produce gains equaling those of cattle fed solvent cottonseed meal.

Table 5. Effect of soybean meal, brewer's dried grains to MP, or brewer's dried grains plus urea as supplements in corn silage rations for growing calves.

	Soybean meal	Brewer's dried grains to MP	Brewer's dried grains plus urea
Northeast[a]			
Avg. daily gain, lb.	1.64	1.51	1.58
Dry feed/gain, lb.	8.75	9.03	8.81

[a] Percent ration protein and pounds natural protein fed/day in supplement for soybean meal, brewer's dried grains and brewer's dried grains plus urea: 11.5, 0.67; 11.3, 0.30; 11.9, 0.27.

At North Platte, cattle fed expeller cottonseed meal had gains equaling cattle fed soybean meal. However, when urea was added to the expeller cottonseed meal, gains were reduced.

Performances of steers fed corn silage supplemented with either soybean meal, brewer's dried grains (BDG) or BDG plus urea are shown in Table 5.

Average daily gains of cattle fed brewer's dried grains to MP were slightly less than those of cattle fed soybean meal or BDG plus urea. Most likely microorganisms in the rumen of these cattle needed another source of nitrogen, since urea additions to brewer's dried grains resulted in more gain.

Summary

Calves fed corn silage rations need a natural protein source to produce maximum gains. Feeding natural protein by the metabolizable protein method did not change the total amount of protein fed nor did it affect average daily gain in these tests. Urea fermentation potential underestimated the amount of urea that could be used in these rations. At the present time, therefore, when urea is fed, it is recommended that the same protein requirement (11.1%) be used as that used for natural protein.

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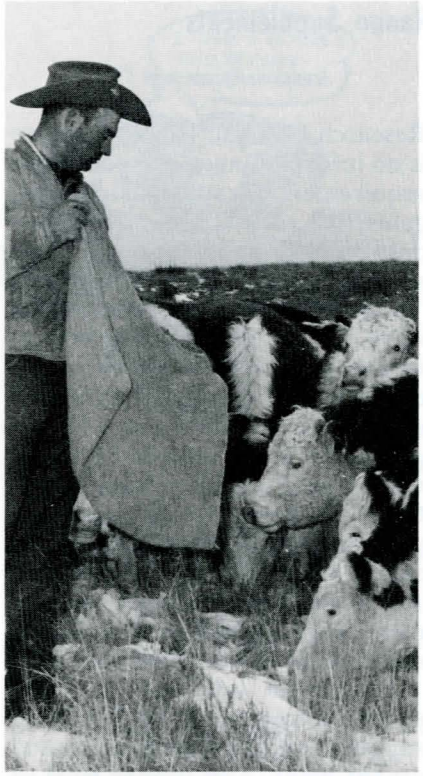

Young cows in winter range supplementation study.

Potassium In Range Supplements

J. F. Karn,
D. C. Clanton[1]

Cattle fed forage diets generally consume enough potassium to meet their requirements. One exception appears to be cattle grazing native grass winter ranges. Native grasses contain relatively low levels of potassium and as they mature their potassium content decreases further. Potassium levels as low as 0.3% have been measured in winter range grass diets at the North Platte Station and as low as 0.1% in Sandhills winter range forage diets.

Growing-finishing cattle require 0.6 to 0.8% potassium in ration dry matter according to the National

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Range Supplements

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Research Council. However, there is no information on the potassium requirement of cattle making small gains (0.3 to 0.7 lb per head per day) on low quality rations such as standing mature grass forage.

Objectives of three experiments were (1) to examine potassium levels in winter range forage throughout the winter grazing season and (2) to determine whether potassium levels were low enough to limit weight gains of steer calves. Cattle in these experiments were pastured together but were corralled daily and individually fed 1.5 lb of their assigned supplement. Eight calves were fed each supplement in each experiment.

Potassium addition to nonprotein nitrogen (NPN) containing supplements resulted in increased weight gains. The proper level of supplemental potassium was not established; but it appears that if animals are fed 1.5 lb of a protein supplement, it should contain about 2% potassium, the level in a soybean meal based range supplement.

Experiment I

The first experiment was conducted during the winter of 1972–73 to compare the effect of supplements containing NPN with and without additional potassium on average daily gains of steer calves grazing native winter range. Phosphorus and vitamin A levels were the same in all supplements in all experiments.

Results of the first experiment are presented in Table 1. An all plant protein (soybean meal) supplement (1) was used as a control. Other supplements were: (2) dehydrated alfalfa and biuret; (3) corn and biuret; (4) corn, biuret plus potassium; (5) soybean meal and urea; and (6) soybean meal, urea plus potassium.

Steers fed supplement 1 (control) gained significantly more than those that received supplements containing NPN (biuret or urea), except supplement 6 which contained added potassium. Steers fed the soybean-urea plus potassium (6) gained significantly more than those that received the same supplement without potassium (5). Gains of steers fed the corn-biuret plus potassium supplement (4) were not greater than those that received the same supplement without additional potassium (3).

Comparing both supplements containing additional potassium (4 and 6) with 3 and 5 showed a significant advantage in weight gain for supplements containing additional potassium. Steers fed the dehydrated alfalfa-biuret supplement (2) had significantly greater weight gains than steers that received the corn-biuret supplement (3). This may have been due to the high potassium content of dehydrated alfalfa.

Table 1. Effect of different supplements on performance of steers grazing winter range. Experiment I.

Supplement number	Principal ingredients	Supplement Content: Potassium	Urea or Biuret	Protein equivalent from NPN	Daily supplement consumption	Average daily gain
		%	%	%	lbs	lbs
1	Soybean meal	2.45	0.0	0	1.50	0.56
2	Dehydrated alfalfa, 50% + biuret	1.89	12.0	69	1.37	0.37
3	Corn + biuret	0.92	12.0	69	1.47	0.16
4	Corn + biuret + 2.90% potassium chloride	1.92	12.0	69	1.47	0.29
5	Soybean meal + urea	1.69	5.0	35	1.50	0.35
6	Soybean meal + urea + 1.47% potassium chloride	2.08	5.0	35	1.49	0.55

Table 2. Effect of different supplements on performance of steers grazing winter range. Experiment II.

Supplement number	Principal ingredients	Supplement content: Potassium	Urea	Protein equivalent from NPN	Daily supplement consumption	Average daily gain
		%	%	%	lbs	lbs
1	Soybean meal	2.22	0.0	0.0	1.50	.73
2	Soybean meal + urea	1.69	5.0	35.0	1.43	.56
3	Soybean meal + urea + 0.6% potassium chloride	1.87	5.0	35.0	1.48	.56
4	Soybean meal + urea + 1.20% potassium chloride	2.25	5.0	35.0	1.50	.66
5	Soybean meal + urea + 1.80% potassium chloride	2.26	5.0	35.0	1.47	.60
6	Soybean meal + urea + 2.40% potassium chloride	2.72	5.0	35.0	1.42	.57
7	Dehydrated alfalfa, 25% + urea	2.15	5.0	35.0	1.41	.52

Experiment II

Experiment II was conducted to determine the proper level of supplemental potassium for range supplements fed to growing calves (Table 2). Five supplements (2 through 6) containing 5% urea with gradually increasing potassium levels were compared to an all plant protein (soybean meal) supplement (1). Another supplement (7) containing 5% urea and 25% dehydrated alfalfa was fed to further examine the value of dehydrated alfalfa in range supplements. Only 25% dehydrated alfalfa was used in this supplement because previous range supplements containing higher levels of dehydrated alfalfa were not readily consumed.

Weight gains of steers fed the all

Table 3. Potassium content of native winter range collected via esophageal fistula. Experiments II and III.

Experiment II (NP Station)		Experiment III (SAL)	
Date of collections	Potassium % of DM	Date of collections	Potassium % of DM
Dec. 1973	1.07	Dec. 1974	.09
Jan. 1974	.46	Jan. 1975	.09
Feb. 1974	.23	Feb. 1975	.10
Mar. 1974	.15	Mar. 1975	.11
Apr. 1974	.57	Apr. 1975	.59

plant protein supplement (1) were again significantly greater than gains of steers fed supplements containing NPN (2 through 7). In contrast to Experiment I, a significant response to supplemental potassium did not occur. This was probably due to the presence of green grass (which is high in potassium) in certain areas of the pasture throughout the experimental period.

Pasture samples collected via esophageal fistula (Table 3) were extremely low in potassium during February and March of Experiment II and December through March in Experiment III. Potassium levels during these periods were far below National Research Council recommendations for growing calves, clearly indicating that potassium may be a limiting nutrient under winter grazing conditions.

Experiment III

The last experiment was carried out during the winter of 1974–75 in a further effort to confirm results of Experiment I. The first two experiments were conducted at the North Platte Station where cool season grasses are mixed with warm season grasses. The third experiment was conducted at the Sandhills Agricultural Laboratory (SAL) which is a more typical Sandhills range site with predominately warm season grasses.

Two supplements containing 5% urea, one with potassium (3) and one without (2) were compared to an all plant protein (soybean) supplement (1). Although gains of steers on all treatments were quite low, steers fed the soybean-urea plus potassium supplement (3) which contained 1.85% potassium had significantly greater gains than steers that received the same supplement without additional potassium (1.35% potassium). Weight gains of steers fed the control supplement (1) were greater than gains of steers that received the soybean-urea plus potassium supplement (3). These results indicate that even though potassium was shown to enhance weight gains NPN utilization was still poor.

Pasture samples indicate that potassium concentrations were below National Research Council recommendations for growing calves during a substantial portion of the winter grazing period. Combining the data from all three experiments showed that adding potassium to supplements containing 5% urea improved weight gains significantly. Thus, when NPN is substituted for plant protein in range supplements potassium probably should be added. According to these results the potassium level should be at least 2% or about the same level found in soybean meal based range supplements.

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Table 4. Effect of different supplements on performance of steers grazing winter range. Experiment III.

Supplement number	Principal ingredients	Supplement content: Potassium	Urea	Protein equivalent from NPN	Daily supplement consumption	Average daily gain
		%	%	%	lbs	lbs
1	Soybean meal	1.90	0.0	0.0	1.50	0.34
2	Soybean meal + urea	1.35	5.0	35.0	1.41	0.09
3	Soybean meal + urea + 1.2% potassium chloride	1.85	5.0	35.0	1.41	0.20

Refeeding Cattle Wastes

Paul Q. Guyer, Lyle Petersen[1]

Every steer leaving the feedlot leaves behind him at least 1.5 tons of wet manure. Most of that manure needs to be removed, but what do you do with it? The economics of feed costs, along with the increased number of close confinement feeding units, have focused attention on the potentials of recycling cattle wastes.

Feedlot wastes have greater potential value as feed than as fertilizer because the energy they contain can be partly utilized.

Manure from cattle fed high concentrate rations contains undigested grain and microorganisms which were not completely digested. Both are still highly digestible "the second time around." In addition, manure contains plant cell wall components that have relatively low digestibility but should contribute some energy when recycled.

A considerable amount of animal wastes can be safely re-fed. An environmental impact analysis report submitted to the Food and

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Refeeding Cattle Wastes

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Drug Administration indicates that feeding animal wastes will not endanger human or animal health if proper attention is given to processing and withdrawal periods.

The most practical and economical methods of refeeding are yet to be developed. We still need to know:

1. The complete nutrient content of cattle wastes.
2. Nutrient losses during the storage and processing of wastes.
3. More information about potential disease-causing organisms and effective and economical methods of controlling them.
4. Practical ways to harvest and process cattle waste for refeeding.

Currently, refeeding seems to be best adapted for ruminant rations because wastes are relatively high in nonprotein nitrogen and crude fiber. Ensiling relatively fresh wastes in combinations with other feedstuffs seems to produce a relatively palatable feedstuff for cattle that is free of disease causing organisms. The kind and amount of waste and other feedstuffs used will determine whether this waste silage is adapted for growing, finishing or cow rations.

Table 3. Composition of feedlot manure and its coarse and fine fractions.[a]

		Total manure	Coarse fraction	Fine fraction
Dry matter	(lb)	2000	394	1606
Digestible solids	(lb)	1088	200	888
Protein	(lb)	400	31.6	368.4
Fiber	(lb)	248	112.6	135.4

[a] Adapted from unpublished data—Dept. of Agricultural Engineering, University of Nebraska.

Digestibility Differences

What an animal eats will affect what's in the manure. The influence of ration composition on digestibility and excreta (manure and urine) content are indicated by results of lamb metabolism trials (Table 1). Feces and urine were collected over a 7-day period. Dry matter consumption and excretion were determined.

Dry matter digestibility decreased as the amount of concentrate in the ration decreased. Lambs fed the 23% concentrate ration excreted three times the dry matter excreted by lambs fed the 90% concentrate ration. Study of the excreta indicates a difference in feed value: fiber in the excreta increases as the concentrate content decreases. Fiber has relatively low digestibility so manure from cattle fed high concentrate rations looks better for refeeding.

Separating cattle wastes into fine and coarse fractions has been proposed. A look at nutrient content of these fractions should help determine whether it is worthwhile to do this separation (Table 2).

Dry matter digestibility of feces from cattle fed hay and corn silage was very low—lower than most any feedstuff used in feeding cattle. Digestibility of the coarse fraction was exceptionally low. While the fine fraction was considerably higher in digestibility, it is questionable that it is high enough to justify separation.

Feces from cattle fed the high concentrate ration were more digestible—only slightly lower than corn silage. There was only a slight difference in the digestibility of the coarse and fine fractions.

The coarse fraction from both the hay and corn silage rations are rather high in fiber (Table 2). The comparatively high digestibility of the coarse fraction of feces from a high concentrate ration was probably because much of the undigested grain was retained by the screen.

Protein Content

Protein content makes an important contribution to the value of feedstuffs. The protein content of feces from a grass hay ration is relatively low with the coarse fraction comparable to crop residues and mature hay. The protein con-

Table 1. Influence of diet on digestibility and composition of excreta.[a]

	Concentrate in ration (%)			
	90	67	45	23
Dry matter digested	85.3	74.0	64.2	54.1
Dry matter excreted	14.7	26.0	35.8	45.9
Fiber excreted[b]	6.5	14.5	21.6	29.6
Bacteria, etc. excreted[c]	8.2	11.5	14.2	16.3
% fiber in excreta	44	56	60	64

[a] Lamb metabolism trials, University of Nebraska.
[b] Neutral detergent fiber.
[c] Neutral detergent solubles.

Table 2. Effect of ration type on content of coarse and fine fraction of beef cattle wastes.[a]

Waste Fraction[b]	Hay	Corn silage	High concentrate
		Dry matter digestibility (%)[c]	
Coarse	9.4	27.7	59.6
Fine	38.4	42.7	62.9
Total	27.4	36.4	61.5
		Fiber content (%)	
Coarse	44.2	37.9	19.1
Fine	21.8	14.1	7.0
Total	30.3	24.1	12.1
		Protein content (%)	
Coarse	4.4	7.4	8.6
Fine	10.5	20.5	20.3
Total	8.2	15.0	15.4

[a] Adapted from University of Nebraska Research Bulletin 262.
[b] Fine = Material through a 500 micron screen.
Coarse = Material retained by a 500 micron screen.
[c] *In vitro*.

Table 4. Dry matter digestibility of cobs and manure.[a]

Roughage	Dry matter digestibility: Total ration	Roughage[b] portion	Manure[c] portion
Whole manure + cobs	61.9	61.9	71.4
Screened manure + cobs	60.1	58.1	64.0
Screened manure + cobs + sodium hydroxide	59.1	57.0	51.4
Cobs	57.2	52.4	--
Cobs + sodium hydroxide	66.0	62.7	--

[a] Lamb metabolism trials, University of Nebraska.
[b] Estimated by subtracting estimated digestibility of the supplement.
[c] Estimated by subtracting digestible dry matter from either cobs or cobs treated with NaOH.

tent of the coarse fraction of feces from the corn silage and high concentrate ration is not high enough to encourage keeping for feeding. Protein content of the fine fractions of both these rations is high enough to encourage refeeding.

The relatively small amount of total solids in the coarse fraction of manure from cattle fed finishing rations also raises the question of whether cattle waste should be fractionated (Table 3).

Cattle manure ensiled with corn cobs had greater dry matter digestibility than corn cobs (except when treated with sodium hydroxide) in lamb metabolism trials at Lincoln. Manure collected from cattle fed a high concentrate ration in a confinement unit at Mead was fed as whole manure. Screened manure was from the same source and collected by saving the portion that would not pass through a 500-micron sieve. Treatments were:

1. Whole manure, 50: corn cobs, 50 (dry basis).
2. Screened manure, 50: corn cobs, 50 (dry basis) plus supplements.
3. Screened manure, 50: corn cobs, 50 treated with sodium hydroxide (NaOH) at 4% of dry matter plus supplement.
4. Corn cobs plus supplement.
5. Corn cobs treated with sodium hydroxide (NaOH) at 4% of dry matter plus supplement.

Table 5. Cattle waste for cows (98 da).[a]

		Stalklage	Excreta silage
Gain	(lb)	64	197
Feed consumed	(lb)	29	19

[a] Iowa Beef Report, 1975 — Excreta supplied 41.5% of the excreta silage dry matter.

The supplements (protein, calcium and phosphorus) were added at feeding time. The manure-cob mixtures were stored in 55-gallon drums, sealed and allowed to ensile. The ground cob control rations had water added and were handled in the same manner. Each ration was individually fed to four lambs during a 14-day preliminary and a 7-day collection period.

Whole manure had a relatively high dry matter digestibility indicating an energy content suitable for refeeding to finishing cattle (Table 4). Screened manure was lower in digestibility but about 20% higher than the digestibility of corn cobs. Sodium hydroxide treatment of screened manure and cobs did not appear to improve this mixture as much as it did the cobs.

Cattle waste from a 25% cob finishing ration mixed with other feeds (including some corn) produced an excreta silage with more energy than dry cows needed in wintering trials at Iowa (Table 5). Excreta contributed 41.5% of the dry matter in the excreta silage. More waste and less grain could be used in making a suitable feed for dry beef cows.

Excreta silage was satisfactory for part of the ration of growing calves in companion studies at Iowa (Table 6). When rations provided 70% total digestible nutrients (TDN), performance of calves fed excreta silage was comparable to those fed corn silage. However, when the ration provided only 60% TDN, feed consumption and gain were much lower for calves fed excreta silage than those on the corn silage ration. Poor palatability was the apparent problem.

Table 6. Excreta silage for growing calves.[a]

Basal feed	Da. gain (lb)	Feed intake (lb)
Corn silage		
60% TDN	1.9	12.7
70% TDN	1.9	11.6
Excreta silage		
60% TDN	1.1	9.3
70% TDN	1.9	12.2

[a] Iowa Beef Report, 1975 — Excreta supplied 36 or 50% of the silage dry matter.

Cattle manure can be fed back to finishing cattle with satisfactory results according to Alabama tests (Table 7). Fresh manure and excreta silage provided 40% of the weight of finishing rations as fed. Gains were comparable to cattle fed a control ration. It is hard to compare efficiency because of the moisture differences between rations.

Summary

Our knowledge and application of recycling cattle wastes is in its infant stage. We have much to learn before practical and economical methods of recycling are developed. The high nonprotein nitrogen content and the fact that it can be ensiled to produce a reasonably palatable and safe feed indicates that wastes may be best utilized in refeeding to cattle.

Study of protein and energy content indicates that excreta from high concentrate finishing rations may be the only manures with high enough feed value for recycling. Separating coarse and fine fractions may not be feasible for refeeding. Tests indicate that considerable excreta can be re-fed in growing and finishing as well as cow rations.

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Table 7. Cattle manure for finishing cattle.[a]

	Control	40% Manure	40%[b] Wastelage
Daily gain	2.68	2.62	2.71
Feed/gain[c]	7.37	10.70	9.42

[a] Anthony. Proceedings of International Symposium on Livestock Wastes, 1971.
[b] Coastal bermuda grass 43% and wet cattle manure 57%.
[c] As fed.

Stable flies cause cattle discomfort.

Contented cattle in screen-enclosed lot.

Stable Flies Slow Weight Gains

J. B. Campbell,
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J. E. Wright,
D. C. Clanton[1]

Blood sucking stable flies on feedlot cattle have long been suspected of slowing weight gains. Cattle bothered by these flies bunch together and each animal attempts to keep its front legs (the prime feeding site of stable flies) protected within the bunch. Foot stamping, tail switching, bunching, standing in water, throwing the head down toward the front legs in an effort to dislodge the flies are all indications that stable flies are annoying cattle.

During the fly season, summer and early fall, many Nebraska feedlots either have high populations of stable flies or the manager must exert a great deal of time, effort and expense to maintain fly control. Previous weight gain studies with beef cattle dealt with a biting fly complex (stable, horn and tabanid flies and mosquitoes) so that the effects of just the stable fly have not been determined.

Special Structure Built

Economic data cannot be researched by controlling flies on one or several pens of cattle and comparing their weights with cattle in untreated pens because of the mobility of the pest. Therefore, a special structure was built for this and other future studies.[2] A 60 x 80 x 14 foot steel Butler building was erected. Within this structure, four 10-head capacity feedlot pens were built. Each pen was individually screened with fly screen and each contained a feedbunk, waterer and mineral holder. The feed bunks were equipped with lids (opened only for feeding) which restricted movement of flies in and out of the pens.

Fly pupae (immobile flies in a life stage which develops into adults) were placed in two of the pens as needed to maintain the desired number of flies on the cattle. Heifers were used for these trials and were allotted to treatment by weight and breed. In the first year of the study, a growing ration was used and in the second, a finishing ration.

Table 1. Influence of stable flies on performance of calves fed growing or finishing rations. University of Nebraska, North Platte Station, 1974-75.

Ration	Avg. No. flies per calf	Avg. daily gain[a]	Lb dry matter consumed per lb of gain
Growing	None	1.50	10.09
Growing	50	1.30	11.64
Finishing	None	2.65	7.01
Finishing	50	2.22	7.85

[a] Fed 100 days.

Fly numbers were kept at a level of about 50 per animal in the first trial. This population level is encountered in many Nebraska feedlots during the summer. In the second trial, the population level was increased to about 100 flies per animal. This heavy infestation is found in 15 to 20% of Nebraska feedlots in wet years.

Feed Efficiency Better

Data in Table I indicate the effect of stable fly feeding on feeder cattle weight gains and feed efficiency.

Feed efficiency for calves without flies was 13.32% better in the growing ration group and 10.71% better in the finishing ration group than calves with flies. This would imply a shorter time to reach a marketable product and thus savings from that standpoint.

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[2]Study supported in part by Grants-in-Aid by Chemagro Corporation, Stauffer Chemical Company, Dow Chemical Company and Chevron Chemical Company.

Hydroxide Treated Residues

Energy for Beef Cows

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Crop residues normally provide enough energy to maintain dry mature cows. However, these feeds do not supply adequate energy or protein for lactating cows. With various types and quantities of residues available, there is increasing interest in finding ways to improve the quality and utilization of such forages for the lactating cow.

In work reported previously, hydroxide treatment of crop residues improved energy availability sufficiently to support daily gains of approximately 2 lb in growing rations for steer calves. Therefore, it would appear that similarly treated material might provide adequate energy for the lactating cow.

Cow Feeding Trials

Two trials were designed to measure the effect of hydroxide treatment on corn cobs fed as the only source of roughage or as part of the roughage for lactating cows. Design of the trials and rations involved are shown in Tables 1 and 2, respectively. Cows were bunk-fed once daily with 2 ft of linear space per head. Salt and a mineral mix were supplied free choice.

In trial 1, 38 five-year-old Angus x Hereford cows with Charolais sired calves averaging about 35 days of age were divided into four groups for a 73 day feeding period starting May 7, 1974. Rations fed were calculated to supply 12.8 lb of total digestible nutrients (TDN) daily and 2.0 lb of crude protein (CP).

Sixty four cow-calf pairs with 4- or 6-year-old Angus x Hereford cows were divided into 8 groups and fed one of four rations in trial 2 for 63 days starting August 12, 1975. Calves by Charolais or Hereford sires averaged 122 days of age at the start and were weaned at the end of the experiment. Rations were based on forage ranging from 100% sweet clover silage to 100% hydroxide treated corn cobs along with combinations of ⅓ and ⅔ of each forage. Forage was fed ad lib with protein supplemented in rations 3 and 4 from soybean meal to supply 1.9 lb CP daily.

Results

Performance of cows in trial 1 was similar on all rations; however, calf gain was slightly higher in the silage fed group. Cows fed cobs, particularly treated cobs, did not go on feed as readily as those on silage which might have had an adverse effect on milk production.

Breeding performance of cows in trial 1 showed average respective conception dates of July 8, 5, 4 and 4, respectively; however, a control group on bromegrass pasture had an average conception date of June 23.

Cow and calf performance in trial 2 was slightly higher on the sweet clover silage ration than on treated cobs or combinations of the two forages. Calves appeared to be consuming significant quantities of the rations, particularly sweet clover silage. This may have been due in part to the fact that these calves were almost 3 months older than calves used in trial 1.

Summary

Cow gain in trial 1, although limited, did not prevent conception. Silage fed cows and their calves gained slightly more than cob fed cows.

Cow and calf gain in trial 2 was slightly higher in the silage fed groups. Forage consumption by calves appeared to be greater in the silage fed than in cob fed groups.

Cow performance on hydroxide treated cobs in two drylot trials was somewhat lower than might have been expected based on growth trials previously conducted using hydroxide treated residues.

Table 1. Performance of lactating cows in drylot for 73 days on corn silage or corn cob rations.

	Treatment			
	1	2	3	4
Cow-calf pairs (no.)	9	10	9	10
Initial cow wt. (lb.)	992.9	981.6	959.0	977.6
Cow average daily gain (lb.)	0.32	0.26	0.33	0.22
Cow average conception date (July)	8	5	4	4
Calf average daily gain (lb.)	1.71	1.64	1.54	1.44
Average daily feed (lb. of DM)				
Corn silage	17.0			
Ground corn cobs untreated		17.0		
Ground corn cobs treated[a]			22.0	17.0
Ground corn		2.8		2.8
Soybean meal	1.1	2.7	3.0	2.7
	18.1	22.5	25.0	22.5

[a] Treated with 3% sodium and 1% calcium hydroxide on a dry matter basis with a NaOH – $Ca(OH)_2$ mixture with a 3:1 ratio.

Table 2. Performance of cow-calf pairs in drylot for 63 days on sweet clover silage or treated corn cobs.[a]

	Treatment			
	1	2	3	4
Cow-calf pairs (no.)	16	16	16	16
Initial cow wt. (lb.)	1074.0	1085.2	1045.7	1080.2
Cow average daily gain (lb.)	0.11	−0.63	−0.37	−0.39
Calf average daily gain (lb.)	1.52	1.27	1.33	1.22
Average daily feed (lb. of DM)				
Sweet clover silage	31.1	19.0	9.4	
Ground corn cobs treated[a]		10.8	21.1	24.1
Soybean meal			1.1	3.0

[a] Treated with 3% sodium and 1% calcium hydroxide on a dry matter basis with a NaOH – $Ca(OH)_2$ mixture with a 3:1 ratio.

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Effects on Calf Weight Gains

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Research that emphasizes the study of factors influencing growth rate in beef calves will contribute to the beef industry. Among possible factors that might be studied to increase growth rate are hormones because they have roles in controlling growth processes. An earlier report (1972 Nebraska Beef Cattle Report, E.C.72–218) indicated hormonal implants (Synovex) stimulated body weight gains in nursing heifer and steer calves. Most of the weight gain appeared to occur the first month after implantation.

The present study was conducted to obtain additional information on the effects of Synovex implants on body weight gain in nursing calves and to determine if reimplanting calves might have beneficial effects.

Study Design

Implants containing 20 mg of estradiol benzoate and 200 mg of progesterone (Synovex S) were used in heifer calves, and implants of 20 mg of estradiol benzoate and 200 mg of testosterone (Synovex H) were used in steer calves.

All implants were placed under the skin in the ear as described in the 1972 Report. Synovex H (Syn H) was used in the steer calves because the previous study indicated that it was more effective than Synovex S (Syn S) in stimulating gains in steer calves. Syn S was utilized in heifer calves because it contains only female type hormones and might be less likely to have harmful effects on later reproductive activity than Syn H which contains a male hormone.

Fifty-three Angus x Hereford heifer calves out of Hereford cows were randomly assigned to a nonimplanted control group (18 calves), Syn S-1X group (18 calves) and a Syn S-2X group (17 calves). Syn S-1X calves received a single implant whereas Syn S-2X calves received a second implant two months later. The average age and average body weight of the heifer calves at the first implant were 60 days and 168 pounds, respectively.

For the steer calf study, 54 Angus x Hereford and 12 Hereford calves out of Hereford cows were randomly assigned with respect to type of breeding to a nonimplanted control group (22 calves), Syn H-1X group (22 calves) and a Syn H-2X group (22 calves). Syn H-1X calves received a single implant at the beginning of the study whereas Syn H-2X calves received a second implant two months later. The average age and body weight of steer calves at time of first implant were 61 days and 183 pounds, respectively.

All calves remained with their dams on warm season pasture with no creep feed and were weaned four months after insertion of the first implant. Calves were weighed at monthly intervals after overnight separation from their dams without feed or water.

Results and Discussion

Body weight gains for heifer calves treated with Syn S are summarized in Table 1. The heifer calves receiving the Syn S implants gained at least five more pounds than the nonimplanted calves during the preweaning period. There appeared to be more variation among the three groups of heifer calves in weight gained during the first three weight periods than at the last period. The value of the second implant (Syn S-2X group) is questionable since there was no indication of a stimulation in weight gain at periods (3rd and 4th months) after its insertion.

Syn H stimulated additional weight gain in steer calves (Table 2). Implanted steer calves averaged 12 pounds more total gain than non-implanted calves. Similar to the response in heifer calves, there appears to be little advantage in reimplanting (Syn H-2X group) steer calves. In this regard, the gains at the first weigh period (3rd month) after the second implant were similar for the Syn H-1X and 2X groups. However, at the next weigh period (4th month) there was an indication of some additional weight gain in the reimplanted group.

The trends for stimulated body weight gains in nursing heifer and steer calves implanted with Syn S and H, respectively, agree with the earlier report (1972 Nebraska Beef Cattle Report, E.C.72–218). However, the degree of weight stimulation was much more striking in the previous study. For example, heifer calves in the previous study had gained 17 pounds more at weaning than controls in response to a single Syn S implant. The advantage for the same treatment in the present study, which was conducted during a later year, was only five pounds. Such differences are to be expected because of year to year variation in weather and grazing conditions which may affect the

Table 1. Average preweaning weight gains of heifer calves subsequent to Synovex S implantation.

Treatment group	No. Calves	Gains in pounds/head				
		1st month	2nd month	3rd month	4th month	Total
Control	18	65.9	45.2	49.3	35.1	195.5
Syn S-1X	18	66.2	43.4	54.6	36.6	200.8
Syn S-2X	17	62.4	55.1	52.4	35.9	205.8

Table 2. Average preweaning weight gains of steer calves subsequent to Synovex H implantation.

Treatment group	No. Calves	Gain in pounds/head				
		1st month	2nd month	3rd month	4th month	Total
Control	22	64.8	46.3	46.5	30.2	187.8
Syn-H-1X	22	77.6	40.4	50.1	32.2	200.3
Syn H-2X	22	66.8	46.3	49.2	37.7	200.0

milk production of dams and, consequently, the level of nutrition of noncreep-fed calves.

It appears that creep feeding implanted calves could minimize nutritional stresses that calves might face in some years. Creep feeding might also help maximize the growth stimulating effect of the implants since, at least in feedlot cattle, the effect of such hormonal preparations is maximal only when adequate feed is available. However, economic value of creep feeding depends on cost of feed relative to price received for additional pounds gained.

The materials used in the studies for both years are actually natural hormones that are produced by the ovaries and testicles. In addition to having roles in general body growth, they have other effects such as on the development and function of reproductive structures and the mammary gland. In our studies, mammary gland stimulation was not observed in any of the treated calves. Increased mounting or riding activity among implanted heifers and steers was observed but this did not seem a serious problem.

Summary

There was an indication of increased body weight gains in nursing heifer calves treated with Synovex S and nursing steer calves treated with Synovex H. However, the gains were not as large as those reported in a previous year. This is probably related to climatic variations and their influence on nutritional conditions. Reimplanting both heifer and steer calves appeared to have little, if any, advantage on body weight gain over the single implant.

Further study utilizing creep feeding would seem to be worthy. Continued attention needs to be given to possible undesirable side effects since the hormonal materials can have effects, both desirable and undesirable, over and above general growth and development.

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Hormone Implants

Effects on Heifer Reproductive Performance

John L. Lesmeister, Earl F. Ellington[1]

Hormonal implants containing estrogen and progestogen (Synovex S) can stimulate body weight gains in nursing heifer calves (1972 Nebraska Beef Cattle Report, E.C. 72–218 and 1976 Nebraska Beef Cattle Report, E.C. 76–218). What effect(s) such treatments might have on subsequent development and reproductive performance of heifer calves are reported here.

Even though treating females with some hormones, estrogens in particular, at or near the time of breeding can harm reproduction, it should be noted that the hormones contained in these implants are natural female hormones. They have specific roles in the development of the female reproductive system and female body configuration characteristics. Included here could be an effect on pelvic size, a factor associated with calving problems.

Study Design

The experiment reported here is the second phase of the Synovex heifer calf study reported in the preceding article where calves were assigned at 60 days of age to one of three groups: unimplanted control, one Synovex S implant (Syn-1X) and two Synovex S implants spaced two months apart (Syn-2X). The first phase dealt with the growth and development to weaning; the second phase deals with the animals from weaning in the fall to calving in the spring when the heifers were two years of age. The animals were maintained on warm season pasture during the summer and winter and cool season pasture during the spring and fall. Protein supplement and hay were provided during the two winters and grain was fed during the first winter.

Body weights and pelvic measurements were obtained from the 53 Angus x Hereford heifer calves beginning at weaning (121 days after insertion of the first implant) and at monthly intervals thereafter until calving at two years of age.

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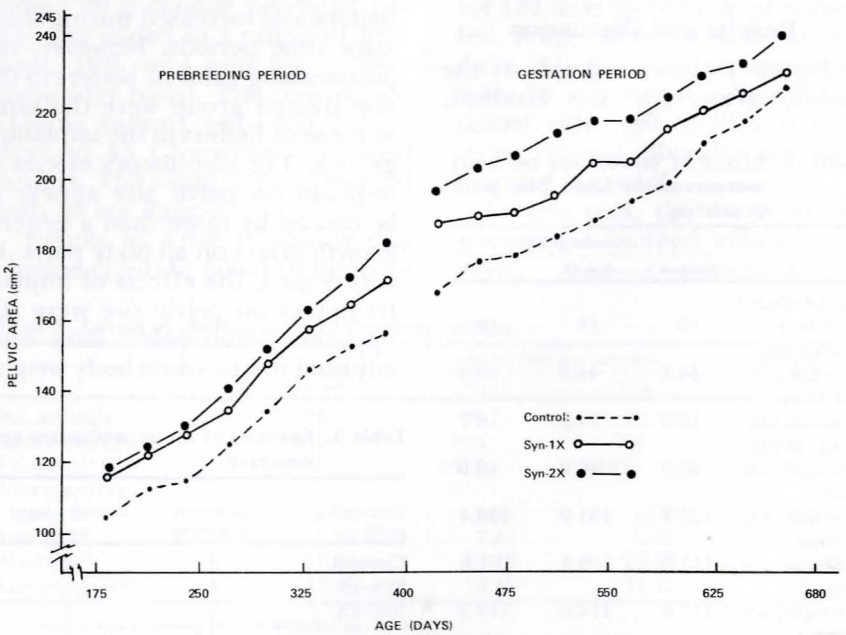

Figure 1. Graph of pelvic areas of control, Syn-1X, and Syn-2X groups from 182 days to 678 days.

Hormone Implants

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Transverse and vertical pelvic measurements were made via the rectum with use of a "scissor type" pelvimeter. The pelvic area for an animal was calculated as the product of the two measurements. The heifers were pasture mated as yearlings to Angus bulls for a 73-day breeding season. Pregnancy was checked by rectal palpation 50 days after the end of the breeding season. Animals diagnosed as nonpregnant were slaughtered for autopsy information.

External measurements of body size were made at the measurement period that immediately preceded calving. These measurements were taken with a sliding caliper or steel tape and included width between the hook bones, width between the pin bones, hook to pin distance, body length, wither height and chest depth. Calving data collected included calf sex, birth weight and calving difficulty scores. Calving scores were based on the amount of assistance required: 1 = no assistance given, 2 = manual assistance given, 3 = mechanical calf puller used and 4 = cesarean birth or extreme difficulty requiring surgical assistance.

Results and Discussion

Figure 1 shows a graph of the pelvic areas for the control, Syn-1X and Syn-2X groups from an average age of 182 days to 678 days. Data collected during the prebreeding period (first 8 measurement times) include all heifers whereas data collected during the gestation period (last 10 measurement times) pertain only to heifers that conceived during the breeding season.

Both Syn-1X and Syn-2X treatments increased pelvic size over controls, with Syn-2X heifers showing the greatest response. The differences were apparent from the first measurement period, which was actually 121 days after insertion of the first implant, to the last measurement period which was just before calving. There was a tendency for some of the differences between implanted and control groups to disappear as the time of calving at two years of age was reached. However, it is notable that the differences persisted as long as they did considering the first implant was given when the animals were 60 days of age.

As expected, body weights of the heifers also increased during these same time periods. However, the postweaning gains of heifers in the non-treated group were the same as those of heifers in the implanted groups. The stimulatory effects of implants on pelvic size appear to be caused by more than a general growth effect on all body parts. In this regard, the effects of implant treatment on pelvic size were still apparent when pelvic data were adjusted to a constant body weight.

Hopefully, a larger pelvis would contribute to calving ease. The calving score data suggest that less assistance was needed in calving the implanted heifers than the controls (Table 2). However, the differences were not large. The heifers were not given a large calving difficulty challenge since they were bred to Angus bulls and did not have to deliver calves of excessive size. A better test of the implant treatment on calving difficulty would require the use of sires that produce larger calves at birth.

As shown in Table 1, the implants did not have marked effects on the various external body measurements. Exceptions are the height measurements at the wither and hip which were decreased by the implant treatments. Estrogens are known to check growth in length of long bones in laboratory animals and may have reduced height measurements here by retarding growth in the long bones of the legs.

The external body measurements such as width between hook bones, width between pin bones and distance between hook and pin bones were not highly correlated with pelvic area. Because of this and the fact that direct measurement of the pelvis via the rectum is relatively easy, the pelvis should be measured directly when there is interest in determining pelvic size.

Unfortunately, the implant treatments appeared to have a detrimental effect on reproductive activity. Table 2 shows that 5 of the

Table 1. Effect of treatments on body measurements taken just prior to calving.

Item	Treatment group		
	Control	Syn-1X	Syn-2X
No. pregnant heifers	16	13	10
Hook bone width, cm	44.5	44.8	45.8
Pin bone width, cm	14.2	14.2	13.7
Hook to pin length, cm	46.0	46.0	46.0
Body length, cm	129.7	131.9	130.4
Wither height, cm	111.6	109.5	107.8
Hip height, cm	117.6	114.6	113.3
Chest depth, cm	56.2	55.2	54.8

Table 2. Effect of treatments on calving performance.

Treatment group	No. heifers	No. calving	Avg. calving date	Calf birth wt, pounds	Calving score
Control	18	16	Mar. 22	67.2	1.4
Syn-1X	18	13	Mar. 26	64.8	1.3
Syn-2X	17	10	Apr. 2	65.3	1.1

Table 3. Features of the reproductive systems in heifers slaughtered after they failed to conceive.

Treatment group	No. heifers slaughtered	No. underdeveloped tracts	No. with follicles >10 mm	No. showing ovulation evidence	Other abnormalities
Control	2	1	1	2	none
Syn-1X	5	0	4	5	ovarian cyst (1)
Syn-2X	7	3	5	5	persistent hymen (1); resorbing fetus(1)

18 Syn-1X and 7 of the 17 Syn-2X heifers failed to calve as compared to 2 of the 18 controls. Calving appeared to be delayed by the implant treatment, as control heifers calved an average of 4 days earlier than Syn-1X heifers and 11 days earlier than Syn-2X heifers. The delayed calving reflects delayed conception during the breeding season in the implanted heifers.

Examination of the reproductive tracts obtained at slaughter from heifers that failed to conceive indicated that the implant treatment, especially Syn-2X, disturbed activity of the reproductive tract (Table 3). Three of the seven open heifers in the Syn-2X group were judged to have underdeveloped reproductive tracts in contrast to none of the Syn-1X heifers and one control heifer. Evidence for ovulation was found in all except for two heifers in the Syn-2X group. Abnormal features including an ovarian cyst, a persistent hymen and a resorbing fetus were found only in implanted heifers.

Summary and Future

Synovex S implants given to heifer calves were effective in increasing pelvic size which would appear to be helpful in overcoming some calving problems. However, some of the pelvic size advantage decreased as the heifers approached calving time at two years of age.

Reimplanting at later stages to maintain or increase the pelvic size difference would appear to offer promise. However, Synovex S did have detrimental effects on reproductive performance even though given at an early age. It would seem worthwhile to work with materials that might have beneficial effects on the pelvis without detrimental reproductive effects. Preliminary research results with Ralgro implants seem to offer promise and Ralgro will be studied along with other growth promotants to determine their effect on pelvic growth and development.

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Choline for Finishing Rations

Stanley D. Farlin, Robert Britton, V. H. Arthaud[1]

Adding choline to beef rations to improve feed efficiency and rate of gain has produced variable results without providing a definite answer as to the value of the practice.

This, along with reports suggesting that choline may improve the level of marbling in beef carcasses, led to four trials evaluating the effect of feeding choline to cattle which were fed relatively shorter periods. It was an attempt to reduce the total grain fed yet produce a carcass which would grade.

Results of the four trials involving 611 head of steers, heifers and bulls showed that choline did not improve either the degree of marbling or rate and efficiency of gain of relatively short fed cattle.

In trial 1 choline chloride providing 20 g choline per head per day was added to a ration of 85% corn, 10% cobs and 5% supplement (dry basis). The control and choline rations were fed for 87 days to 45 Charolais crossbred heifers. The cattle were implanted with 36 mg Ralgro.

Results of Trial 1 indicate that choline chloride failed to improve rate of gain or marbling. Efficiency of gain was slightly better for choline fed heifers.

Trial 1. The effect of choline chloride on gain and carcass grades of heifers.

	Control	20 g Choline
No. animals	23	22
Initial wt., lb.	832	802
Average daily gain,[a] lb.	2.67	2.57
Feed/gain	7.83	7.59
Marbling[b]	10.38	9.29
Carcass grade[c]	10.81	10.41

[a] Final weight adjusted to 61% dress from hot carcass weight.
[b] 9=slight, 10=slight plus.
[c] 10=average good, 11=high good.

Trial 2. The effect of choline chloride on gains and carcass grades of steers and heifers.[a]

	Control	20 g Choline
No. animals	111	111
Initial wt., lb.	723	719
Final wt., lb.	1034	1045
Average daily gain[b], lb.	2.50	2.63
Feed/gain	8.54	8.07
Marbling[c]	11.84	11.93
Carcass grade[d]	11.31	11.31

[a] Cattle previously on pasture fed 131 days. Cattle previously on corn silage fed 117 days.
[b] Final weight adjusted to 57.4% dress using hot carcass weight.
[c] 9=slight, 10=slight plus.
[d] 10=average good, 11=high good.

In the second trial, 20 g choline as choline chloride was tested using 222 head of mixed breed heifers and steers. Cattle were fed an average of 124 days. Those cattle previously on pasture were fed for 131 days while cattle previously fed silage were on test for 117 days. All cattle were implanted with 36 mg Ralgro. Animals received either 80 or 90% concentrate rations. Results are summarized in trial 2.

In this trial, there was an improvement in feed efficiency of

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Trial 3. Levels of choline for beef finishing rations.

	Control	Choline fatty acid complex 5 g	Choline fatty acid complex 10 g	Choline chloride 30 g
No. animals	75	75	75	75
Initial wt., lb.	800	794	796	800
Final wt.,[a] lb.	1024	1012	1021	1016
Average daily gain, lb.	2.78	2.69	2.78	2.72
Feed/gain	7.55	7.81	7.62	7.74
Marbling[b]	13.07	13.12	12.80	13.08
Carcass grade[c]	12.10	12.10	12.11	12.09

[a] Adjusted to equal dressing percent using hot carcass weight.
[b] 12=small, 13=small plus.
[c] 11=high good, 12=low choice.

Choline . . .

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5.5% with choline. Gain was improved by 5.2%. Marbling and carcass grade were not different for control and choline fed cattle.

In trial 3, treatments included control, 5 and 10 g level of choline as choline fatty acid complex and 30 g choline as choline chloride. This is the only trial where choline fatty acid complex was tested. Three hundred Angus X Brangus steers were fed a 90% concentrate ration for 106 days but choline was included in the ration only for the last 78 days of the trial. Steers were not implanted.

Results from this trial indicate choline had no effect on rate of gain, feed efficiency, marbling, or carcass grade.

A fourth trial was conducted to measure the effect of feeding choline on the marbling of young bulls fed for slaughter. Zero or 20 g choline as choline chloride was fed for the last 70 days before slaughter. The 44 Angus or Charolais X Angus bull calves were fed an 80% concentrate ration for 74 days followed by a 90% concentrate ration the final 86 days of the test.

The bulls were about 15 months old at slaughter. Results indicated that choline had no effect on marbling score and carcass grade. Marbling score for control and choline groups was 6.3 and 6.4, both traces. Carcass grade was 8.7 and 8.6 which represents high standard grade.

Combined results from all four trials indicate that feeding choline in finishing rations had no appreciable effect on carcass quality grade as influenced by marbling or on rate and efficiency of gain.

The average values for all trials for daily gain, feed efficiency and marbling score for control and choline treatment, respectively, were 2.65, 7.97, 10.40 and 2.64, 7.79, 10.13.

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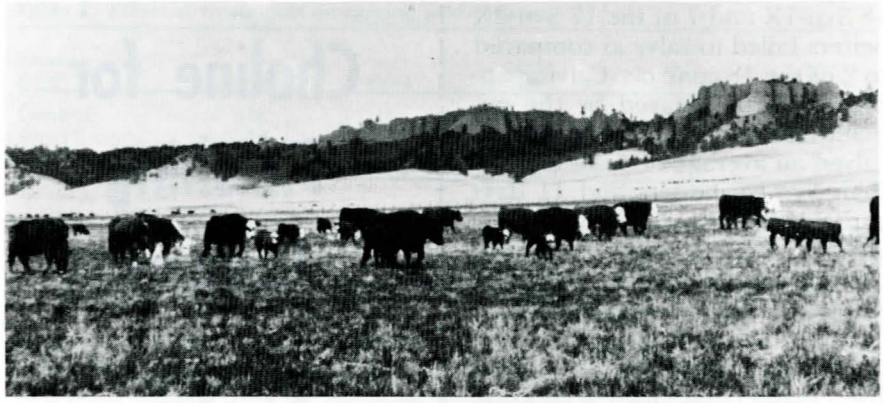

Cattle at the Fort Robinson Beef Cattle Research Station.

Hereford, Angus, Shorthorn

Effect of Heterosis

Larry V. Cundiff, Keith E. Gregory, Robert M. Koch[1]

An extensive crossbreeding experiment was started at the Fort Robinson Beef Cattle Research Station in 1957 involving Hereford, Angus and Shorthorn cattle. In 1972 cows and calves were transferred to the U.S. Meat Animal Research Center where the evaluation of heterosis or hybrid vigor through three genera-

Table 1. Effects of individual heterosis in Herefords, Angus and Shorthorns from Phase I of Fort Robinson experiment.[a]

Item	Crossbred calves	Straightbred calves	Heterosis Difference	Heterosis %
Number of matings	470	447		
Calves born, %	89	89	0	--
Calves alive at 2 weeks, %	86	82	4*	--
Calves weaned, %	84	81	+3	--
Birth wt, lb.	74.2	71.5	2.7**	3.8
Weaning wt, 200 days, lb.	437.4	418.0	19.4**	4.6
200-day wt/cow exposed, lb.	367.4	338.6	28.8*	8.5
Steers:				
Postweaning daily gain, lb.	1.845	1.794	0.052	3.0
452-day wt, lb.	912	883	29**	3.3
TDN/gain	5.76	5.77	−.01	−.1
Retail product, lb.[b]	331	320	11**	3.4
Retail product, %	63.4	63.9	−.5	−.9
Carcass grade[c]	10.2	9.9	0.3*	--
Retail product/unit TDN	0.1345	0.1338	+.0007	0.5
Net merit, $[d]	220.33	211.52	8.81	4.2
Heifers:				
2-year-old management[e]				
Postweaning daily gain, lb.	1.173	1.100	0.073**	6.6
550-day wt, lb.	853	805	48**	6.0
Age at puberty, days	321	356	−35**	9.8
Wt at puberty, lb.	580	587	−7	1.2
3-year-old management[f]				
Postweaning daily gain, lb.	0.985	0.910	0.075**	8.2
550-day wt, lb.	764	712	52**	7.3
Age at puberty, days	382	422	−40**	9.5
Wt at puberty, lb.	528	534	−6	1.1

[a] From Gregory *et al.*, J. Anim. Sci. 24:21; 25:290; 25:299; 25:311 and Wiltbank *et al.*, J. Anim. Sci. 25:744; 26:1005.

[b] Pounds closely trimmed, boneless cuts from the carcass.

[c] Grade of 9 = high good, 10 = low choice, USDA grades.

[d] Net merit is value of retail product (dollars) minus feed costs from weaning to slaughter.

[e] Heifers managed and developed to calve as 2-year-olds were born in 1962 and 1963 and fed about 4 pounds of concentrate feed per head per day during their first winter.

[f] Heifers managed and developed to calve first as 3-year-olds were born in 1960 and 1961 and fed 1 pound of 40% protein supplement per head per day during their first winter.

* P<.05.

** P<.01.

tions of systematic crossbreeding will be completed in 1976.

Heterosis or hybrid vigor has been evaluated by comparing crossbreds with straightbreds for a comprehensive series of traits of economic importance in beef production. The experiment has been conducted in three phases.

In phase I, estimates were made of individual heterosis expressed by the first generation (F_1) crossbred calf. In phase II estimates were made of maternal heterosis expressed by the F_1 crossbred cow. In phase III, which is nearly completed, an evaluation is being made of the level of heterosis sustained from one generation to the next by two- and three-breed rotational systems of crossbreeding. This report will briefly review results from phases I and II and provide preliminary information from Phase III.

Table 2. Effects of maternal heterosis in Herefords, Angus and Shorthorns from Phase II of Fort Robinson experiment.[a]

Item	Crossbred cows	Straightbred cows	Heterosis Difference	Heterosis %
Number of matings	687	570		
Conceived 1st service, %[b]	63.2	56.6	6.6*	--
Pregnant end breeding, %[b]	91.5	85.9	5.6**	--
Pregnant in fall, %[b]	89.7	84.5	5.2**	--
Full term calf, %[b]	87.2	81.1	6.1**	--
Live calf born, %[b]	86.2	80.4	5.8**	--
Live calf 2 weeks, %[b]	84.4	77.8	6.6**	--
Live calf weaned, %[b]	81.6	75.2	6.4**	--
Calving to 1st estrus, days	53.6	56.3	−2.7*	--
Conception date, Julian date	156.3	159.1	−2.8*	--
Gestation length, days	284.7	283.5	1.2	--
Calving date, Julian date	76.0	77.6	−1.6	--
Calf weight:				
No. calves	555	420		
Birth wt, lb.	76.4	75.2	1.2*	1.6
135 days, lb.	338.0	326.3	11.7**	3.6
Weaning, 200 days, lb.	453.1	434.6	18.5**	4.3
12-hour milk production, lb.				
2 weeks	6.79	6.73	0.06	0.09
6 weeks	7.55	7.02	0.53*	7.5
June (approx. 14 weeks)	7.91	7.45	0.46	6.2
Weaning (approx. 29 weeks)	3.31	2.40	0.91**	37.9
200-day wn wt/cow, lb.[b]	379.3	333.0	46.3**	13.9
Actual wn wt/cow, lb.[b]	392.5	341.8	50.8**	14.8

[a] From Cundiff *et al.* J. Anim. Sci. 38:711; 38:728.

[b] Based on all cows exposed to breeding: 687 cow-year-matings for crossbred females and 570 cow-year-matings for straightbred females.

* P<.05.

** P<.01.

Individual Heterosis (Phase I)

The three straightbreds and reciprocal crosses (e.g. Hereford-Angus and Angus-Hereford) among Herefords, Angus and Shorthorns were produced in four calf crops (1960–63). The data included 393 crossbred and 358 straightbred calves sired by 16 Herefords, 17 Angus and 16 Shorthorn bulls. A series of economically important traits were studied, including those presented in Table 1.

There was no difference between crossbred and straightbred calves for percent calf crop born, but survival was significantly greater in crossbreds. Crossbred calves were 4.6% heavier at weaning (7 months of age) than strightbreds. The combined advantages in survival and growth rate accounted for an 8.5% advantage in weight of calf weaned per cow exposed in favor of crossbred calves over straightbred calves.

There was essentially no difference between crossbred and straightbred steers in feed efficiency. The crossbred steers produced slightly fatter carcasses when killed at the same age; however, when adjusted for differences in carcass weight, there were no differences in carcass composition.

The effect of heterosis on post-weaning growth rate of heifers on lower levels of feeding was greater than in steers on a growing-fattening ration. There was a tendency for effects of heterosis on growth rate to decrease with age after about one year of age.

Crossbred heifers reached puberty (first estrus) 35 and 40 days younger than straightbreds on the moderate level of feeding associated with 2-year-old first calving and the low level of feeding associated with 3-year-old first calving, respectively.

Maternal Heterosis (Phase II)

The straightbred and reciprocal cross females produced in Phase I of the experiment involving Angus, Herefords and Shorthorns were kept to evaluate maternal heterosis for reproduction and maternal traits in Phase II. Straightbred and reciprocal cross females of each pair of breeds were compared when they were mated to the same sires of a third breed. For example, to evaluate maternal heterosis in Angus-Shorthorn reciprocal crosses, we compared the performance of Angus-Shorthorn and Shorthorn-Angus cows with that of Angus and Shorthorn straightbred cows when the cows in all four groups were mated to the same Hereford bulls.

There were 570 matings of straightbred cows and 687 matings of straightbred cows accumulated over six breeding seasons to produce spring calf crops from 1963 through 1968. About half of the cows were developed and managed to calve first as 2-year-olds and half as 3-year-olds, to evaluate the effects of maternal heterosis expressed from 2 through 6 years of age and 3 through 8 years of age in each management regime, respectively.

Calf crop weaned was 6.5% greater for crossbred than straightbred cows (Table 2). This difference was due to higher pregnancy rates and first service conception rate in the crossbreds. Differences in suvival of calves from birth to weaning were small and not significant in the second

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Effect of Heterosis

(continued from page 29)

phase of the experiment when crossbred and straightbred cows were both raising crossbred calves.

Effects of maternal heterosis (Table 2) were 1.7% for birth weight, 3.6% for weight at 135 days and 4.7% for weight at 200 days (weaning). These effects of maternal heterosis did reflect greater and especially more persistent milk production favoring crossbred cows over straightbred cows by 0.9% at 2 weeks after giving birth, 7.5% at 6 weeks, 6.1% at about 14 weeks and 38% at weaning at about 29 weeks after giving birth. Actual weaning weight was 14.8% greater per cow exposed to breeding for crossbred cows than for straightbred cows on the average over both management regimes due to combined effects of maternal heterosis on reproduction and maternal ability.

Cumulative Effects of Heterosis

When advantages of individual heterosis on survival and growth of F_1 crossbred calves (Phase I) and the advantage of maternal heterosis on reproduction and maternal ability of crossbred cows (Phase II) are combined, results indicate that weight of calf weaned per cow exposed to breeding would be increased 23% or about 80 pounds. The effect of individual heterosis on survival and growth of the F_1 crossbred calf was responsible for 8.5% or 28 pounds (Table 1) of this total increase. In Phase II crossbred cows were compared to straightbred cows when they were both raising crossbred calves by the same sires of a different breed. The crossbred cow contributed 14.8% or about 51 pounds (Table 2) to the total effect of heterosis. Thus, more than half of the increased performance from heterosis was attributable to crossbred cows.

Preliminary results indicate that further advantages will be accrued through greater longevity and lifetime production of crossbred cows compared to straightbreds. The cows involved in Phase II were kept until November of 1975 when the cows ranged in age from 12 to 15 years of age. Since their first breeding season when all open heifers were culled, the cows were removed only for serious management reasons such as cancer eye, severe injury or bad udders; death; or being open two years in succession between the ages of 2 through 10. Ten-year-old and older cows were culled the first time they were open.

Twenty-four percent (43/178) of the original crossbred heifers assigned to breeding pastures to initiate Phase II remained in the breeding herd until the end of the experiment, compared to 11% (17/158) of the straightbreds.nAt 12 years of age, 40% of the crossbreds remained compared to 21% of the straightbreds.

Systems of Crossbreeding (Phase III)

There have been differences among Herefords, Angus and Shorthorns for specific traits. However, these differences have been relatively small compared to the range of germ plasm available. Results indicate that these breeds are compatible in terms of calving difficulty. They have been comparable in terms of level of nutrients required to provide for growth, maintenance, lactation and reproduction.

Thus, the primary benefit of crossing these breeds would be to take advantage of the substantial effects of heterosis on survival and growth of calves and reproduction and maternal performance of cows which increased production per cow 23%. Only about 60% of this advantage could be realized if straightbred cows were required to continuously produce F_1 cows and replace themselves. Hence, Phase III of the experiment was designed to determine the level of heterosis that can be restored from one generation to the next by two- and three-breed rotation among the Hereford, Angus and Shorthorn breeds. The outcome will depend on the mode of gene ac-

Table 3. Experimental design and number of matings in Phase III of heterosis experiment with Herefords (H), Angus (A) and Shorthorns (S).

Generation 1 (4 Calf crops, 1969–72)			Generation 2 (5 Calf crops, 1971–75)				
				No. matings/sire			
Sire	Dam	No. matings	Dam	H	A	S	Total
			Straightbred Controls				
H	H	131	H	94			94
A	A	137	A		153		153
S	S	163	S			164	164
		431					141
			2-Breed Rotation				
H	HA	42	H.HA		34		34
H	AH	34	H.AH		26		26
A	HA	41	A.HA	52			52
A	AH	34	A.AH	42			42
		151					154
H	HS	24	H.HS			35	35
H	SH	39	H.SH			29	29
S	HS	23	S.HS	17			17
S	SH	39	S.SH	33			33
		125					114
A	AS	26	A.AS			36	36
A	SA	40	A.SA			55	55
S	AS	26	S.AS		16		16
S	SA	42	S.SA		43		43
		134					150
All 2-Breed		410					
			3-Breed Rotation				
H	AS	26	H.AS		21	20	41
H	SA	44	H.SA		21	27	48
A	HS	25	A.HS	15		15	30
A	SH	39	A.SH	38		32	70
S	HA	42	S.HA	26	26		52
S	AH	35	S.AH	11	13		24
All 3-Breed		211					265

tion responsible for heterosis and provide knowledge on optimal mating procedures to utilize heterosis.

The mating plan followed and the number of matings made in Phase III of the experiment are shown in Table 3. The Phase II cows consisting of straightbred Hereford, Angus, Shorthorn and all possible reciprocal F_1 crosses were used to produce the first generation of Phase III. All straightbred cows were mated to produce straightbred calves. The F_1 reciprocal cross cows were mated to produce either backcross (to set up the two-breed rotations) or three-way cross calves (to set up the three-breed rotations). Four calf crops were produced in generation 1 of Phase III with the final calf crop produced in 1972.

Heifers produced in generation 1 of Phase III were kept to evaluate heterosis maintained in two-breed and three-breed rotations relative to straightbreds. Matings were made such that contemporary comparisons between controls consisting of straightbred Herefords, Angus and Shorthorns could be made to all possible two-breed rotations and the three-breed rotation in all possible sequences when all matings were made using the same purebred sires. Five calf crops were produced. The final calf crop was produced in the spring of 1975.

Information on percentage of calf crop weaned, weaning weight and weight of calf weaned per cow exposed found in the first generation of Phase III are shown in Table 4. Percentage calf crop was 8% greater for three-way crosses out of F_1 dams than for straightbreds which compare closely to the expected 9.4% advantage resulting from combining effects of individual heterosis (3%) and maternal heterosis (6.4%) found in Phase I and Phase II, respectively. The 25% advantage in weight of calf weaned per cow exposed is very close to the cumulative advantage of 23% expected when comparing three-way crosses out of F_1 cows to straightbreds.

Backcross calves are expected to show half of the heterosis expressed by F_1 calves for individual heterosis (Phase I) and all of the maternal heterosis (Phase II) since they are out of F_1 dams. Results shown in Table 4 are close to expectation for all three traits, and especially close for weight of calf weaned per cow exposed.

Table 5 provides preliminary results for percentage calf crop weaned, weaning weight and weaning weight per cow exposed for the first four of five calf crops produced in the second and final generation of Phase III. Results exceed expectations slightly in both two- and three-breed rotations for all three traits. These results indicate that the level of heterosis sustained from one generation to the next is proportional to the level of heterozygosity expected for rotational systems of mating. Rotational systems of crossbreeding are very successful compared to straightbreeding, in sustaining a high level of heterosis and performance from one generation to the next.

Table 5. Effects of heterosis in rotational systems of crossbreeding (Phase III, 1972-1974 calf crops, preliminary analysis).

Item	Control	Rotational systems: 2-Breed	Rotational systems: 3-Breed
	Second Generation		
Mating type:			
Cow	St-Bred	1st backcross	3-Way cross
Calf	St-Bred	2nd backcross	1st backcross
No. matings	273	279	169
Calves weaned, %	68	75	81
205-Day wt, lb.	423	459	464
Wn wt/cow exposed:			
205-day wt/cow, lb.	288	344	375
Diff., lb.	0	56	87
Observed ratio	100	119	130
Expected ratio[a]	100	114	121

[a] Based on the expectation that calves in this generation of the two-breed crisscross express 75% of the individual heterosis of an F_1 calf (8.5% in Phase I) and being raised by a backcross cow express 50% of the maternal heterosis (14.8% in Phase II) while in this generation three-breed rotation calves express 75% of the individual heterosis and 100% of the maternal heterosis. This assumes that heterosis is proportional to heterozygosity and due to dominant gene effects.

Table 4. Effects of heterosis in rotational systems of crossbreeding (Phase III, preliminary analysis).

Item	Control	Rotational systems: 2-Breed	Rotational systems: 3-Breed
	First Generation		
Mating type:			
Cow	St-Bred	F_1 cross	F_1 cross
Calf	St-Bred	Backcross	3-Way cross
No. matings	431	410	211
Calves weaned, %	75	79	83
200-Day wt, lb.	433	477	488
Wn wt/cow exposed:			
Pounds	324	378	405
Diff., lb.	0	54	81
Observed ratio	100	119	125
Expected ratio[a]	100	119	123

[a] Based on the expectation that all backcross calves express half of the individual heterosis of an F_1 calf (estimated from Phase I to be 8.5%) and all maternal heterosis (determined in Phase II to be 14.8%) while 3-way crosses have maximum individual (Phase I) and maternal heterosis (Phase II). This assumes that heterosis is proportional to heterozygosity and due to dominant gene effects.

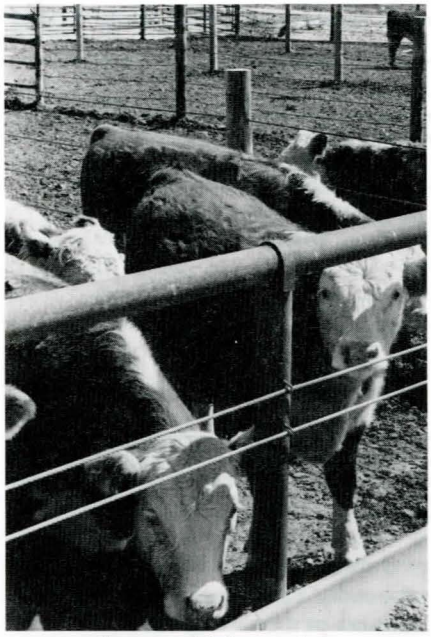
Summary

Heterosis can increase pounds of calf weaned per cow exposed 23%, according to results with Angus, Herefords, and Shorthorns.

More than half of this 23% advantage is dependent on the use of crossbred cows.

Compared to straightbreeding, rotational systems of crossbreeding sustain a high level of heterosis and performance from one generation to the next.

[1]Larry V. Cundiff is Research Geneticist, Keith E. Gregory is Director, and Robert M. Koch is Research Geneticist, U. S. Meat Animal Research Center, Clay Center, NE.



Steers on Ralco study.

"Ralco" in a Beef Cattle Finishing Ration

D. C. Clanton,
L. E. Jones[1]

Rising fixed costs and rising costs of grain and protein supplement have led to a continual search for ways to improve feed efficiency. One contender in the effort to improve feed efficiency is the commercially prepared product "Ralco." Ingredients are lactic acid, Verxite (non-nutritive), cobalt carbonate, grain products, wheat middlings, natural and artifical flavors added.

Experiments conducted during 1973 and 1974 at the North Platte Station indicate little or no advantage for Ralco in three finishing experiments and one digestion trial. There was a non-significant improved performance in only one of the three trials.

Table 1. Feeding Ralco in a finishing ration to heifers (99 days).

	10.0% Protein		11.5% Protein	
	No Ralco	Ralco	No Ralco	Ralco
No. of animals	16	16	16	16
Weight, lb.				
Initial	692	684	686	683
Daily gain[a]	2.16	2.16	2.34	2.33
DM consumed, lb.[b]				
Daily	19.39	18.71	18.94	18.87
Per lb. gain	8.98	8.66	8.09	8.10
Quality grade[c]	12.2	12.2	11.9	12.0

[a] Final weight adjusted to 62% yield.

[b] First 50 days the heifers received silage as the roughage and the last 49 days received grass hay fed at the same dry matter level.

[c] Average choice = 13, low choice = 12 and high good = 11.

Table 2. Feeding Ralco in a finishing ration to steers (146 days).

	10.0% Protein		11.5% Protein	
	No Ralco	Ralco	No Ralco	Ralco
No. of animals	11	12	12	12
Weight, lb.				
Initial	644	649	649	650
Daily gain[a]	2.41	2.59	2.63	2.58
DM consumed, lb.[b]				
Daily	18.13	18.57	18.76	19.56
Per lb. gain	7.52	7.17	7.13	7.58
Quality grade[c]	11.2	11.9	11.7	11.7

[a] Final weight adjusted to 62% yield.

[b] 85% dry rolled corn, 7% silage and 8% supplement dry matter basis.

[c] Low choice = 12 and high good = 11.

The Experiments

Three feeding experiments involving five replications were conducted. There were two replications of lightweight heifers starting the experiment at 14 months of age. The other three replications were yearling steers starting the experiment at about 18 months of age. There were four treatments in all experiments (two ration protein levels with and without Ralco). The third experiment using yearling steers contained these four and two additional treatments: high protein the first half of the feeding period and low protein the last half of the period with and without Ralco.

The basic ration in all experiments was (dry basis) 85% rolled corn, 7% corn silage and 8% supplement containing protein, minerals, vitamin A and appropriate additives. Stilbestrol was not fed but was used as an implant in the third experiment. No other implants were used.

In the first two experiments (two replications of heifers and one replication of steers) the concentration of Ralco in the supplement was formulated to provide as near as possible a half ounce per head per day. In the last experiment Ralco was not put in the supplement but was fed on a constant basis of a half ounce per head per

Table 3. Feeding Ralco in a finishing ration to steers (123 days).

	10.0% Protein		11.5% Protein		11.5% to 10.0%	
	No Ralco	Ralco	No Ralco	Ralco	No Ralco	Ralco
Steers per treatment	20	20	20	19	20	19
Avg. weights, lb.						
Initial	720	701	719	717	709	720
Daily gain[a]	2.63	2.63	2.58	2.79	2.43	2.70
DM consumed, lb.[b]						
Daily	18.4	18.7	18.3	19.0	18.1	18.8
Per lb. of gain	7.0	7.2	7.1	6.9	7.4	7.0
Carcass data						
Quality grade[c]	12.3	12.3	12.4	12.6	12.6	12.0
Yield grade	2.4	2.6	2.4	2.2	2.4	2.2

[a] Final weight adjusted to 62% yield.

[b] 85% dry rolled corn, 7% silage and 8% supplement dry matter basis.

[c] Average choice = 13, low choice = 12.

day using fine ground corn as a carrier. Calculated protein levels were 9.5% and 11% of the ration dry matter, but chemical analyses indicated that they were closer to 10% and 11.5% protein. The exact protein content of the rations is also subject to sampling error in that different corn sources were used as the experiments progressed.

A digestion trial was conducted using two rations, one without Ralco and the other with the recommended level of Ralco added. Both rations contained 8.7% crude protein on a dry matter basis, which was low enough to demonstrate a protein sparing effect of Ralco if it had that potential.

Results

Results of the three experiments are shown in Tables 1, 2 and 3. Grouping all three studies, there was no improvement in weight gains or feed efficiency resulting from the feeding of Ralco or from elevating the protein content of the ration from 10%.

Performance improved slightly from the 11.5% protein as compared to the 10% protein ration. This was because in the heifer experiment performance was better on the higher level of protein compared to the lower level, partly explained by the fact they were younger animals and may have still had a higher protein requirement.

Although not significant, there was a trend toward improved gain in the steers in the third experiment when they were fed Ralco on the higher protein rations. Those two groups of cattle ate more feed, thus the improvement in feed efficiency was not as pronounced.

There was no difference in the dry matter and protein digestibility of the two rations, one with and one without Ralco. The dry matter digestibilities were 82.3 and 83.5% for the rations with and without Ralco, respectively. The comparable protein digestibilities were 90.4 and 89.7% respectively.

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Selection—The Primary Force For Changing Herd Composition

Robert M. Koch[1]

Selection is the primary force for changing average genetic composition of herds, breeds, or species. Individual changes from one generation to the next associated with selection are usually small. In time, however, the change can be as dramatic as the difference between house cats and tigers.

Selection is deciding which bulls and cows get to become parents and how many offspring we allow them to have. Both the will of man and the will of nature are directive forces in selection. Rate of progress from selection is determined by (1) average selection differential of parents for all traits under selection, (2) heritability of traits, (3) genetic correlations between traits and (4) interval between generations of parents.

Selection differential is the difference in performance of selected sires and dams compared with the average of the unselected group from which they came.

Heritability is the fraction of observed differences between animals caused by average genetic differences.

Genetic correlation is the average genetic association between traits.

Interval between generations is the average age of sires and dams when offspring are born (which in our herd was 4.6 years).

Procedure

An experiment to study selection effects in beef cattle was started in 1960 with the Hereford herd at the Fort Robinson Beef Cattle Research Station. Foundation cows came from 14 different herds and were the progeny of 130 different bulls. Forty-two sires were used in the formative years.

In 1960 about 325 cows were randomly divided into three lines. Weaning weight, standardized to 200 days and adjusted for age of dam, was the selection criterion to pick replacement bulls and heifers in one line (WWL). Adjusted weight, at 452 days for bulls and 550 days for heifers, was the selection criterion in a second line called Yearling Weight Line (YWL). In the third line selection was based on an index giving equal emphasis to adjusted yearling weight and a muscling score (IXL).

Each line was expanded and maintained at 150 cows and 6 sires for any given year. Two bulls, selected on their respective criteria, were retained in each line each year. Bulls were used first as 2-year-olds and continued in service for 3 years. Lines were maintained at 150 cows after 1964 by retaining 25 bred heifers per line and removing 25 cows. Cows were removed according to criteria in the following priority:

1. Not pregnant when examined at time offspring were weaned.
2. Serious unsoundness.
3. Failure to raise a live calf two consecutive years.
4. Oldest age.

The cattle were transferred to

(continued on next page)

Table 1. Performance summary of lines (1961–1970).

Selection line	Sex	Birth weight[a] (lb)	Weaning weight[b] (lb)	Yrlg. weight[c] (lb)	Muscle score (units)
Weaning weight	Bulls	80.9	454	968	81.6
	Hfrs.	76.1	426	836	80.8
Yearling weight	Bulls	82.2	448	981	82.1
	Hfrs.	76.3	412	827	80.8
Index	Bulls	82.7	450	972	82.5
	Hfrs.	77.0	419	836	82.3

[a] Adjusted for age of dam.
[b] Adjusted for age of dam and standardized at 200 days of age.
[c] 452 days age for bulls and 550 days for heifers.

Selection . . .

(continued from page 33)

the U.S. Meat Animal Research Center in 1971.

Selected bulls and heifers born in 1960 produced the first selected generation in 1963. Average performance of these lines for the 10-year period is shown in Table 1.

Selection Applied

Selection differentials of replacement sires were calculated by expressing records as deviations from the average of their respective year-line-sex group.

For example, the two sires selected in the Weaning Weight Line from the 1966 calf crop had selection differentials as shown in Table 2.

In a typical year there were 64 to 75 bulls in a line-year group at weaning. Of these, 60 to 70 bulls completed postweaning performance in sound condition. Two of these bulls were then selected on the basis of their weaning weight (WWL), or yearling weight (YWL). In the Index Line the deviations for yearling weight and muscling score were combined in such a manner that the two bulls with the largest average deviation (Index) were selected. Mean selection differentials of 57 sires selected from 1960 to 1968 and used in their respective lines are shown in Table 3.

Selection differentials in Table 3 emphasize that primary selection for one trait may lead to significant selection differentials in other traits because of natural correlation between traits or chance. Selection differentials of all traits and their normal relationships were considered in interpreting the amount of total selection practiced and response expected in each trait.

Selection of replacement heifers in each line was similar to selection procedures for bulls. There were only 36 to 45 heifers available in each line-year group at fall yearling age from which the 25 "best" pregnant heifers were selected. Fewer heifers than bulls were available at yearling age because three heifers out of mature cows were randomly selected from each sire group (18 per line) at weaning, placed on a growing-finishing program for 225 to 250 days and slaughtered for carcass evaluation.

This sampling of heifers provided data on feedlot gain, efficiency of feed use and carcass merit as affected by selection programs of the three lines. All remaining heifers were exposed to bulls during the summer breeding season. On the average, 90% of the heifers became pregnant and selection of replacements was restricted to pregnant heifers. Selection differentials of the replacement heifers are shown in Table 3.

Sires and dams contribute equally to the average genetic makeup of offspring. Midparent values in Table 3 show the average selection pressure applied when both bull and heifer replacements are considered.

Comparative size of bull and heifer selection differentials illustrates the often quoted phrase that "most of the selection intensity must come from bull selection." In the case of weaning weight in WWL, 80% of the midparent selection differential was due to

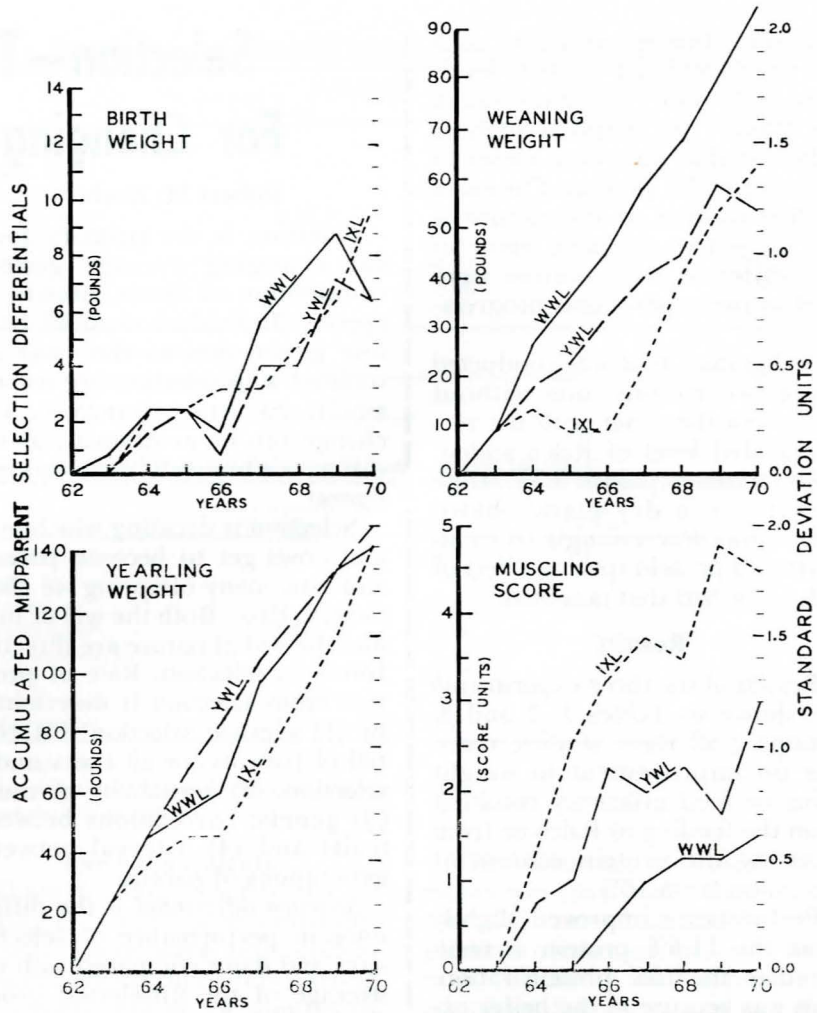


Figure 1. Accumulated midparent selection differentials of calves born 1962–1970 in the weaning weight line (WWL), yearling weight line (YWL), or index line (IXL). All traits scaled in standard deviation units as shown by the scale on the right. Equivalent scales in actual units, i.e., pounds or scores are given at the left of each graph.

Table 2. Selection differentials of sires in weaning weight line (1966).

Trait	Avg 1966, WWL, bulls	Bull A Record	Bull A Sel. diff.	Bull B Record	Bull B Sel. diff.
Birth wt, lb.	77	64	−13	89	12
Wean. wt, lb.	465	518	53	541	76
Yrlg. wt, lb.	996	1081	85	1037	41
Musc. score	81	82	1	81	0

Table 3. Selection differentials of selected parents (1960–1968).

Selection line	Trait: Birth wt (lb)	Wean. wt (lb)	Yrlg. wt (lb)	Muscle score (units)
		Bull selection differentials		
Weaning weight	6.8	78	122	1.1
Yearling weight	5.6	58	140	2.7
Index	7.6	51	111	4.5
		Heifer selection differentials		
Weaning weight	1.6	19	22	0
Yearling weight	1.5	12	18	0
Index	2.2	12	25	0
		Midparent[a] selection differentials		
Weaning weight	4.2	48	72	0.6
Yearling weight	3.6	35	79	1.4
Index	4.9	32	68	2.3

[a] Midparent is the average of bulls and heifers.

bulls and for yearling weight in YWL, 89% of the midparent selection differential was due to bulls.

Annual patterns of selection as determined by the total accumulated midparent selection differentials of all calves born in each line are shown in Figure 1. Accumulated selection differentials include selection differentials of parents, plus the average selection differentials of each set of parents from previous generations.

There was a three-year lag (1960 to 1963) from initiation of the experiment until offspring were produced by parents selected in the experiment. Increase in accumulated selection was quite regular for weaning weight in WWL and yearling weight in YWL. It was somewhat irregular for unselected traits, for example, yearling weight or muscling score in WWL or weaning weight and muscling score in YWL. It was also somewhat irregular when a trait was only part of the selection criterion. For example, (1) birth weight as a part of weaning or yearling weight or (2) muscling score and yearling weight in the Index Line.

Response to Selection

Only that fraction of selection differentials in the parents due to differences in average genetic merit is recovered in terms of increased (or decreased) performance of offspring.

Average response observed in offspring associated with selection in the parents is shown in Table 4. Amount of selection shown in parents corresponds to one standard deviation for each trait, i.e., 8.3 lb birth weight or 46 lb weaning weight or 72 lb yearling weight is one standard deviation unit. Values underlined along the diagonal indicate response to direct selection for these traits. The off-diagonal values are the correlated responses expected in traits not under primary selection.

For example, if we paid no attention to other traits but selected parents that average 72 lb superiority in yearling weight we could expect offspring to weigh 34.6 lb heavier than average for yearling weight which is direct response to selection. We would also expect these calves to weigh 3.3 lb more at birth, 12.0 lb more at weaning, and have muscle scores .15 unit more than the average calves from unselected parents as correlated response to selection for yearling weight.

Change per generation of selection was estimated by five different methods for each line and the average results are given in Table 5. Birth weight increased in all lines because of direct selection as a component of weaning or yearling weight and from correlated response associated with gain from birth to weaning or yearling age. Expected increase in birth weight could be reduced by 30% if all growth selection was directed to gain after birth instead of total weaning or yearling weight.

Response in weaning weight was greatest in the Weaning Weight Line. Response in yearling weight was greatest in the Yearling Weight Line while muscling score was greatest in the Index Line. The response of correlated traits in the three lines are probably of as much interest as the differences in the primary selection traits. Similarity of response in birth, weaning and yearling weight in the three lines which differed markedly in relative selection applied is evidence of strong genetic correlations between traits under selection. This situation is fortunate in that improvement programs can use a wide variety of performance evaluation patterns as may be dictated by various management considerations to attain improved growth performance.

The experiment will be continued for another 5 to 10 years to check on continued progress. A "control" line, established from foundation cows bred with semen from foundation sires, has been added at the U. S. Meat Animal Research Center. Comparison of the selected lines to the control line will provide an additional direct measure of selection response.

[1]Robert M. Koch is Research Geneticist, U.S. Meat Animal Research Center, Clay Center, Nebraska.

Table 4. Average change in offspring per standard deviation of selection in parents.

Trait	Midparent: Stand. dev.	Change in offspring: Birth wt	Wean. wt	Yrlg. wt	M. sc
Birth wt	8.3 lb	3.9	6.4	20.0	−.10
Wean. wt	46 lb	2.2	5.5	20.0	.15
Yrlg. wt	72 lb	3.3	12.0	34.6	.15
M. sc	2.5 u	2.3	5.1	17.3	.78

Table 5. Estimated genetic change per generation.

Line	Birth wt	Wean. wt	Yrlg. wt	Muscle score
Weaning weight	1.8	10.6	25.9	−.08
Yearling weight	2.3	7.8	31.0	.02
Index	2.3	6.9	23.8	.60

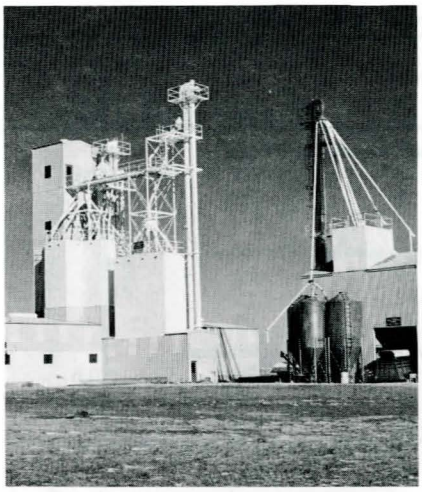
Monensin—Tylosin Combinations

Stanley D. Farlin[1]

Monensin is effective in reducing the amount of feed required for gain but does not reduce liver abscesses. Tylosin reduces liver abscesses and may slightly improve feed efficiency and rate of gain.

Results of a trial where the combination of monensin and tylosin was studied indicate that tylosin was effective in reducing liver abscesses and produced a small improvement in efficiency of gain which was additive to the improved feed efficiency obtained from monensin.

The combination of 30 g monensin and 10 g tylosin improved feed efficiency by 14.5%. Monensin alone at 30 g level improved feed efficiency by 9.3%. Tylosin alone at 10 g level improved feed efficiency by 4.3%. Monensin at the 30 g level only reduced gain slightly, however, in combination with 10 g tylosin, 30 g monensin did not effect rate of gain. There was a 1 to 3 lb reduction in daily feed intake with the higher levels of monensin which resulted in much of the improvement in feed efficiency. Tylosin did not appear to affect intake when added with monensin.



New feed mill at Mead expands capability for preparing experimental rations.

Experimental Procedure

The trial involved a total of 383 yearling Angus, Hereford, Angus X Hereford and Charolais crossbred steers weighing about 660 pounds. The cattle were fed a ration consisting of 10% alfalfa brome hay, 85% high moisture corn and 5% supplement (dry basis) for 153 days. All cattle were implanted with Synovex-S implants on day 30 of the trial.

The treatment groups included 0, 5, 20 and 30 g/ton monensin with 0 or 10 g/ton tylosin replicated in confinement pens and conventional outside lots.

Carcass measurements were obtained at slaughter. Incidence and severity of liver abscesses were recorded.

Results

Feed efficiency, gain, feed intake and carcass data are summarized in Table 1.

There was an improvement in feed efficiency as level of monensin was increased through the 30 g level. Monensin levels of 0, 5, 20 and 30 g/ton of ration combined with 10 g tylosin resulted in 6.56, 6.02, 6.19 and 5.61 lb of feed required per pound of gain. Tylosin consistently caused a slight reduction in feed required per pound of gain in all monensin treatments.

Monensin alone reduced feed intake at the 20 and 30 g/ton levels by 4% and 15%, respectively. Combining tylosin and monensin did not affect the reduction in feed intake observed with the higher levels of monensin. Rate of gain was about 6% higher than control when 5 g monensin alone or 5 g monensin combined with 10 g tylosin was included in the ration. The 30 g level of monensin was the only level to reduce gain. It reduced rate of gain by about 6%.

Tylosin reduced incidence of liver abscesses from 31% observed with no tylosin to 19% in tylosin treatment groups. Sixty additional cattle of the same source and fed the same ration but in a different facility also received the 10 g tylosin/20 g monensin combination and confirmed the reduction of incidence of abscesses with a 20% incidence observed. Tylosin reduced the severity of liver abscesses as determined by number and appearance of abscesses on the liver.

The effects of feeding monensin and tylosin in combination in finishing rations on efficiency of gain, rate of gain, feed intake and incidence of abscessed liver are the same as when fed alone. Results indicate that effects of the two compounds are additive.

Table 1. Effect of monensin and tylosin in finishing rations.

	Tylosin and monensin treatments (g/ton ration)							
Items	T-M 0,0	T-M 0,5	T-M 0,20	T-M 0,30	T-M 10,0	T-M 10,5	T-M 10,20	T-M 10,30
No. animals	48	48	47	47	46	47	48	46
Initial wt, lb.	657	666	668	663	659	667	678	669
Final wt[a], lb.	1120	1151	1131	1099	1133	1160	1128	1136
ADG, lb.	3.02	3.17	3.02	2.84	3.09	3.21	2.99	3.05
Avg. daily feed, DM, lb.	19.80	20.43	19.04	16.90	19.42	19.34	18.50	17.10
F/G	6.56	6.44	6.30	5.95	6.28	6.02	6.19	5.61
Hot carcass wt, lb.	670	683	667	649	678	700	673	671
USDA carcass grade[b]	11.6	12.0	11.9	11.4	12.0	12.2	11.8	11.6
Yield grade[c]	2.5	2.7	2.4	2.5	2.7	3.0	2.8	2.6
Liver abscesses[d]	15(9)	12(7)	16(11)	16(15)	10(3)	12(6)	5(3)	9(6)

[a] Final weight adjusted to equal dressing percent based on hot carcass weight.

[b] 11=high good; 12=low choice.

[c] Yield grade 2.0 and 3.0 represents 52.3 and 50.0%, respectively of carcass weight in boneless, closely trimmed retail round, loin, rib and chuck.

[d] Number in parenthesis is number of abscessed livers with a minimum of 2 severe abscesses.

[1]Stanley D. Farlin is Associate Professor, Beef Nutrition.

Steers can eat at will through use of new electronically operated gates tuned to open only for their individual key carried on their neck chain.

Adding Whey to Roughage Rations

Mike Prokop,
T. J. Klopfenstein,
Lyle Petersen[1]

Cattle fed high roughage growing rations, such as those based on corn silage or corn cobs, perform better when supplemented with soybean meal than with urea. This difference is greatest during the initial 21 to 28 days on feed.

Previous Nebraska research suggested that the addition of ½ lb of dried whole whey daily to urea-supplemented corn silage rations reduced the difference in performance between rations supplemented with urea and soybean meal. No advantage was obtained by feeding whey for the entire trial as compared to feeding whey for only the first 28 days.

Two feeding trials were conducted to evaluate the addition of partially delactosed whey to urea-supplemented corn cob-based rations.

Delactosed whey contains 45% lactose, compared to 70% for dried whole whey. Lactose removal results in higher protein and vitamin levels than dried whole whey. Animals fed delactosed whey in combination with urea had consistently more rapid and efficient gains that those fed urea alone.

Table 1. Steer performance data.

		Treatment		
	Period, days	SBM	Urea	Urea + whey
Initial wt, lb.	–	456	477	449
Avg. daily gain, lb.	0-28[a]	3.01	2.04	2.17
	0-115[b]	1.64	1.14	1.37
Avg. daily feed, lb.	0-28	15.7	15.4	15.2
	0-115	13.0	12.4	13.0
Feed/gain	0-28	5.22	7.55	7.00
	0-115	7.95	10.90	9.52

[a] Shrunk to full weight.
[b] Shrunk to shrunk weight.

Table 2. Heifer performance data.

		Treatment		
	Period, days	SBM	Urea	Urea + whey
Avg. daily gain, lb.	0-28[a]	3.57	1.58	2.55
	0-112[b]	2.09	0.91	1.31
Avg. daily feed, lb.	0-28	17.07	15.54	15.06
	0-112	18.34	15.82	16.67
Feed/gain	0-28	4.78	9.84	5.91
	0-112	8.78	17.38	12.73

[a] Shrunk to full weight.
[b] Shrunk to shrunk weight.

Table 3. Pooled performance data[a]

	Treatment		
	SBM[b]	Urea[c]	Urea + whey[c]
Avg. daily gain, lb.	1.72	1.15	1.38
Feed/gain	8.95	12.93	10.97

[a] Data obtained from two corn cob based trials and one corn silage based trial.
[b] 28 animals.
[c] 29 animals.

Feeding Trials

The influence of feeding various sources of supplemental protein to predominantly Angus calves, fed a 65% ground corn cob ration, was studied in Trial 1. Two pens of five steers were fed one of the following sources of supplemental protein: (1) soybean meal, (2) urea, (3) urea plus ⅓ lb whey/hd/day.

Feed intakes among rations were held about equal throughout the 115-day experiment. Complete rations were supplemented with vitamins and minerals to meet National Research Council (NRC) requirements. All rations contained 8% molasses and corn to balance for energy.

Trial 2 was similar to Trial 1 in that a 65% ground corn cob ration was supplemented with either soybean meal, urea, or a combination of urea and ½ lb of delactosed whey daily. Seven Charolais cross heifers averaging 550 lb were assigned to each treatment and allotted into two pens of two head each and one pen of three head. Complete rations were fed free choice for the 112-day trial. Rations were balanced at 11% crude protein, .4% calcium and .35% phosphorous.

In both trials, supplemental nitrogen supplied over half of the total ration protein. This was specifically designed to stress the source of supplemental nitrogen. The cattle were started and removed from experiment following a 16-hour period without feed or water.

Results

In Trial 1 soybean meal-supplemented animals gained

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Adding Whey . . .

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more rapidly and were more efficient than those on other treatments during the first 28 days (Table 1). The addition of whey to urea resulted in an increased daily gain of 0.13 pounds. Over the entire trial, soybean meal retained the advantage and the advantage of urea-whey increased to 0.23 lb over urea alone.

In Trial 2 cattle fed soybean meal gained 2 lb/day faster than those fed urea during the first 28 days (Table 2). The addition of whey decreased the advantage of SBM one-half. The soybean meal advantage is associated with fill. Through the entire trial, the addition of whey gave a 0.4 lb daily gain advantage over the urea control. Whey resulted in intake and feed efficiency between those obtained with urea and soybean meal.

Over both trials, soybean meal-fed animals gained .84 lb per day more than those fed urea. This difference was reduced to .53 lb per day by feeding delactosed whey to the urea-fed animals. Calves fed urea required 5.9 lb more feed per pound of gain than those fed soybean meal. Addition of whey reduced this to 2.8 lb more feed per pound of gain than for SBM.

These trials were pooled with data from previously reported corn silage trials (Table 3). Compared to urea alone, the addition of whey increased daily gain 0.23 lb and decreased feed required per pound of gain by 1.96 pounds.

Whey added to urea-supplemented rations improved animal performance. Whey has been proposed as an excellent source of branched chain carbon structures which are required by rumen microbes for protein synthesis. In addition, whey may furnish supplemental growth factors such as B vitamins.

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[1]Mike Prokop is Graduate Assistant. T. J. Klopfenstein is Professor, Ruminant Nutrition. Lyle Petersen is Graduate Assistant.

Steers fed drought damaged corn silage.

Drought Damaged Corn Silage

Vernon Krause,
T. J. Klopfenstein,
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Drought damaged corn harvested as silage has been shown, in previous studies, to be nearly equal to normal corn silage when fed as the main ingredient in calf and yearling growing rations. However, these results, while very useful, may be subject to question as silages used in these comparisons were not harvested during the same growing season. Either drought damaged or normal silages were held over a year to make the comparisons. In addition, quantities of silages held over were limited, so numbers of cattle were smaller, and trial length was reduced.

In 1974, drought was severe. Rainfall was plentiful early in the growing season, but for about 60 days during June, July and August, no appreciable precipitation occurred. Drought and hot, dry winds during tasseling limited corn grain production to less than 10 bushels per acre. Harvest of drought damaged corn began when dry matter of the plant reached 30%. Dry matter of the silage when fed averaged 33%.

Corn irrigated from a nearby creek was harvested to serve as a normal corn control. Normal (irrigated) corn plants were harvested following completion of drought corn harvest. Dry matter content of the normal silage was 55%.

Drought or Normal Silage

Hereford, Angus, and Angus-Hereford crossbred steer calves were fed either drought or normal corn silage rations. Calves fed each silage also received either no supplemental protein or protein coming from soybean meal or urea. Rations containing urea were formulated, using protein analysis of the silages, to contain 11.5% crude protein. Rations containing soy-

Table 1. Drought vs normal corn silages for growing steers.[a]

	Silage	
	Drought	Normal
Number of cattle	140	45
Avg. daily gain, lb.	1.44	1.63
Avg. dry matter consumed, lb.	14.2	13.6
Feed/gain	9.87	8.37

[a] Trial length, 190 days.

Table 2. Effect of urea and soybean meal as supplemental protein sources for calves fed drought or normal corn silage.[a]

	Drought Silage			Normal Silage		
	Soybean meal	60% protein urea supplement[b]	No protein	Soybean meal	60% protein urea supplement	No protein
Number of cattle	28	28	28	9	9	9
Initial weight, lb.	425.5	424.5	420.3	400.0	399.2	412.0
Avg. daily gain, lb.	1.47	1.18	1.08	1.81	1.64	1.03
Avg. dry matter consumption, lb.	14.4	14.0	13.2	13.9	13.6	12.3
Dry matter feed consumed/gain	9.8	11.9	12.4	7.7	8.3	11.9

[a] Trial length, 190 days.

[b] 60% *protein* urea supplement: ground corn 81.15%, urea 18.85%.

bean meal were formulated to 11.5% protein using average protein content values for normal corn silage. All rations were formulated to contain minerals and vitamins.

Performance of steers fed drought or normal corn silages is shown in Table 1.

Steers fed normal silage gained 12% more and consumed 4% less feed than steers fed drought silage. Feed efficiency was 18% greater for steers fed normal silage than steers fed drought silage. Gains and feed efficiency indicate that energy in drought silage was less than in normal silage.

Drought silage, in most instances, contains a higher nitrogen (protein) content than normal silage. Utilization of this nitrogen depends upon the form in which it exists in the plant. Protein in the corn plant may be readily soluble, therefore easily degraded, while protein in corn grain may be slowly degraded.

A large portion of the protein in normal silage comes from grain. Protein in drought damaged corn is found in the corn plant due to limited grain production.

Soybean meal, urea and no supplemental protein treatments were added to drought and normal silages to measure the effect of type of protein found in drought and normal silages. Performance of steers fed drought or normal silages with no supplemental protein or protein from soybean meal or urea is shown in Table 2.

Steers fed normal silage supplemented with urea gained 0.61 lb/head/day more than steers fed no supplemental protein. Gain of steers fed normal silage (8.5% protein, dry basis) and no protein supplement were most likely limited by lack of adequate ration protein. Gains of steers on drought silage (10.1% protein, dry basis) were probably limited by the lower energy content of the silage since those fed urea gained only 0.1 lb/head/day more than steers fed no supplemental protein.

While energy may be one factor limiting gains, formed protein may be another, especially in rations fed to lightweight calves. The large differences in daily gain for cattle fed urea supplemented drought or normal silages could be partly due to the formed protein in the grain of normal corn silage.

Steers fed drought silage and soybean meal gained 0.28 lb/head/day more than steers fed urea. Cattle fed normal silage and soybean meal gained 0.19 lb/head/day more than steers fed urea. Most likely, normal corn silage contains more slowly degraded protein than does drought silage.

Feed efficiency of cattle fed the silage rations followed very closely the relationships found in average daily gain.

Summary

Harvesting drought corn as silage salvages a crop. While of less value than normal corn silage, drought silage is of considerable value when fed to growing calves.

Supplementation of drought silage with a natural protein source such as soybean meal, ignoring the additional protein in drought silage, results in the greatest average daily gains and feed efficiency.

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Chemical Treatment Of Crop Residues

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Chemical treatment of crop residues can increase the energy content of fibrous materials such as cornstalks. The result: more grain is freed from meat production in a world where demand for feed grains is rising.

Previous Nebraska research has shown that chemical treatment has practical significance. Three growth trials have since been conducted to further evaluate chemical treatment for improving the energy utilization of corn cobs and corn stalklage by steer calves and lambs.

Calf Trial

In Trial 1, 64 calves weighing 575 lb initially were allotted to four ration treatments for a 116-day trial. Ground corn cobs were treated with two ratios of sodium hydroxide [NaOH] to calcium hydroxide [$Ca(OH)_2$] added at the rate of 3 and 1% of cob dry matter or 1 and 3%, respectively. Water was added to increase the moisture level of the treated cobs to 60%. The cobs were fed as the only roughage source in two rations or in a 50:50 mixture of treated cobs and forage sorghum silage in the other two rations. A brewer's dried grain and urea supplement were used to balance the rations for 11.5% crude protein.

Steers fed either 3:1 or 1:3 treated cobs alone gained 1.9 lb/hd/day (Table 1) although the 3:1 fed steers were 4.2% more efficient in converting feed dry matter to liveweight gain (7.55 vs 7.87 lb

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Chemical Treatment . . .

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feed DM/lb gain). Either cob treatment fed as the only roughage source supported faster and more efficient gains than the mixture of treated cobs and silage. The steers fed 3:1 treated cobs with silage gained faster (1.72 vs 1.59 lb/hd/day) and more efficiently (8.57 vs 9.46 lb feed DM/lb gain) than those fed 1:3 treated cobs and silage. Dry matter intake was about equal for all treatments.

Lamb Trial

In Trial 2, 36 lambs weighing 50 lb initially were individually fed ensiled corn stalks which had been chemically altered by the addition of one of six ratios of NaOH:-$Ca(OH)_2$. After water was added to increase the moisture to 60%, the following ratios of NaOH and $Ca(OH)_2$ were added as a percent of the original stalk dry matter: 0:0; 1:3; 3:1; 3:2; 4:0; 4:1. The stalks had been harvested in the fall of 1974 with a stacker and remained in the stack until ground, treated and ensiled in 55-gallon barrels in mid-August, 1975. The treated material was allowed to ensile for seven days before starting the trial.

Untreated control stalks provided essentially a maintenance ration producing very little gain and poor feed efficiency (Table 2). Stalks treated with the 1:3 ratio increased gain by 200% and feed efficiency by 131% over the control ration. Lambs fed stalklage treated with 3% or more NaOH gained similarly and at a rate five times that of the control-fed lambs. Feed efficiency was also improved over the control-fed lambs with these levels of NaOH.

In addition to the trials discussed, a 106-day growth trial with steer calves was conducted to compare stalks treated with NaOH and $Ca(OH)_2$ to sweet clover control silage. The calves gained only 1 lb/hd/day on all rations. The stalklage-fed calves gained equally as well as the silage-fed calves indicating similar energy utilization. Feed efficiency was relatively poor on all treatments. The stalklage appeared to be highly contaminated with soil. Due to the considerable amount of soil that was fed to the calves, it is believed that this trial was not a fair evaluation of treated stalklage.

3:1 Ratio Effective

The results of Trials 1 and 2 indicate that the 3:1 ratio of NaOH:$Ca(OH)_2$ is effective as a means of increasing utilization of fibrous feedstuffs such as corn stalks or corn cobs.

Calcium hydroxide is cheaper than sodium, therefore, this treatment is relatively economical while supporting improved animal performance over control rations.

Using sodium levels above 3% increases the amount of sodium in the manure which may affect the soil to which it is applied and increases the cost of chemical treatment.

The use of $Ca(OH)_2$ in the treatment serves as a calcium source, reduces the cost, and decreases the amount of NaOH needed while maintaining animal performance equal to that observed with higher levels of NaOH.

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Treated cobs and stalks are stored like silage.

Table 1. The effect of treatment of corn cobs with different ratios of sodium hydroxide and calcium hydroxide on rate and efficiency of gain of steers.[a]

Treatments	Daily gain, lb.	Daily feed,[b] lb.	Feed/gain[b]
3 NaOH:1 $Ca(OH)_2$	1.90	14.3	7.55
1 NaOH:3 $Ca(OH)_2$	1.88	14.8	7.87
50% 3 NaOH:1 $Ca(OH)_2$ 50% sorghum silage[c]	1.72	14.8	8.57
50% 1 NaOH:3 $Ca(OH)_2$ 50% sorghum silage[c]	1.59	15.0	9.46

[a] 16 per treatment fed for 116 days; rations were supplemented with brewer's dried grains, urea, vitamins and minerals.

[b] Dry matter basis.

[c] Forage sorghum silage and cobs mixed 50:50 on a dry matter basis before supplementation.

Table 2. The effect of treatment of corn stalks with different ratios of sodium hydroxide and calcium hydroxide on rate and efficiency of gain of lambs.[a]

Treatments	Daily gain, lb.	Daily feed,[b] lb.	Feed/gain
Control	.040	2.09	25.27
1 NaOH:3 $Ca(OH)_2$	.121	2.76	10.93
3 NaOH:1 $Ca(OH)_2$	.196	3.04	7.42
3 NaOH:2 $Ca(OH)_2$	.196	3.01	7.37
4 NaOH:0 $Ca(OH)_2$	.199	3.22	7.91
4 NaOH:1 $Ca(OH)_2$	.202	3.02	7.23

[a] Rations fed to 6 individually penned lambs/treatment for 62 days.

[b] Dry matter basis, rations contained 75% treated stalks and 25% supplement based on brewer's dried grains and urea.