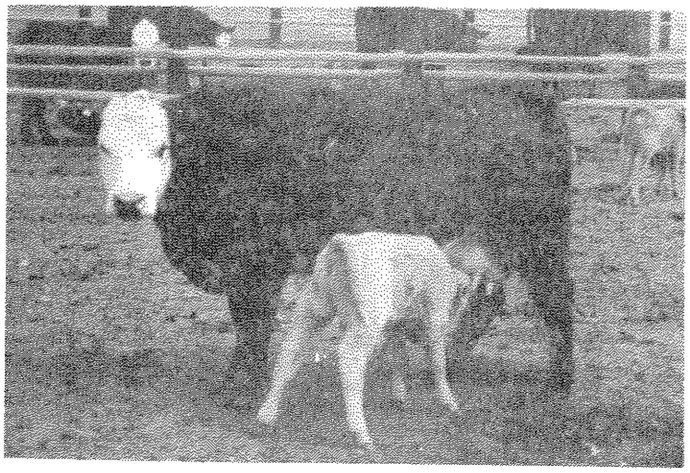
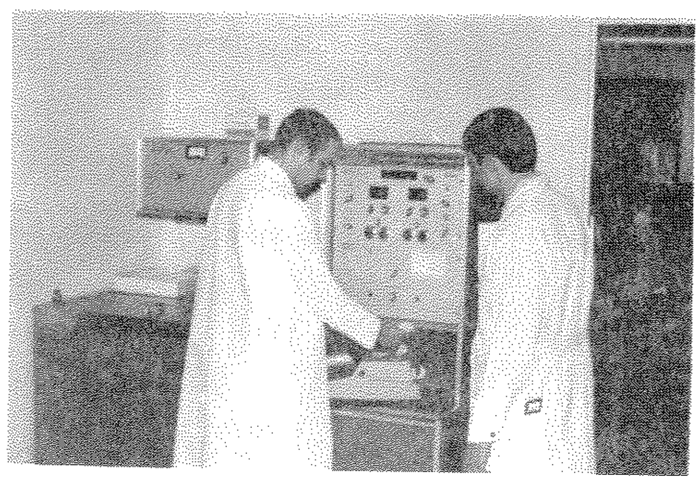
BEEF CATTLE FIELD DAY

U. S. Range Livestock Experiment Station

Miles City, Montana **APRIL 28, 1972**





Animal Science Research Division

Agricultural Research Service
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BULLS VS. STEERS--GROWTH AND CARCASS PERFORMANCE

Preliminary Results

by

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Consumer purchasing habits today show a greater preference for beef with higher proportions of lean and a correspondingly smaller percentage of fat. Furthermore, there is evidence of the beef producers rising to meet this demand with the wider use of breeding programs and management systems to increase growth with the accompanying cutability advantage. The interest in the feeding of young bulls is also increasing because of the advantages that producers are aware of. Bulls grow faster and produce a higher proportion of lean to fat than steers or heifers, but are subject to some discrimination on the beef market.

A current crossbreeding study at the Miles City Station was initiated in 1965 and designed to compare mating systems (straight breeding with two- and three-way rotational crossing) with the Angus, Hereford and Charolais breeds. In addition, in the initial design of the experiment, consideration was given to the production of bulls vs. steers. The male calves were equally divided within breed groups and ages--one-half were castrated around May 20 each year. The other half were left intact. Throughout the grazing season and feedlot period, bulls and steers were handled under similar conditions.

Following weaning each year these calves were given a 14-day warm-up period. They were then separated and fed as bulls and steers in replicated lots with from about 20 to 25 head being assigned to each lot. For the entire feedlot period the ration consisted of 80% concentrates and 20% grass hay ground and mixed together. The concentrate portion of the ration consisted of a mixture of beet pulp pellets, oats, barley or corn and some protein supplement. The total ration is considered a medium energy ration and averaged about 66.5% total digestible nutrients. This ration was full fed in open feed bunks. The calves were kept in outside lots with open sheds for weather protection. As these bulls and steers reached 1000 to 1050 pounds in the feedlot they were taken off test and slaughtered. The average off test weight of all bulls and steers was 1030 and 1016 pounds, respectively. The carcass data were obtained at the local packing plant. Carcass grades and estimated percent of kidney, pelvic and heart fat were obtained by USDA meat graders. Area of ribeye and thickness of fat over the ribeye were obtained between the 12th and 13th rib of the left half of each carcass. Estimated percent cutability was calculated from the hot carcass weight, area of ribeye, fat thickness over the ribeye and the estimated kidney, pelvic and heart fat. In this case, the percent cutability indicates the percent trimmed boneless retail cuts from the round, loin, rib and chuck. Trimmed retail cuts per day of age was calculated by multiplying the percent cutability X carcass weight per day of age and was considered as it reflects efficiency of carcass production.

From the preliminary results of this crossbreeding experiment it has been possible to make some comparisons of the overall performance of bulls vs. steers for growth and carcass composition. Any comparisons that are made between breeds or specific crossbred groups, that have limited numbers, are mentioned only as they may reflect trends--several years with additional data should make these results become more meaningful.

Performance of Bulls vs. Steers in Straight Breeds

The average performance of straight breed Angus, Hereford and Charolais bulls and steers, with overall averages for these breeds, are shown in table 1. For the straight breeds, bulls averaged 14 pounds heavier at 205 days of age than steers. In the feedlot the bulls had almost 0.50 pound daily gain advantage amounting to 20% when fed to an average final weight of 1021 pounds and required 16% less time on test. Thus, bulls showed a greater growth advantage over steers in the feedlot than during the period they were on the dams. Individual straight breed comparisons in these traits show similar trends with bulls being superior to steers for growth in all cases. There was a greater difference in daily gain between bulls and steers in the Angus breed than in the Hereford or Charolais.

As shown by the overall averages in table 1, bulls from all straight breeds had an advantage in area of ribeye and a smaller percent of fat which resulted in a 3.4% increase in estimated percent cutability. For both carcass weight per day of age and estimated trimmed retail cuts per day of age, bulls were superior to steers. Steers, however, excelled the bulls by about 1% for dressing percent and graded about two-thirds of a grade higher in the carcass. In this group of cattle, steers were observed to have more marbling which is considered an important quality criteria in carcass grading.

In the comparisons between the straight breeds, Angus bull and steer carcasses graded the highest and were followed by Hereford and Charolais, respectively. The potential for carcasses reaching choice grade at these final weights was not limited to steers as the Angus bull carcasses averaged high good with a small percentage reaching choice grade. Angus bull carcasses averaged two-thirds of a grade higher than Charolais steer carcasses. In this experiment, consideration should be given to the shorter period of time that bulls were on test when compared to the steers as it might influence carcass grades. The potential to reach choice carcass grade at these final weights, with less time than steers, suggests an additional advantage for Angus bulls. Charolais bull and steer carcasses graded high standard and low good, respectively, and in comparison with the other two breeds excelled in percent cutability, carcass growth per day of age and trimmed retail cuts per day of age. When compared to bulls and steers from the Angus and Charolais breeds, Herefords tended to be intermediate for most carcass traits, but ranked below for growth.

Performance of Crossbred Bulls and Steers

A comparison of the performance of bulls and steers, both in specific crosses and from overall averages of these crosses, can be observed in tables 2 and 3. These crossbred bulls and steers were two-breed and three-breed crosses which are further described in later discussion. The differences between the performance of bulls and steers in most of these comparisons are consistently similar as were observed among the straight breeds in table 1. For daily gain on test and carcass grade, however, the difference between the bulls and steers in the three-breed crosses seemed to be slightly more pronounced than in the two-breed crosses or straight breeds.

An overall summary of bulls and steers from all straight breeds and crossbred groups can be observed in table 4. These results show the bulls excelling steers by 2.3, 16.6, 20.2, 9.7 and 16.9%, respectively, for these growth traits:

205-day weaning weight, total days on test, average daily gain on test, carcass weight per day of age and estimated trimmed retail cuts per day of age. During this study bulls required 12% less feed per pound of gain. The bulls had a cutability advantage of 3.2 percentage points, which would result in an additional 19 pounds of trimmed retail cuts from each carcass if similar in weight to that of the steers. Steers showed an advantage of 0.6 percentage points for dressing percent and produced carcasses grading two-thirds of a grade higher.

A Comparison of Mating Systems as Evaluated from Bull and Steer Performance

An overall summary for evaluating the influences of three mating systems: straight breeding, 2-way, and 3-way rotation schemes is shown in table 5. The mating systems to produce the two- and three-breed cross calves can be observed in tables 2 and 3. In the initial stage of this study, the 2-way cross calves were produced, as observed in table 2, by backcrossing the first-cross females to one of the parent breed of sires. For example, A X H female X A sire, or C X H female X C sire, etc. Thus from these initial 2-way matings, calves produced are 75% of one breed ancestory and 25% of the other which are included in this summary. As the initial backcross females are produced in this study they are being mated to the more distantly related breed of sire that the specific cross represents, for example, AAH female X H sire, or HHC female X C sire, etc. Calves from these second rotation matings have not been included in this summary. A continuation of this 2-way rotation system is commonly described as either backcrossing or crisscrossing, and if continued over an extended period of time should furnish additional information of the effectiveness of the 2-way system to produce and maintain hybrid vigor.

In the initial part of the 3-way crossing system the first-cross females were mated to the third breed of sire as shown in table 3, for example, A X H female X C sire, or A X C dam X H sire, etc. These calves represent 50% of one breed with each of the other two having a 25% representation. Only the initial three-breed cross calves from these matings are considered in this summary. However, calves from the second phase of this 3-way rotation, for example, (C X AH) female X (A or H) sire, etc., are now being produced and will be evaluated as sufficient numbers become available to further determine the effectiveness of this 3-way rotation system to produce and maintain hybrid vigor similarly as in the 2-way rotation.

An overall estimate of hybrid vigor influences from this study was obtained by a comparison of the average performance of animals in each of the crossing systems with the average of the straight breeds represented. Thus in this case the hybrid vigor shown, and which is considered to be a crossing advantage, is the net effect of crossbreeding in both dam and offspring. In this crossbreeding study the primary objective was to measure the influences of hybrid vigor rather than make breed comparisons.

In obtaining estimates for hybrid vigor, fewer animals were used than for making the comparisons between bulls and steers. This resulted because some of the data used for the previous bull and steer comparisons were not considered appropriate for the hybrid vigor comparisons. As shown in table 5, both two- and three-breed crossing systems resulted in growth advantages in both bulls and steers when compared to the average performance of the parent breeds. These growth advantages were from 3 to 10%. The magnitude of these growth advantages, at this stage of the crossbreeding study suggest a rather important contribution as the result of hybrid vigor.

At this stage, the differences that were shown between the two- and three-breed crossing systems for growth were rather inconsistent for the two sexes considered. While 3-way cross bulls appeared to have a slight advantage over those from the 2-way crossing for most of the growth traits, this was not evident in the steers. After several more years are added to this study, the differences resulting between the two crossing systems should become more meaningful.

From the overall breed group averages it can be observed that both crossing systems produced carcasses that were generally similar, in lean to fat composition, to the average parent breed performance. However, three-breed cross steers showed a slight advantage for average carcass grade over both the two-breed and mid-parent average.

If no consideration is given to sex differences, by averaging bulls and steers together, the three-breed crosses showed a small advantage over those from two-breed crossing for 205-day weaning weight and total days on test, but were similar for other traits as shown in table 5.

Summary

Among straight breed and crossbred groups, bulls produced heavier weaning weights and continued to grow faster than steers during a feedlot period when all were finished at similar weights. Bulls required less time in the feedlot, were more efficient gainers, had a higher percentage of lean, but produced lower grading carcasses than steers. Breed differences were reflected in both bull and steer performances. To produce comparable carcass grades as were obtained from steers, bulls would require somewhat different management than was practiced.

When compared to the average performance of the straight breeds, two- and three-breed crosses produced advantages in most growth traits but generally were similar for carcass composition. From the preliminary results of this study, the differences in overall performance between animals of two- and three-breed crossing systems were considered to be small.

TABLE 1. A COMPARISON OF BULLS VS. STEERS IN ANGUS, HEREFORD AND CHAROLAIS STRAIGHT BREEDS

Item	Straight breeds						Avg. over all straight breeds	
	Angus		Hereford		Charolais			
	Bulls	Steers	Bulls	Steers	Bulls	Steers	Bulls	Steers
No. head	14	11	13	14	16	13	43	38
Weaning wt., lb.	445	429	386	374	533	506	455	436
Weaning age, days	197	194	196	192	192	190	195	192
205-day adjusted weaning wt., lb.	460	450	401	393	562	538	474	460
Feedlot Data								
No. head	13	11	12	14	16	13	41	38
Initial wt., lb.	485	446	399	392	550	531	478	456
Final wt., lb.	1024	994	1002	969	1036	1035	1021	999
Days on test	191	238	229	258	154	189	191	228
Gain on test, lb.	539	549	603	577	486	504	543	543
Average daily gain, lb.	2.89	2.33	2.69	2.25	3.17	2.70	2.92	2.43
Slaughter & Carcass Data								
Slaughter wt., lb.	973	949	962	930	997	991	977	957
Hot carcass wt., lb.	608	601	593	582	616	620	606	601
Dressing %	62.5	63.3	61.6	62.6	61.8	62.6	62.0	62.8
Ribeye area, sq.in.	12.6	10.6	12.6	10.4	14.5	12.8	13.2	11.3
Fat thickness over ribeye, in.	.48	.72	.37	.63	.18	.36	.34	.57
Kidney, pelvic, heart fat %	2.8	4.1	2.3	3.4	1.7	3.2	2.3	3.6
Carcass grade[a]	14.5	8.9	17.5	13.1	19.6	17.5	17.2	13.2
Est. % cutability[b]	50.9	47.5	52.0	48.4	54.5	51.5	52.5	49.1
Carc. wt./day age[c], lb.	1.51	1.35	1.35	1.25	1.71	1.58	1.52	1.39
Trimmed retail cuts/day age[b], lb.	.77	.64	.70	.61	.93	.81	.80	.69

[a] 8 = High choice, 10 = Avg. choice, 12 = Low choice, 14 = High good, 16 = Avg. good, 18 = Low good and 20 = High standard.
[b] See manuscript for explanation.
[c] Total days age = Age to weaning + 14 days warmup period + Days on test.

TABLE 2. A COMPARISON OF BULLS VS. STEERS IN TWO-BREED CROSSES

	Angus sires				Hereford sires			
	AH & HA X Dams		AC & CA X Dams		AH & HA X Dams		CH & HC X Dams	
Item	Bulls	Steers	Bulls	Steers	Bulls	Steers	Bulls	Steers
No. head	6	8	5	6	8	5	4	3
Weaning wt., lb.	452	421	502	492	441	435	476	451
Weaning age, days	198	187	192	202	192	194	190	183
205-day adjusted weaning wt., lb.	465	454	530	499	465	454	507	495
Feedlot Data								
No. head	6	3	5	6	7	5	4	3
Initial wt., lb.	483	433	530	496	446	447	512	474
Final wt., lb.	1033	989	1041	1019	1022	1027	1023	1034
Days on test	191	239	177	226	215	216	173	222
Gain on test, lb.	550	556	510	523	576	580	511	560
Average daily gain, lb.	2.89	2.34	2.91	2.34	2.71	2.71	2.95	2.53
Slaughter & Carcass Data								
Slaughter wt., lb.	985	938	1007	974	979	981	989	974
Hot carcass wt., lb.	616	598	633	614	608	618	600	612
Dressing %	62.5	63.8	62.9	63.0	62.1	63.0	60.7	62.8
Ribeye area, sq.in.	13.1	11.0	13.3	10.9	13.4	12.0	12.8	11.4
Fat thickness over ribeye, in.	.49	.78	.40	.73	.40	.67	.27	.62
Kidney, pelvic, heart fat %	3.2	4.2	2.5	3.8	2.4	3.4	1.9	3.5
Carcass grade[a]	14.0	10.7	15.6	11.7	17.4	14.4	18.0	13.3
Est. % cutability[b]	51.0	47.5	51.8	47.7	52.2	49.0	52.8	48.9
Carc. wt./day age[c], lb.	1.53	1.36	1.65	1.39	1.44	1.46	1.59	1.46
Trimmed retail cuts/day age[b], lb.	.78	.65	.85	.66	.75	.71	.84	.71

[a,b,c] See footnotes under Table 1 for explanations.

TABLE 2. Continued

Item	Charolais sires X AC & CA Dams		Charolais sires X CH & HC Dams		Avg. over all two-breed crosses	
	Bulls	Steers	Bulls	Steers	Bulls	Steers
No. head	6	6	4	7	33	35
Weaning wt., lb.	502	522	504	471	480	465
Weaning age, days	195	195	191	191	193	192
205-day adjusted weaning wt., lb.	523	544	534	499	504	491
Feedlot Data						
No. head	6	6	4	7	32	35
Initial wt., lb.	532	542	529	495	505	481
Final wt., lb.	1036	1026	1035	1034	1032	1022
Days on test	164	163	146	191	178	210
Gain on test, lb.	504	484	506	538	526	540
Average daily gain, lb.	3.12	3.06	3.48	2.84	3.01	2.64
Slaughter & Carcass Data						
Slaughter wt., lb.	998	977	986	992	991	973
Hot carcass wt., lb.	617	600	594	614	611	609
Dressing %	61.8	61.4	60.2	61.9	61.7	62.7
Ribeye area, sq.in.	13.1	12.2	12.6	12.3	13.0	11.6
Fat thickness over ribeye, in.	.22	.33	.16	.46	.32	.61
Kidney, pelvic, heart fat %	2.2	3.2	2.1	2.7	2.4	3.5
Carcass grade[a]	19.0	17.0	20.0	15.7	17.3	13.3
Est. % cutability[b]	53.0	51.1	53.2	50.8	52.3	49.2
Carc. wt./day age[c], lb.	1.65	1.61	1.69	1.55	1.59	1.47
Trimmed retail cuts/day age[b], lb.	.87	.82	.90	.79	.83	.72

[a,b,c] See footnotes under Table 1 for explanations.

TABLE 3. A COMPARISON OF BULLS VS. STEERS IN THREE-BREED CROSSES

Item	Three-breed cross calves: Angus sires X CH & HC dams		Hereford sires X AC & CA dams		Charolais sires X AH & HA dams		Avg. over all three-breed crosses	
	Bulls	Steers	Bulls	Steers	Bulls	Steers	Bulls	Steers
No. head	8	8	8	11	10	9	26	28
Weaning wt., lb.	462	465	461	450	502	497	475	471
Weaning age, days	190	193	188	190	198	195	192	193
205-day adjusted weaning wt., lb.	492	488	496	478	517	518	502	495
Feedlot Data								
No. head	8	8	8	10	10	8	26	26
Initial wt., lb.	491	497	496	484	529	508	505	496
Final wt., lb.	1037	1037	1032	1010	1038	1030	1036	1026
Days on test	174	210	183	225	163	204	173	213
Gain on test, lb.	546	540	536	526	509	522	530	529
Average daily gain, lb.	3.18	2.59	2.99	2.35	3.14	2.57	3.10	2.50
Slaughter & Carcass Data								
No. head	6	8	8	10	6	8	20	26
Slaughter wt., lb.	989	979	990	959	984	986	988	975
Hot carcass wt., lb.	617	612	616	606	619	613	617	610
Dressing %	62.4	62.5	62.2	63.2	62.9	62.2	62.5	62.6
Ribeye area, sq.in.	12.0	11.2	13.8	11.3	13.2	12.0	13.0	11.5
Fat thickness over ribeye, in.	.32	.69	.33	.57	.24	.44	.30	.57
Kidney, pelvic, heart fat %	2.3	3.8	2.2	3.4	2.8	3.3	2.4	3.5
Carcass grade[a]	16.3	11.8	15.8	11.4	19.0	13.5	17.0	12.2
Est. % cutability[b]	51.6	48.2	52.9	49.2	52.7	50.4	52.4	49.3
Carc. wt./day age[c], lb.	1.63	1.47	1.60	1.41	1.65	1.48	1.63	1.45
Trimmed retail cuts/day age[b], lb.	.84	.71	.85	.69	.87	.75	.85	.72

[a,b,c] See footnotes under Table 1 for explanations.

TABLE 4. AVERAGE PERFORMANCE OF BULLS VS. STEERS OVER ALL BREEDS AND CROSSES

Item	Bulls	Steers	Difference	% Difference
Live Animal Growth Performance				
No. head	102	101		
205-day adjusted weaning wt., lb.	493	482	11	2.3
Days on test	181	217	36	16.6
ADG on test, lb.	3.01	2.52	0.51	20.2
Carcass Growth Performance				
Carcass wt./ day age, lb.	1.58	1.44	0.14	9.7
Trimmed retail cuts/day age, lb.	0.83	0.71	0.12	16.9
Slaughter & Carcass Results				
Dressing %	62.1	62.7	0.6	-1.0
Ribeye area, sq.in.	13.1	11.5	1.6	13.9
Fat thickness over ribeye, in.	0.32	0.58	0.26	44.8
Carcass grade	Low - Middle good	High good - Low choice	2/3 grade	
Est. % cutability	52.4	49.2	3.2	

TABLE 5. STRAIGHT BREED AND CROSSBRED AVERAGES, DIFFERENCES AND PERCENT HYBRID VIGOR AMONG BULLS AND STEERS

Mating systems	No.	205-day adjusted wn. wt.	Days on test	ADG on test	Carcass wt./day age	Est. trim. retail cuts/ day age	Carcass grade	Est. % cutability
		lb.		lb.	lb.	lb.		
Bull Averages								
Straight breeds	20	471	188	2.97	1.55	.81	16.4	52.5
2-breed crosses	20	491	182	2.97	1.60	.84	16.5	52.6
3-breed crosses	26	502	173	3.10	1.63	.85	17.0	52.4
2-br.cross minus str.brd.		20	-6	0	.05	.03	-.1	.1
Difference, %		4.2	3.2	0	3.2	3.7	-.6	.2
3-br.cross minus str.brd.		31	-15	.13	.08	.04	-.6	-.1
Difference, %		6.6	8.0	4.4	5.2	4.9	-3.7	-.2
Steer Averages								
Straight breeds	27	458	230	2.39	1.39	.69	13.2	49.3
2-breed crosses	24	490	211	2.63	1.48	.73	13.6	49.4
3-breed crosses	28	495	213	2.50	1.45	.72	12.2	49.3
2-br.cross minus str.brd.		32	-19	.24	.09	.04	-.4	.1
Difference, %		7.0	8.3	10.0	6.5	5.8	-3.0	.2
3-br.cross minus str.brd.		37	-17	.11	.06	.03	1.0	0
Difference, %		8.1	7.4	4.6	4.3	4.4	7.6	0
Bull and Steer Averages								
Straight breeds		464	209	2.68	1.47	.75	14.8	50.9
2-breed crosses		490	196	2.80	1.54	.78	15.0	51.0
Difference		26	-13	.12	.07	.03	-.2	.1
Difference, %		5.6	6.2	4.5	4.8	4.0	-1.4	.2
3-breed crosses		498	193	2.80	1.54	.78	14.6	50.8
Difference		34	-16	.12	.07	.03	.2	-.1
Difference, %		7.3	9.2	4.5	4.8	4.0	1.4	-.2

THE U.S. MEAT ANIMAL RESEARCH CENTER CATTLE GERM PLASM EVALUATION PROGRAM[1]

A Preliminary Report
presented by
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Clay Center, Nebraska

The cattle germ plasm evaluation program at the U.S. Meat Animal Research Center is designed to characterize breeds from different biological types in the full spectrum of economic traits relating to growth, feed efficiency, reproduction, maternal ability and carcass and meat traits. The basic objective of this program is to develop an understanding relating to optimizing such biological factors as cow size, milk level, etc., in different feed environments and production situations.

The first cycle of this program is designed to characterize the Hereford, Angus, Jersey, South Devon, Limousin, Simmental and Charolais breeds as representatives of different biological types. Results of the first calf crop including calving data, preweaning growth, postweaning feedlot growth and feed efficiency, and carcass and meat traits relating to composition and quality are presented in this report. Postweaning growth and reproductive performance of the heifers in the first calf crop are also presented. The preliminary nature of this report is emphasized because the data are limited to only the first of three calf crops that will be produced from the breeds involved in the first cycle of this program. Also, all females in the program are being retained for evaluation of fertility and maternal traits under different feed environments.

Experimental Procedure

Commercial Hereford and Angus females were bred by artificial insemination to the seven breeds of sires used in this program. The females were purchased as calves at weaning from commercial producers in Nebraska, and were 2, 3, 4 and 5-year-olds at calving in 1970. The calves were born in late March, April and early May, and were creep fed a ration of whole oats starting in mid-July. Creep feed consumption averaged 1.5 lb. per head per day until weaning in mid-November.

The following numbers of animals were involved in each kind of data presented: calving 1003, preweaning growth 878, postweaning growth, feed efficiency and carcass and meat of steers 451, postweaning growth and fertility of heifers 337. A total of 48 heifers were removed at random at weaning time (12 from each of the four following breeding groups: Hereford X Angus, Jersey X Angus, Simmental X Angus, and Charolais X Angus) for a cooperative study with the Research Branch, Canada Department of Agriculture.

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[1] U.S. Meat Animal Research Center, Clay Center, Nebraska, Animal Science Research Division, and Market Quality Research Division, ARS, USDA; Livestock Division, CMS, USDA; Kansas State University, Manhattan, and the University of Nebraska, Lincoln, cooperating.

[2] Leader, Nutrition and Management Investigations, U.S. Meat Animal Research Center, Clay Center, Nebraska.

In 1969, 14 Hereford, 14 Angus, 10 Charolais, 8 Simmental, 14 South Devon, 12 Jersey, and 6 Limousin sires were used. The Hereford and Angus bulls used in this program had been selected on individual performance information as a basis for gaining entry into the progeny testing program of an artificial insemination organization. The Charolais bulls included three domestic and seven French bulls, either imported or with imported parents (Bingo, Ali Baba Bramard, Ali Baba Dessauny, Bonaparte, Carnaval, J. G. Otono, Chatenay Snow Ball, Sir Sam 88, El Fortin 38, and FWT Linn Barr 255). The eight Simmental bulls included the five bulls that were available through commercial channels in 1969, and three bulls that had been imported for research purposes by the Canada Department of Agriculture (Firn, Capitaine, Parisien, Sultan, Bismark, Cuartier, Petunia, and Pacific). The Limousin bulls were the six bulls that were available commercially after early July of 1969 (Prairie Pride, Prairie Danseur, Diplomate, Dandy, Prince Pompadour, and Decor). The South Devon bulls were sampled from an importation made early in 1969 by a commercial organization, and the Jersey bulls were selected at random from two commercial artificial insemination organizations.

It is not planned to make general releases of information on individual sires. The objective of the program is to characterize breeds representing different biological types. To do this effectively, it is necessary to sample a large number of sires of each breed. Thus, the number of progeny per sire is generally low. A relatively large number of progeny per sire are required for a high level of accuracy in ranking individual sires on their breeding value for most economic traits. The individual sire information is provided to the owners and/or semen distributors. The bull(s) he controls are identified to him and all other bulls of that breed are coded. The progeny information provided to the owners of the bulls can be combined with that obtained from other efforts to obtain adequate numbers of progeny per sire necessary for a high level of accuracy in ranking individual sires for economic traits. We believe this is the fairest procedure to both the owners and users of the semen service, since erroneous conclusions may be drawn on the ranking of individual sires with the relatively small number of progeny per sire in this program.

Calving difficulty scores, presented in table 1 for the 2-year-old females and in table 2 for the 3, 4 and 5-year-old females, were assigned to each calf at birth on the basis of the following scoring system:

Score	Description
1. No difficulty	- Calves unassisted; however, it may be necessary to straighten head and/or front legs.
2. Little difficulty	- Assistance given by hand, but no jack or puller used; assistance actually may not have been required.
3. Moderate difficulty	- Assistance given with jack or calf puller; some difficulty was encountered even with the pullers being used.
4. Major difficulty	- Calf jack used and major difficulty encountered; usually 30 minutes or more required to deliver calf.
5. Caesarean birth	-
6. Posterior presentation	-

The weaning weights of the calves, presented in table 3, were adjusted to a steer basis and to a 4 or 5-year-old cow basis. The adjustment factors were developed from these data and were as follows:

	Birth wt.	Preweaning A.D.G.	200 day wt.
Heifer calf adj.	+6	+.113	+29
Steer calf adj.	0	0	0
2-year-old dam	+8	+.265	+61
3-year-old dam	+3	+.033	+ 9
4 or 5-year-old dam	0	0	0

At weaning, steer calves with adjusted weaning weights more than three standard deviations below the mean (9 head) were removed from the study. The remaining steers were placed in the feedlot by breed of sire groups (replicated, two lots per breed of sire) to obtain data on growth rate and feed efficiency. Steers sired by Simmental and Charolais sires were further divided into lots by breed of dam and replicated during the feedlot period. Four steers were removed from the study due to death (3) or injury (1) during the feedlot period. The rations and periods fed are presented in table 4.

The postweaning average daily gains presented in table 5 are based on actual weaning weights (no weaning shrink) and final weights at slaughter. Final weights at slaughter were obtained as the average of two weights (on feed and water) taken on different days to reduce errors due to differences in fill. Adjusted final weight was obtained by adding the sum of postweaning average daily gain X days on feed to weaning weight adjusted to 200 days of age and to a 4-5 year old dam basis. The average daily gains and adjusted final weights (415 days, 443 days, 471 days of age) presented in table 5 for each of the three slaughter groups are only for the steers slaughtered in that group. Feed efficiency for each breeding group was obtained by dividing the cumulative average daily TDN consumption per steer by the average daily gain of the steers remaining on feed up to each of the three slaughter dates.

Approximately one-third of the steers in each breed of sire by breed of dam group were slaughtered at each of three slaughter dates, which were 215, 243 and 271 days on feed after weaning. The steers to be slaughtered from each breeding group at each of the three times (215, 243 and 271 days postweaning) were identified at random across the full range of birth dates. Thus, the steers slaughtered at each of the three times had the same average birth date, resulting in an average difference in age of steers at slaughter of 28 days between slaughter groups 1 and 2 and between slaughter groups 2 and 3. However, the birth dates did not average the same for all breeding groups because of differences in conception date and gestation length. The average birth dates are presented in table 3 by breeding group. Birth date had no significant effect on either preweaning or postweaning growth rate of steers. The steers were transported to a commercial slaughter plant approximately 12 hours prior to slaughter, and were allowed to chill 24 hours after slaughter before obtaining the carcass data. Carcasses were evaluated for conformation, maturity, marbling, color, texture and firmness and U.S.D.A. Quality Grade determined by representatives of the Livestock

Division, CMS, USDA, and Kansas State University. Loin eye area and external fat thickness were measured and U.S.D.A. Yield Grade determined. These results are presented in tables 6 and 7. In addition, selected linear carcass measurements and measures of other traits were obtained that are not included in this report.

The right side of each carcass was transported to Kansas State University approximately 56 hours after slaughter to obtain detailed cut-out and meat quality data. The right side was separated into wholesale cuts, and the wholesale cuts were processed into closely trimmed, boneless cuts with no more than 0.30 inch of fat on any surface. The amounts of retail product, fat trim and bone were determined for each wholesale cut. These results are presented in table 8 on a percent of carcass basis.

One steak was removed from each carcass at the 11th rib for Warner-Bratzler shear determination. The steaks were cooked at 350°F to an internal temperature of 150°F. After cooling for approximately 30 minutes at room temperature, one-half inch cores were removed for shear determination. Steaks were removed at the 10th rib from four representative carcasses per breed group per slaughter date (168 carcasses), cooked at 350°F to an internal temperature of 160°F, and subjected to taste panel evaluation for tenderness, flavor, juiciness and overall acceptability by trained taste panelists. These results are presented in table 9.

The data for the carcass and meat traits were analyzed by least-squares procedures for unequal subclass numbers using a model that included the effects of age of dam (2, 3, 4 and 5-year-olds); breed of sire (straightbred Hereford and Angus, Hereford-Angus reciprocal crosses, Jersey, South Devon, Limousin, Simmental and Charolais); breed of dam (Hereford, Angus); time of slaughter (215, 243 and 271 days postweaning); the interactions of breed of sire-breed of dam, breed of sire-time of slaughter, breed of dam-time of slaughter, and breed of sire-breed of dam-time of slaughter; and birth date was included as a covariate to adjust for differences in age of calf within slaughter groups. Thus, the least-squares means for the carcass and meat traits are adjusted for age of dam and to 415, 443 and 471 days of age for the three slaughter groups.

Postweaning average daily gain and adjusted final weight for both steers and heifers were analyzed by least squares procedures using the same model except that birth date was not included as a covariate.

Postweaning growth, puberty and pregnancy data on the heifers in the first calf crop are presented in table 10. The heifers were kept in drylot from weaning through the artificial insemination breeding period (November 17 - July 7). The postweaning ration for the heifers was 50% corn silage and 50% grass silage fed *ad libitum*. The adjusted 400-day weight is based on a full weight and the adjusted 550-day weight is based on a shrunk weight.

Date of puberty, defined as date of the first observed standing estrus, was determined by checking animals for estrus twice daily. Body weights were taken every 28 days from weaning to the breeding period and again at the termination of the breeding period. Heifers were inseminated only after standing for vasectomized bulls or other heifers. Following the artificial insemination breeding season, (starting May 24 and ending July 7, 45 days) the heifers were placed on pasture for a 26-day natural service breeding period. The percent of heifers reaching puberty by 15 months and the average age of those that reached puberty are only for heifers observed in estrus up to the end of the artificial insemination breeding season, while the percent pregnant would include heifers that may have reached puberty and bred during the 26-day natural service breeding period.

Final analysis and interpretation of these results will be made after all of the data have been collected involving the additional calf crops and the data that will be collected on fertility and maternal traits of the females. This will include attention to such traits as calf survival; feed required per pound of edible portion of carcass; differences in meat quality; feed required for maintenance, lactation and reproduction in the females; calf production in the females, etc.

TABLE 1. U.S. MEAT ANIMAL RESEARCH CENTER GERM PLASM EVALUATION PROGRAM
CALVING DIFFICULTY SUMMARY
1970 CALF CROP - 2 YEAR OLD FEMALES

Breed of Sire	Breed of Dam	No. Calves	Calving Difficulty Score 1 No.	1 %	2 No.	2 %	3 No.	3 %	4 No.	4 %	5 No.	5 %	6 No.	6 %	Dead at or Shortly After Birth No.	%
Hereford	Hereford	25	8	32.0	2	8.0	1	4.0	13	52.0	1	4.0	0		0	
Angus	Angus	44	29	65.9	1	2.3	0		14	31.8	0		0		4	9.1
	Average	69	37	53.6	3	4.3	1	1.4	27	39.3	1	1.4	0		4	5.8
Angus	Hereford	37	16	43.2	3	8.1	1	2.7	17	46.0	0		0		5	13.5
Hereford	Angus	50	34	68.0	1	2.0	1	2.0	14	28.0	0		0		3	6.0
	Average	87	50	57.5	4	4.6	2	2.3	31	35.6	0		0		8	9.2
Jersey	Hereford	27	19	70.4	3	11.1	1	3.7	4	14.8	0		0		0	
	Angus	44	41	93.1	2	4.6	0		1	2.3	0		0		1	2.3
	Average	71	60	81.8	5	7.9	1	1.8	5	8.6	0		0		1	1.2
South Devon	Hereford	15	5	33.3	2	13.3	2	13.3	5	33.3	1	6.7	0		1	6.7
	Angus	33	12	36.4	1	3.0	2	6.1	17	51.5	1	3.0	0		4	12.0
	Average	48	17	34.9	3	8.2	4	9.7	22	42.4	2	4.9	0		5	9.4
Limousin	Hereford	37	4	10.8	1	2.7	2	5.4	26	70.3	3	8.1	1	2.7	3	8.1
	Angus	27	8	29.6	2	7.4	2	7.4	15	55.6	0		0		1	3.7
	Average	64	12	20.2	3	5.1	4	6.4	41	63.0	3	4.1	1	1.4	4	5.9
Simmental	Hereford	16	2	12.5	0		0		8	50.0	6	37.5	0		1	6.3
	Angus	17	8	47.0	1	5.9	1	5.9	5	29.5	2	11.7	0		2	11.7
	Average	33	10	29.8	1	3.0	1	3.0	13	39.8	8	24.6	0		3	9.0
Charolais	Hereford	21	4	19.0	2	9.5	0		11	52.4	3	14.3	1	4.8	3	14.3
	Angus	22	6	27.3	0		1	4.6	15	68.1	0		0		3	13.6
	Average	43	10	23.2	2	4.8	1	2.3	26	60.3	3	7.2	1	2.4	6	14.0
Average	Hereford	178	58	32.6	13	7.3	7	3.9	84	47.2	14	7.9	2	1.1	13	7.3
All Sire	Angus	237	138	58.2	8	3.4	7	3.0	81	34.2	3	1.3	0		18	7.6
Breeds	Average	415	196	45.4	21	5.4	14	3.5	165	40.7	17	4.6	2	.6	31	7.5

TABLE 2. U.S. MEAT ANIMAL RESEARCH CENTER GERM PLASM EVALUATION PROGRAM
CALVING DIFFICULTY SUMMARY
1970 CALF CROP - 3-4-5 YEAR OLD FEMALES

Breed of Sire	Breed of Dam	No. Calves	Calving Difficulty Score 1 No.	1 %	2 No.	2 %	3 No.	3 %	4 No.	4 %	5 No.	5 %	6 No.	6 %	Dead at or Shortly After Birth No.	Dead at or Shortly After Birth %
Hereford Angus	Hereford	37	34	91.9	1	2.7	1	2.7	0		0		1	2.7	2	5.4
	Angus	32	30	93.8	0		1	3.1	1	3.1	0		0		2	6.3
	Average	69	64	92.6	1	1.5	2	2.9	1	1.5	0		1	1.5	4	5.8
Angus Hereford	Hereford	29	29	100.0	0		0		0		0		0		0	
	Angus	47	44	93.6	2	4.3	0		1	2.1	0		0		0	
	Average	76	73	96.1	2	2.6	0		1	1.3	0		0		0	
Jersey	Hereford	29	28	97.0	0		1	3.0	0		0		0		1	3.0
	Angus	32	32	100.0	0		0		0		0		0		0	
	Average	61	60	98.5	0		1	1.5	0		0		0		1	1.5
South Devon	Hereford	17	12	70.0	1	6.0	2	12.0	2	12.0	0		0		1	6.0
	Angus	12	12	100.0	0		0		0		0		0		0	
	Average	29	24	85.0	1	3.0	2	6.0	2	6.0	0		0		1	3.0
Limousin	Hereford	44	38	87.0	1	2.0	1	2.0	3	7.0	0		1	2.0	2	5.0
	Angus	42	33	78.0	2	5.0	2	5.0	4	10.0	0		1	2.0	3	7.0
	Average	86	71	82.5	3	3.5	3	3.5	7	8.5	0		2	2.0	5	6.0
Simmental	Hereford	64	45	71.0	6	9.0	4	6.0	9	14.0	0		0		10	16.0
	Angus	72	59	82.0	2	3.0	3	4.0	7	10.0	0		1	1.0	4	6.0
	Average	136	104	76.5	8	6.0	7	5.0	16	12.0	0		1	0.5	14	11.0
Charolais	Hereford	64	46	72.0	3	5.0	6	9.0	7	11.0	0		2	3.0	8	13.0
	Angus	67	53	79.0	0		2	3.0	9	13.0	0		3	5.0	5	7.0
	Average	131	99	75.5	3	2.5	8	6.0	16	12.0	0		5	4.0	13	10.0
Average All Sire Breeds	Hereford	284	232	81.7	12	4.2	15	5.3	21	7.4	0		4	1.4	24	8.5
	Angus	304	263	86.5	6	2.0	8	2.6	22	7.2	0		5	1.7	14	4.6
	Average	588	495	84.1	18	3.1	23	4.0	43	7.3	0		9	1.5	38	6.6

TABLE 3. U.S. MEAT ANIMAL RESEARCH CENTER GERM PLASM EVALUATION PROGRAM
PREWEANING SUMMARY - 1970 CALF CROP

Breed of Sire	Breed of Dam	No. Calves[a]	Birth Date	Birth Wt.	Preweaning A.D.G.	Adjusted 200 Day Wt.	200 Day Wt. Ratio
Hereford Angus	Hereford	55	April 17	80	1.82	445	94.7[b]
	Angus	66	April 6	72	1.95	463	96.0[c]
	Average	121	April 12	76	1.89	454	95.4[d]
Angus Hereford	Hereford	59	April 13	81	1.90	460	97.9
	Angus	87	April 8	78	2.01	479	99.4
	Average	146	April 11	80	1.96	470	98.7
Jersey	Hereford	53	April 13	73	1.90	452	96.4
	Angus	71	April 2	66	1.90	444	92.2
	Average	124	April 7	69	1.90	448	94.3
South Devon	Hereford	28	April 13	85	1.90	466	99.1
	Angus	39	April 9	81	2.00	482	100.0
	Average	67	April 11	83	1.95	474	99.5
Limousin	Hereford	70	May 2	87	1.94	476	101.5
	Angus	63	April 26	84	2.06	496	102.9
	Average	133	April 29	86	2.00	486	102.2
Simmental	Hereford	65	April 21	93	1.99	491	104.5
	Angus	78	April 11	85	2.09	503	104.4
	Average	143	April 16	89	2.04	497	104.4
Charolais	Hereford	68	April 18	92	2.03	498	106.1
	Angus	76	April 11	85	2.11	507	105.2
	Average	144	April 14	88	2.07	502	105.6
Average All Sire Breeds	Hereford	398	April 18	84	1.93	470	100.0
	Angus	480	April 10	78	2.02	482	100.0
	Average	878	April 14	81	1.97	476	100.0

[a] Includes all steer and heifer calves that were weaned.
[b] Ratio computed relative to average for Hereford cows, adjusted to a steer calf and a 4 and 5-year-old cow basis.
[c] Ratio computed relative to average for Angus cows, adjusted to a steer calf and a 4 and 5-year-old cow basis.
[d] Ratio computed relative to overall average adjusted to a steer calf and a 4 and 5-year-old cow basis.

TABLE 4. U.S. MEAT ANIMAL RESEARCH CENTER GERM PLASM EVALUATION PROGRAM

POSTWEANING STEER FEEDLOT RATIONS

Ingredient	Nov. 17-Nov. 24	Nov. 25-Jan. 10	Jan. 11-Apr. 28
	%	%	%
Corn Silage	89.0	77.5	60.0
Concentrate[1]	7.5	17.5	35.0
Supplement, 38% Crude Protein[2]	3.5	5.0	5.0
Ration Analyses, 90% Dry Matter Basis			
Crude Protein, %	10.6	11.6	10.8
Digestible Protein, %	8.1	8.9	8.6
Total Digestible Nutrients, %	64.8	68.0	71.6

1 The concentrate portion included varying amounts of ground shelled corn, ground sorghum grain, and ground wheat.

2 Composition of a ton of supplement: 1492 lb. soybean meal; 200 lb. salt; 100 lb. dicalcium phosphate; 130 lb. ground limestone; 7.0 lb. vitamin ADE premix (4,000,000 I.U. Vitamin A/lb.); 1.4 lb. Aureomycin (50 grams/lb.); 10 lb. trace mineral premix; 60 lb. ammonium chloride.

TABLE 5. U.S. MEAT ANIMAL RESEARCH CENTER GERM PLASM EVALUATION PROGRAM
LEAST SQUARES MEANS FOR POSTWEANING AVERAGE DAILY GAINS, ADJUSTED FINAL WEIGHTS AND TDN EFFICIENCIES

Breed of Sire	Breed of Dam	No. Steers[a] 215	243	271	Total	Postweaning Average Daily Gain[b] 215	243	271	Avg.	Adjusted Final Weight[c] 215	243	271	Avg.	TDN Efficiency[d] 215	243	271	Avg.
Hereford	Hereford	8	8	7	23	2.43	2.38	2.38	2.40	969	1017	1098	1028				
Angus	Angus	13	12	13	38	2.48	2.26	2.26	2.34	1006	1016	1072	1032				
	Average	21	20	20	61	2.45	2.32	2.32	2.37	988	1017	1085	1030	5.97	6.45	6.58	6.33
Angus	Hereford	10	11	10	31	2.45	2.52	2.40	2.45	980	1077	1108	1055				
Hereford	Angus	17	17	16	50	2.38	2.37	2.36	2.37	986	1066	1116	1056				
	Average	27	28	26	81	2.42	2.44	2.38	2.41	983	1071	1112	1055	6.11	6.47	6.76	6.45
Jersey	Hereford	7	8	8	23	2.36	2.15	2.24	2.25	953	965	1072	997				
	Angus	15	14	14	43	2.22	2.18	2.08	2.16	931	973	1024	976				
	Average	22	22	22	66	2.29	2.16	2.16	2.20	942	969	1048	986	6.58	6.88	7.11	6.86
South Devon	Hereford	3	4	3	10	2.37	2.58	2.73	2.56	970	1069	1217	1085				
	Angus	6	8	7	21	2.62	2.56	2.31	2.50	1053	1096	1104	1084				
	Average	9	12	10	31	2.50	2.57	2.52	2.53	1012	1082	1161	1085	5.88	6.38	6.66	6.31
Limousin	Hereford	12	11	11	34	2.61	2.54	2.22	2.45	1069	1100	1076	1082				
	Angus	11	13	13	37	2.39	2.43	2.26	2.36	1014	1107	1115	1079				
	Average	23	24	24	71	2.50	2.48	2.24	2.41	1042	1103	1096	1080	5.86	6.20	6.57	6.21
Simmental	Hereford	10	10	10	30	2.78	2.64	2.68	2.70	1069	1125	1216	1137	5.54	6.04	6.19	5.92
	Angus	12	13	14	39	2.58	2.49	2.59	2.55	1064	1105	1222	1130	5.96	6.47	6.60	6.34
	Average	22	23	24	69	2.68	2.57	2.63	2.63	1067	1115	1219	1133	5.75	6.26	6.40	6.13
Charolais	Hereford	10	10	10	30	2.82	2.67	2.66	2.71	1106	1148	1223	1159	5.55	5.89	6.23	5.89
	Angus	14	14	14	42	2.52	2.47	2.44	2.48	1036	1105	1185	1108	6.06	6.56	6.72	6.45
	Average	24	24	24	72	2.67	2.57	2.55	2.60	1071	1126	1204	1134	5.80	6.22	6.48	6.17
Average	Hereford	60	62	59	181	2.54	2.50	2.47	2.50	1017	1071	1144	1077				
All Sire	Angus	88	91	91	270	2.46	2.40	2.33	2.39	1013	1067	1120	1066				
Breeds	Average	148	153	150	451	2.50	2.45	2.40	2.45	1015	1069	1132	1072	5.99	6.41	6.65	6.35

a Number of steers slaughtered after 215, 243 and 271 days on feed.
b Average daily gain = (actual final weight - actual weaning weight) ÷ days on feed.
c Adjusted final weight = adjusted 200 day weight + (postweaning average daily gain x days on feed postweaning).
d TDN efficiency = lb. TDN consumed per lb. gain; 90% dry matter basis for the feed consumed.

TABLE 6. U.S. MEAT ANIMAL RESEARCH CENTER GERM PLASM EVALUATION PROGRAM
LEAST SQUARES MEANS FOR ADJUSTED HOT CARCASS WEIGHT, DRESSING PERCENT AND U.S.D.A. QUALITY GRADE[a]

Breed of Sire	Breed of Dam	Adjusted Hot Carcass Weight, lb.				Dressing Percent				U.S.D.A. Quality Grade[b]			
		215	243	271	Avg.	215	243	271	Avg.	215	243	271	Avg.
Hereford Angus	Hereford	585	614	659	619	60.9	60.4	60.5	60.6	10.0	10.3	10.0	10.1
	Angus	608	618	657	628	60.9	61.2	61.6	61.2	11.3	11.2	11.1	11.2
	Average	596	616	658	623	60.9	60.8	61.1	60.9	10.7	10.7	10.5	10.6
Angus Hereford	Hereford	587	653	685	642	60.6	61.0	62.1	61.2	10.7	11.2	10.8	10.9
	Angus	594	654	692	647	60.6	61.6	62.4	61.5	10.0	10.6	10.4	10.3
	Average	591	653	688	644	60.6	61.3	62.3	61.4	10.3	10.9	10.6	10.6
Jersey	Hereford	577	566	638	594	59.0	59.4	59.7	59.4	9.7	9.7	9.8	9.7
	Angus	557	580	610	582	60.4	60.3	59.9	60.2	10.5	10.8	10.5	10.6
	Average	567	573	624	588	59.7	59.8	59.8	59.8	10.1	10.3	10.1	10.2
South Devon	Hereford	586	653	743	661	61.0	61.3	61.4	61.2	10.7	9.6	11.0	10.4
	Angus	642	676	682	667	61.3	62.1	62.2	61.9	11.0	10.7	10.9	10.9
	Average	614	665	713	664	61.1	61.7	61.8	61.5	10.8	10.1	11.0	10.6
Limousin	Hereford	649	684	672	669	61.1	62.4	62.7	62.1	9.2	9.1	9.6	9.3
	Angus	614	685	688	662	60.7	62.3	62.0	61.7	9.7	9.3	9.6	9.5
	Average	632	685	680	665	60.9	62.4	62.3	61.9	9.4	9.2	9.6	9.4
Simmental	Hereford	628	674	739	681	59.2	60.3	61.0	60.2	9.5	10.1	9.5	9.7
	Angus	646	663	743	684	60.9	60.3	61.1	60.8	10.7	10.4	10.5	10.5
	Average	637	669	741	682	60.1	60.3	61.1	60.5	10.1	10.3	10.0	10.1
Charolais	Hereford	677	689	761	709	61.6	60.3	62.0	61.3	10.1	9.9	10.8	10.3
	Angus	619	688	740	682	60.1	62.5	62.6	61.7	10.3	10.9	11.1	10.8
	Average	648	689	750	696	60.9	61.4	62.3	61.5	10.2	10.4	10.9	10.5
Average All Sire Breeds	Hereford	613	648	700	653	60.5	60.7	61.3	60.9	10.0	10.0	10.2	10.1
	Angus	612	652	687	650	60.7	61.5	61.7	61.3	10.5	10.6	10.6	10.6
	Average	612	650	694	652	60.6	61.1	61.5	61.1	10.2	10.3	10.4	10.3

[a] The data for all carcass traits are adjusted by regression on birthdate to the average age of each slaughter group, and are adjusted for age of dam.

[b] U.S.D.A. Quality Grade: 9 = high good; 10 = low choice; 11 = average choice; 12 = high choice; etc.

TABLE 7. U.S. MEAT ANIMAL RESEARCH CENTER GERM PLASM EVALUATION PROGRAM
LEAST SQUARES MEANS FOR YIELD GRADE, RIB EYE AREA, FAT THICKNESS AND PERCENT KIDNEY, PELVIC AND HEART FAT[a]

		U.S.D.A. Yield Grade				Rib Eye Area, sq. in.				Fat Thickness, in.				Estimated Percent Kidney, Pelvic and Heart Fat			
Breed of Sire	Breed of Dam	215	243	271	Avg.	215	243	271	Avg.	215	243	271	Avg.	215	243	271	Avg.
Hereford Angus	Hereford	3.1	3.2	3.5	3.3	10.4	11.4	11.5	11.1	.50	.59	.65	.58	2.2	2.7	2.9	2.6
	Angus	3.5	3.4	3.9	3.6	10.8	11.4	11.4	11.2	.61	.60	.87	.70	3.5	3.3	3.4	3.4
	Average	3.3	3.3	3.7	3.4	10.6	11.4	11.4	11.1	.56	.60	.76	.64	2.9	3.0	3.2	3.0
Angus Hereford	Hereford	3.2	3.5	3.6	3.4	11.0	11.7	12.3	11.6	.54	.67	.73	.65	3.2	3.3	3.2	3.2
	Angus	3.4	3.7	4.3	3.8	10.8	11.2	11.3	11.1	.61	.72	.89	.74	3.0	3.0	3.3	3.1
	Average	3.3	3.6	3.9	3.6	10.9	11.4	11.8	11.3	.57	.70	.81	.69	3.1	3.1	3.3	3.2
Jersey	Hereford	3.2	3.1	3.7	3.3	10.1	10.9	11.4	10.8	.31	.43	.52	.42	4.4	4.5	5.7	4.8
	Angus	3.5	3.3	3.7	3.5	10.5	11.1	10.9	10.8	.54	.51	.62	.56	4.6	4.6	5.1	4.8
	Average	3.3	3.2	3.7	3.4	10.3	11.0	11.1	10.8	.43	.47	.57	.49	4.5	4.6	5.4	4.8
South Devon	Hereford	2.8	3.1	3.6	3.2	11.8	11.5	11.9	11.8	.41	.47	.62	.50	3.4	3.4	4.1	3.6
	Angus	3.1	3.1	3.6	3.3	11.8	12.4	12.3	12.2	.53	.54	.68	.58	3.6	3.2	4.2	3.7
	Average	2.9	3.1	3.6	3.2	11.8	12.0	12.1	12.0	.47	.51	.65	.54	3.5	3.3	4.1	3.6
Limousin	Hereford	2.3	2.4	2.8	2.5	12.8	13.7	12.7	13.1	.37	.42	.56	.45	2.7	3.1	3.0	2.9
	Angus	2.4	2.6	2.7	2.6	12.2	13.1	13.3	12.9	.37	.49	.51	.46	2.8	3.4	3.3	3.2
	Average	2.3	2.5	2.8	2.5	12.5	13.4	13.0	13.0	.37	.46	.54	.46	2.8	3.2	3.1	3.1
Simmental	Hereford	2.4	2.6	2.8	2.6	11.9	12.5	13.2	12.5	.32	.42	.52	.42	2.8	2.9	2.9	2.9
	Angus	2.8	3.0	3.1	2.9	12.3	12.2	13.3	12.6	.46	.47	.53	.49	3.3	3.5	3.9	3.6
	Average	2.6	2.8	3.0	2.8	12.1	12.3	13.2	12.6	.39	.45	.53	.45	3.0	3.2	3.4	3.2
Charolais	Hereford	3.0	2.4	2.9	2.7	11.8	13.0	12.8	12.5	.42	.35	.42	.40	3.0	2.9	3.1	3.0
	Angus	2.5	3.0	2.8	2.8	11.6	12.8	13.8	12.7	.35	.49	.50	.45	2.7	3.6	4.0	3.4
	Average	2.7	2.7	2.8	2.8	11.7	12.9	13.3	12.6	.39	.42	.46	.42	2.8	3.3	3.6	3.2
Average All Sire Breeds	Hereford	2.8	2.9	3.3	3.0	11.4	12.1	12.2	11.9	.41	.48	.57	.49	3.1	3.3	3.6	3.3
	Angus	3.0	3.2	3.4	3.2	11.4	12.0	12.3	11.9	.50	.55	.66	.57	3.3	3.5	3.9	3.6
	Average	2.9	3.0	3.4	3.1	11.4	12.1	12.3	11.9	.45	.51	.62	.53	3.2	3.4	3.7	3.4

[a] The data for all carcass traits are adjusted by regression on birth date to the average age of each slaughter group, and are adjusted for age of dam.

TABLE 8. U.S. MEAT ANIMAL RESEARCH CENTER GERM PLASM EVALUATION PROGRAM
LEAST SQUARES MEANS FOR ACTUAL PERCENT CUTABILITY, PERCENT RETAIL PRODUCT, PERCENT FAT TRIM AND PERCENT BONE[a]

Breed of Sire	Breed of Dam	Actual Cutability, %[b]				Retail Product, %[c]				Fat Trim, %				Bone, %			
		215	243	271	Avg.	215	243	271	Avg.	215	243	271	Avg.	215	243	271	Avg.
Hereford Angus	Hereford	52.1	51.2	49.7	51.0	65.3	63.5	61.5	63.4	21.1	23.7	26.0	23.6	13.6	12.8	12.6	13.0
	Angus	50.3	49.9	48.5	49.5	63.8	63.2	60.5	62.5	23.6	24.8	28.1	25.5	12.6	12.1	11.4	12.0
	Average	51.2	50.5	49.1	50.3	64.6	63.3	61.0	63.0	22.3	24.2	27.0	24.5	13.1	12.4	12.0	12.5
Angus Hereford	Hereford	51.3	50.9	49.8	50.7	64.9	63.1	61.8	63.3	22.2	24.4	26.2	24.3	12.8	12.5	11.9	12.4
	Angus	50.5	49.3	48.0	49.3	63.8	61.6	59.5	61.6	23.3	26.2	29.3	26.3	12.9	12.2	11.2	12.1
	Average	50.9	50.1	48.9	50.0	64.3	62.3	60.7	62.5	22.8	25.3	27.8	25.3	12.9	12.4	11.6	12.3
Jersey	Hereford	51.2	50.4	49.3	50.3	64.6	63.1	61.0	62.9	21.6	24.0	26.1	23.9	13.9	12.9	12.8	13.2
	Angus	49.4	50.2	49.3	49.6	62.5	62.9	61.4	62.3	24.9	24.7	26.2	25.3	12.6	12.4	12.3	12.5
	Average	50.3	50.3	49.3	50.0	63.5	63.0	61.2	62.6	23.2	24.3	26.2	24.6	13.2	12.7	12.6	12.8
South Devon	Hereford	51.9	52.3	49.9	51.4	64.6	65.0	61.6	63.7	21.2	22.0	25.4	22.9	14.2	13.0	13.0	13.4
	Angus	51.0	52.1	49.6	50.9	64.1	65.1	61.7	63.6	23.0	22.2	26.4	23.9	12.9	12.6	11.9	12.5
	Average	51.5	52.2	49.7	51.1	64.3	65.1	61.6	63.7	22.1	22.1	25.9	23.4	13.5	12.8	12.5	12.9
Limousin	Hereford	56.2	55.0	54.1	55.1	69.2	67.9	66.1	67.7	17.1	19.2	20.9	19.1	13.8	12.9	13.0	13.2
	Angus	56.7	54.5	53.7	55.0	70.1	67.6	65.9	67.9	16.0	19.7	21.6	19.1	13.9	12.7	12.5	13.0
	Average	56.4	54.7	53.9	55.0	69.6	67.8	66.0	67.8	16.5	19.5	21.3	19.1	13.8	12.8	12.7	13.1
Simmental	Hereford	55.3	53.4	53.3	54.0	68.8	66.3	65.4	66.8	16.5	19.9	20.9	19.1	14.7	13.8	13.7	14.0
	Angus	53.3	52.0	52.1	52.5	66.6	64.5	64.3	65.1	19.9	22.3	22.7	21.6	13.5	13.3	13.0	13.3
	Average	54.3	52.7	52.7	53.2	67.7	65.4	64.9	66.0	18.2	21.1	21.8	20.4	14.1	13.5	13.3	13.6
Charolais	Hereford	53.8	55.1	53.6	54.1	67.0	67.8	66.1	67.0	19.2	18.6	20.7	19.5	13.8	13.6	13.3	13.6
	Angus	54.4	53.0	53.5	53.7	67.9	65.9	65.9	66.6	17.7	21.5	21.6	20.3	14.4	12.6	12.5	13.2
	Average	54.1	54.0	53.6	53.9	67.4	66.9	66.0	66.8	18.5	20.0	21.1	19.9	14.1	13.1	12.9	13.4
Average All Sire Breeds	Hereford	53.1	52.6	51.4	52.4	66.3	65.2	63.4	65.0	19.9	21.7	23.7	21.8	13.8	13.1	12.9	13.3
	Angus	52.2	51.6	50.7	51.5	65.5	64.4	62.8	64.2	21.2	23.0	25.1	23.1	13.3	12.6	12.1	12.6
	Average	52.7	52.1	51.0	51.9	65.9	64.8	63.1	64.6	20.5	22.4	24.4	22.4	13.5	12.8	12.5	13.0

[a] The data for all carcass traits are adjusted by regression on birth date to the average age of each slaughter group, and are adjusted for age of dam.
[b] Actual Cutability, % = Actual yield of boneless, closely trimmed beef from the round, loin, rib and chuck.
[c] Retail Product, % = Actual yield of boneless, closely trimmed beef from the carcass.

TABLE 9. U.S. MEAT ANIMAL RESEARCH CENTER GERM PLASM EVALUATION PROGRAM
LEAST SQUARES MEANS FOR WARNER-BRATZLER SHEAR AND TASTE PANEL EVALUATION OF COOKED STEAKS[a]

		Warner-Bratzler Shear, lb.[b]				Taste Panel Tenderness[c]				Taste Panel Flavor				Taste Panel Juiciness				Taste Panel Acceptability			
Breed of Sire	Breed of Dam	215	243	271	Avg.	215	243	271	Avg.	215	243	271	Avg.	215	243	271	Avg.	215	243	271	Avg.
Hereford Angus	Hereford	7.6	6.7	7.3	7.2	7.4	7.2	7.3	7.3	7.3	7.5	7.3	7.4	7.0	6.7	6.8	6.8	7.1	7.2	7.2	7.1
	Angus	7.1	6.4	6.3	6.6	7.3	7.9	7.1	7.4	7.5	7.6	7.4	7.5	6.7	7.3	6.4	6.8	7.3	7.6	7.1	7.3
	Average	7.3	6.5	6.8	6.9	7.4	7.5	7.2	7.3	7.4	7.5	7.4	7.4	6.8	7.0	6.6	6.8	7.2	7.4	7.1	7.2
Angus Hereford	Hereford	6.9	6.5	6.7	6.7	7.8	7.9	6.8	7.5	7.7	7.5	7.1	7.4	7.1	6.8	6.1	6.7	7.5	7.4	6.5	7.2
	Angus	8.0	6.7	7.0	7.3	6.9	7.0	7.6	7.2	7.2	7.2	7.9	7.4	6.9	6.2	7.2	6.8	7.0	6.9	7.6	7.2
	Average	7.5	6.6	6.8	7.0	7.4	7.5	7.2	7.4	7.4	7.4	7.5	7.4	7.0	6.5	6.6	6.7	7.3	7.2	7.1	7.2
Jersey	Hereford	7.1	5.9	6.2	6.4	7.5	7.8	7.2	7.5	7.3	7.6	7.6	7.5	6.7	6.7	7.3	6.9	7.2	7.5	7.3	7.3
	Angus	6.8	5.9	6.6	6.4	7.8	7.9	6.9	7.5	7.5	7.6	7.4	7.5	7.3	6.8	7.2	7.1	7.4	7.5	7.0	7.3
	Average	6.9	5.9	6.4	6.4	7.6	7.8	7.0	7.5	7.4	7.6	7.5	7.5	7.0	6.8	7.2	7.0	7.3	7.5	7.2	7.3
South Devon	Hereford	6.2	5.8	6.3	6.1	7.4	7.4	7.2	7.4	7.2	7.5	6.9	7.2	6.8	7.0	7.3	7.0	7.2	7.3	7.0	7.2
	Angus	6.2	6.6	6.2	6.3	8.1	7.4	7.7	7.7	7.7	7.1	7.5	7.4	7.2	7.0	7.1	7.1	7.6	7.0	7.6	7.4
	Average	6.2	6.2	6.3	6.2	7.8	7.4	7.5	7.5	7.4	7.3	7.2	7.3	7.0	7.0	7.2	7.1	7.4	7.1	7.3	7.3
Limousin	Hereford	7.5	7.6	7.7	7.6	7.0	6.7	6.5	6.8	7.2	7.6	7.6	7.5	7.1	6.7	7.0	6.9	7.1	6.8	7.0	6.9
	Angus	6.7	7.5	7.0	7.1	7.8	7.0	6.8	7.2	7.4	7.0	7.4	7.3	7.4	6.5	6.7	6.9	7.5	6.9	7.0	7.1
	Average	7.1	7.6	7.3	7.3	7.4	6.9	6.7	7.0	7.3	7.3	7.5	7.4	7.2	6.6	6.8	6.9	7.3	6.8	7.0	7.0
Simmental	Hereford	8.3	7.1	7.2	7.5	6.1	7.5	6.7	6.8	7.1	7.9	7.5	7.5	7.1	7.1	7.2	7.1	6.6	7.6	7.0	7.0
	Angus	7.2	7.4	6.7	7.1	7.8	7.2	7.6	7.5	7.8	7.8	7.5	7.7	7.6	7.4	7.2	7.4	7.7	7.4	7.3	7.5
	Average	7.8	7.2	6.9	7.3	6.9	7.3	7.1	7.1	7.5	7.8	7.5	7.6	7.3	7.3	7.2	7.3	7.1	7.5	7.2	7.2
Charolais	Hereford	7.5	7.2	6.7	7.1	7.7	6.7	7.4	7.3	7.3	7.3	7.7	7.4	7.0	6.5	7.3	6.9	7.2	7.4	7.4	7.3
	Angus	7.3	6.0	6.9	6.7	7.5	7.4	7.5	7.5	7.3	7.6	7.8	7.6	7.2	6.6	7.2	7.0	7.2	7.3	7.5	7.3
	Average	7.4	6.6	6.8	6.9	7.6	7.1	7.4	7.4	7.3	7.5	7.8	7.5	7.1	6.5	7.2	6.9	7.2	7.3	7.5	7.3
Average All Sire Breeds	Hereford	7.3	6.7	6.9	7.0	7.3	7.3	7.0	7.2	7.3	7.6	7.4	7.4	7.0	6.8	7.0	6.9	7.1	7.3	7.0	7.2
	Angus	7.0	6.6	6.7	6.8	7.6	7.4	7.3	7.4	7.5	7.4	7.6	7.5	7.2	6.8	7.0	7.0	7.4	7.2	7.3	7.3
	Average	7.2	6.7	6.8	6.9	7.4	7.4	7.2	7.3	7.4	7.5	7.5	7.5	7.1	6.8	7.0	7.0	7.3	7.3	7.2	7.2

[a] The data for all carcass traits are adjusted by regression on birth date to the average age of each slaughter group, and are adjusted for age of dam.

[b] A measure of the pounds of force required to shear one-half inch cores of steaks cooked at 350°F to 150°F internal temperature and cooled for 30 minutes at room temperature. Warner-Bratzler shear was obtained on steaks from all 452 steers.

[c] Taste panel scores are based on a 9-point hedonic scale, with higher scores indicating greater acceptability. Taste panel traits were measured on steaks from 4 steers per breed group per slaughter date (168).

TABLE 10. U.S. MEAT ANIMAL RESEARCH C[illegible]ER GERM PLASM EVALUATION PROGRAM POSTWEANING GROWTH AND REPRODUCTIVE PERFORMANCE OF HEIFERS

Breed of Sire	Breed of Dam	No. Heifers	200-Day Postweaning Avg. Daily Gain, lb.	Adj. 400-Day Wt., lb.[a]	Adj. 550-Day Wt., lb.[b]	Percent Reaching Puberty by 15 Mos. of Age	Avg. Age at Puberty days[c]	Percent Pregnant[d]
Hereford	Hereford	27	0.91	598	658	48	390	67
Angus	Angus	24	1.13	660	683	92	372	80
	Average	51	1.02	629	670	69	381	74
Angus	Hereford	23	1.13	657	704	83	371	87
Hereford	Angus	23	1.14	678	737	91	351	96
	Average	46	1.13	668	721	87	361	92
Jersey	Hereford	29	0.96	615	665	97	319	93
	Angus	16	0.99	613	657	100	324	88
	Average	45	0.98	614	661	98	322	91
South Devon	Hereford	18	1.10	657	721	72	371	67
	Angus	18	1.28	709	740	100	358	78
	Average	36	1.19	683	730	86	365	73
Limousin	Hereford	33	1.02	651	710	42	359	68
	Angus	25	1.14	695	751	96	358	88
	Average	58	1.08	673	730	69	359	78
Simmental	Hereford	28	1.13	688	746	71	369	71
	Angus	22	1.22	718	761	100	360	91
	Average	50	1.18	703	753	86	365	81
Charolais	Hereford	35	1.09	687	746	83	366	78
	Angus	16	1.22	722	796	88	371	75
	Average	51	1.15	704	771	85	369	77
Average All Sire Breeds	Hereford	193	1.04	651	707	71	362	75
	Angus	144	1.16	686	733	95	356	85
	Average	337	1.10	668	720	83	359	80

[a] Adjusted 400-day weight = Adjusted 200-day weight + (200-day postweaning average daily gain x 200 days).
[b] Adjusted 550-day weight = Adjusted 200-day weight + (350-day postweaning average daily gain x 350 days). This is based on a shrunk weight.
[c] Includes only the heifers reaching puberty by 15 months of age, and should be interpreted in relation to the percent reaching puberty by 15 months of age.
[d] The breeding period was 45 days by artificial insemination (May 24 to July 7) and 26 days by natural service (July 8 to August 2).

BEEF CATTLE PRODUCTIVITY RECORDS-- ANOTHER TOOL FOR THE RANCHER

by
Mr. Kenneth A. Coulter
Brusett, Montana

Mr. Chairman, guests, ranchers, ladies and others.

I should say that I am extremely pleased to be here today, but I'm sure I would now be feeling more comfortable if I were sitting out there and one of you were standing up here.

When first approached to be a part of your program today, my first reaction was--what could my contribution to this gathering be? However, upon further consideration I felt that we ranchers who are putting some of the information and livestock to use that is developed here should take an active part in this experiment station. We need to help evaluate the information and lend guidance to the research work so that whatever is produced here can be useful and relative to our needs.

This Station belongs to all of us and your monies and mine help pay the expenses here, so to protect our investment and take care of our business we should participate. Otherwise, this could be a poor investment.

I realize I am one of an extremely minority group addressing you folks today. However the majority of you are probably members of this same minority. If only seven percent of our population is engaged in producing all of this country's agricultural products; then what percent do you suppose produce all the beef for our entire population. I suspect there are more garbage collectors or taxi-cab drivers in these United States than there are feeder cattle producers. Small though our numbers may be, the importance of our industry is very large when you consider that beef is the most widely accepted meat product and possibly general food in America today.

To maintain, progress, and promote our industry, it will be necessary for us to work together as producers and with feeders, packers and merchandisers to see that we have a reasonably priced quality product for the public to purchase and enjoy.

I present myself as an authority on nothing, as I am too close to home. An expert on nothing as my interests are too broad and a degree in nothing as my college training has amounted to three days at MSU of wool grading.

My experience with cattle dates back to the drouth and depression of the 30's when as a 10-year-old boy I saw all our cattle sold to the government except one or two milk cows. For the next few years we milked any cow my step-dad acquired, to help feed the family. Now don't get me wrong, these were not all milk cows. Some gave no more milk than their calves needed and sometimes milking them involved a couple of lariat ropes, hobbles, a bent up milk bucket, splattered clothes and a shattered patience, but milk them we did.

Later, in the middle forties, after running commercial Herefords a few years, I witnessed the productivity, or lack of it, on some overstuffed registered heifers which won honors at the show ring and were so pretty. They should have went to slaughter instead of coming home.

I vividly recall how proud my dad was of these critters when he brought them home. Pride soon wained into disappointment and then to disillusionment as dead calves, lack of milk and infertility evolved. Our commercial Herefords out-produced these over-fat, blue-ribbon babies so far that we would have created our own depression if we/d had very many of them.

I mention this background to let you know why I place emphasis on production. I've seen enough of depressions, self-created or otherwise.

The first production tested bull that went into our herd was No. 646, a Line 1 yearling from Fort Keogh: Weaning weight 535 pounds, birth weight 81 pounds, gain 2.79 pounds per day and final weight as a yearling 1080. Not bad for 1955. His looks weren't too pretty. He kind of reminded me of the story of the Tennessee hogs--to see if they were ready to butcher one is to grab one of them with a hand on each ear and lift him off the ground, if he tips over forwards he isn't ready yet.

The performance of this animal and his records stirred my interest in evaluating each cow and I soon had a set of scales and ear tags.

I have maintained production records on a herd of commercial Herefords since joining the Montana Beef Performance Association in 1963 and thought that perhaps a discussion of production methods and records might be of some value. I hope to create an exchange of ideas and experiences which may be helpful especially to anyone new at herd record keeping.

Some means of identification for each animal must be used. We have used hot iron number brands, freeze brands, metal ear tags and now I use the large size plastic tag which hangs down below the ear and number them ourselves. We find these are inexpensive, easy to install, easily read whether the cow has long hair or short and different colors can represent the age of the animal. The same type of tag only smaller is placed in the opposite ear of each calf at birth and serves as a back-up I.D. if the larger tag is lost. If one does no other record keeping, just this positive identification will more than return the two-bits or less per head investment. How often have you wondered if that was the cow which showed a little prolapse, or didn't mother her calf right, didn't clean, or had such big teats at calving or was it the other cow which looked just about like her. I don't suppose this has ever happened to you, but it did to me before I used positive identification.

Ear tagging, recording birth dates and weighing all calves individually at weaning time takes effort, time and a set of scales, but it is the only accurate method I know of which will put each cow on a comparative productivity basis within your herd. Montana Beef Performance Association will calculate the average daily gain, 205-day adjusted weight and rate the cows on a production percentage basis for you at a reasonable cost. I believe some breed associations also do this for their members.

These records are no substitute for normal culling and selection methods, but do give you a broader, more accurate basis from which to make a reasonable decision.

Let me give you an example. In 1970, our calving was slower than normal and it appeared the ones calving first were those which calved later the previous year. A check of the 1969 calving records verified this situation. You stockmen know this is unusual as the early calving cows usually remain as such. In April of 1969 we had unusually heavy rain and snow, resulting in the cows then nursing calves taking quite a shrink and the subsequent lush grass being low in energy and very high in water content. Feeling that lack of energy could be the problem, I caked the cattle at least two weeks longer following a similar storm in 1970 and calved out much quicker in 1971 with the dry cows reduced to one in about 150 head. I believe records helped find the problem.

In keeping production records on the cows since 1965 I have found the 205-day adjusted weights would have increased on the same number of calves about 50 pounds per calf with no creep feeding. This is from 440 pounds to 490. However, we are expanding the number of cows while at the same time attempting to improve weaning weights and find we are short of high producing replacements. If one is going to reap a greater harvest in weaning weights, then I grant you we may have to shovel in more fuel to stoke the fires. These animals are now putting into milk which once may have placed fat on their own ribs.

It is interesting to note that I still find variations within the herd from about 20 percent above average to about 20 percent below. This is not very much different than the variations noted when first records were kept, although weaning weights have went up. This would seem to indicate that further improvement by selection is available, but it takes time.

How does one select the replacement heifers which will be calving for the first time and have any assurance they will be the top producers. Dr. Jons Bonsma of South Africa selects for traits he calls functional efficiency, but maybe I flunked that course, for some of our replacements just don't produce as their appearance and records indicate they should. We select at about 18-months of age for size, type and feminine appearance. However, one year I kept some heifers already cut out for culls and found a few of the best milking cows were in this group. Now we save about twice the number of heifers necessary for replacements to obtain broader selectivity, after the first calving, before they go into the main cow herd. The largest heifer calf in our bunch seldom turns out to be the best milking cow. Perhaps the largest heifer calves get too fat which could injure the mammary glands, or maybe they acquire their size due to hormones which are not conducive to milking ability, or again maybe this is a natural variation and will continue until the traits become more fixed in the bloodline.

Here I've been talking all cows, but in reality they are the secondary crop. Grass, forbs and shrubs available for livestock grazing are our primary crop and I'm convinced more attention is badly needed in this field. Are there some basic techniques which could improve the quantity and quality of grass production? I believe there is. Perhaps rest rotation systems or deferment at critical seasons could be the answer, but certainly we are going to have to make the same acres produce more if we continue to pay the increasing costs of taxes and other operating expenses. But, this is another subject and I had best not get started on it at this time.

You have been a good audience, and I appreciate the opportunity to be a part of your program.

I will be happy to discuss any of this subject matter with anyone later this afternoon.

Manipulating Livestock Management to Maximize Production From the Forage Resource

R. J. Raleigh
Squaw Butte Experiment Station 1/
Burns, Oregon

Optimum range livestock production can only be achieved through compatible livestock and forage management. A quantatative and qualitative inventory of forage resources is necessary to develop a range, livestock, and forage management program. To accomplish this, an inventory of range forage nutrients at specific times during the grazing season is essential. Only after the relative seasonal availability of nutrients is known can livestock be managed to obtain a maximum return from the available forage resource.

Nutritional value and forage quality are difficult to define and equate without further qualification. From the standpoint of livestock production, this must be defined as the ability of the forage to provide for a specific type of livestock production. Several factors contribute towards nutritional value, such as, chemical composition, availability of the nutrients, and, finally, acceptability by the grazing animal.

I would like to talk about the range nutrition research program at the Squaw Butte Experiment Station. While the specific dates of the calendar and many of the plants may not directly relate to this area, the principles employed will apply to whereever cattle are grazing forage. Forage is an ever changing product, starting out high in quality at the initiation of growth, with quality declining as the forage goes through the growth cycle to maturity.

In developing the range nutrition program at the Station, forage was sampled by both clipping and esophageal and rumen fistulated animals at specific dates during the grazing season. Intake and digestibility studies were also conducted during these same periods. From these data it was possible to calculate the nutrient intake of the grazing animal at specific times during the year and correlate this with production of various classes of animals.

Range forage in the Squaw Butte area is 18 to 20 percent crude protein in early May, dropping to 8 or 9 percent by mid-June, 5 percent by the first of August, and as low as 3 percent by September. Energy values follow this same trend. Table 1 presents some laboratory measures of forage quality at particular times during the summer grazing season.

Production from growing cattle follows the same trend as forage quality. Suckling calves dropped in March and April will gain 1-3/4 pounds per day during May and June, 1 pound per day during the month of July, about 1/2 pound during the month of August, and relatively no gain

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1/ The Squaw Butte Experiment Station is jointly operated by the Oregon Agricultural Experiment Station and Plant Science Research Division, Agricultural Research Service, U.S.D.A., Burns, Oregon. R. J. Raleigh, Superintendent.

if left on this forage after the first of September. Yearling cattle follow this same pattern with yearling steers gaining 2 or 2-1/4 pounds during the month of May, 1-1/2 pounds during July, less than 1 pound during August with relatively no gain after the first of September.

Table 1. Average Concentration of Certain Chemical Constituents of the Diet of Cattle on Range Forage During the Grazing Season

Date	Crude Protein	Cellulose	Phos-phorus	Lignin	TDN
	%	%	%	%	%
May 1	18.8	24	0.22	4.2	70
May 15	17.7	25	0.20	4.3	68
May 29	12.0	27	0.19	4.6	66
June 12	10.6	28	0.18	5.6	62
June 26	8.62	29	0.17	6.6	54
July 10	7.37	30	0.16	6.9	52
July 24	6.31	30	0.15	7.2	50
August 7	5.31	30	0.14	7.4	50
August 21	4.18	30	0.12	7.6	44
September 4	3.31	30	0.11	7.7	40
September 18	2.87	30	0.11	7.7	40

There are several alternatives for management to maximize the return from the forage nutrients. First, yearling cattle should not be permitted on range forage of this quality after about the first of August. Cattle with the growth potential these yearlings have should be removed and put in the feedlot or moved to higher quality pastures such as irrigated pastures. This will not only provide an opportunity to make an economical gain on these yearlings but it will provide additional forage for the breeding herd during this period.

Under these conditions of poor quality late summer and fall range calves should be weaned some time in August and no later than the first of September and put on better feed. This not only gives the livestock operator an opportunity to feed his growing cattle for an economic return but it also provides an opportunity for the cow to graze more freely and come into the wintering period in better condition, thereby reducing the cost of winter feed.

A second alternative is supplementing these cattle. The primary effort for supplementing has been in the area of developing range supplements for yearling cattle during the time they are on summer range from approximately May 1 to November 1. The basic idea behind the supplements was to determine the amount of nutrients this type animal could take from the range forage during particular times of the grazing season, and then to determine the amount of nutrients necessary for a specific rate of gain. The rate of gain should be approximately 2-1/2 pounds per head per day. The supplement then was the difference between those nutrients provided by the forage and those nutrients necessary for the animal to gain this 2-1/2 pounds per day.

During the early part of the season when the protein content of the forage is high, and also the moisture content is high, gains are not as high as expected. During this period a low level of energy supplement will give a good return in daily rate of gain. About mid June both a protein and energy supplement were started gradually increasing as the quality of the forage declined. Table 2 shows a standard range supplementation schedule and Table 3 shows the average daily gains that we get from this type of a program.

Table 2. Daily per head supplemental levels during the growing period

Date	Barley	CSM
	lb	lb
5/1 - 5/31	1.00	----
6/1 - 6/14	0.50	----
6/15 - 6/28	0.25	0.25
6/29 - 7/12	0.30	0.75
7/13 - 7/26	0.50	1.00
7/27 - 8/3	1.10	1.20

Table 3. Average daily gains of steers fed supplements over the total period, from mid-June on, and controls with no supplement

Suppl.	Period			Avg.
	1	2	3	
	lb	lb	lb	lb
None	2.3	1.4	0.9	1.6
6/17 - 8/3	2.3	2.4	2.4	2.4
5/1 - 8/3	2.7	2.6	2.6	2.6

These figures represent averages over 5 or 6 years. In general, during the months of May, June, and July cattle have averaged about 2-3/4 pounds per head per day gain from the supplements whereas those unsupplemented have reached 1-3/4 pounds per day gain. The cost of the supplement for this gain has been less than 5 cents per day or approximately 2 cents per pound of daily gain.

If we extend these supplements much beyond August 1, or rather once the forage reaches a level where it will support less than 1 pound per day gain, supplementing becomes more difficult. Once we reach a level in excess of 3 pounds of supplement per head per day we switch from a supplementation program to a substitute program in which grain is substituted for the forage. Under most conditions this is not economical or practical since our primary reason for having these cattle on range is to provide a market for this forage through the cattle.

We have considered the possibility of taking cattle off the early supplementation program which we referred to as the growing period and putting them on a higher level of supplement to produce slaughter grade cattle from range. We were able to do this by increasing the level of supplementation so that by mid-September the animals had reached a supplemental level approaching 1-3/4 percent of their body weight. This level of supplementation was continued to approximately November 1 at which time these cattle were slaughtered. Table 4 shows the results of this type of program.

Table 4. Supplemental costs and returns from the growing and finishing phase of the range supplement program

Item	Period		Average
	Growing	Finishing	
Days on trial	95	96	----
Daily gain, lb.	2.72	2.25	2.48
Daily barley, lb.	0.75	10.6	5.68
Daily CSM, lb.	0.50	1.4	0.95
Daily feed cost, $	0.048	0.34	0.194
Cost/lb gain, $	0.018	0.15	0.084

The cost of the supplement per pound of gain was 15 cents during the finishing period. Approximately 20 percent of these cattle went to a low choice grade while the rest went to an average to high good grade. Under the current standards it may be difficult to get cattle from this type of feeding into a choice grade. Currently we are looking at the possibilities of feeding with this type of program to about November 1 and then putting the cattle in the feedlot for 30 to 45 days in order to get them to grade.

A third approach to manipulating the management of livestock to take advantage of the high quality range resource is to change the date of calving. Under the present spring calf management system calves are dropped in March and April and go immediately on range. We have a calf weighing under a hundred pounds going on lush forage that is capable of increasing the milk production of this animal; and quite often the calf is not able to take care of this milk production and eventually winds up scouring. Also, during this period when the forage is of high quality the calf is too young to take advantage of the forage directly. By the time the calf is able to utilize forage and higher levels of milk production, the quality of the forage decreases to a point where milk production is drastically reduced, and the forage is poor enough in quality that the calf gets little advantage from it. Consequently, by August 1 gains drop off to less than a pound per head per day on suckling calves.

A fall calving program was developed to turn a calf on range with adequate size to take advantage of the high quality forage during the months of May, June, and July. Calves from this particular operation are weaning 175 to 200 pounds heavier than the spring dropped calves. Research is being conducted to determine the minimal nutrient requirements necessary to carry this fall calving cow through the winter at a level which will not affect her life time reproduction performance. We have taken the approach that we are not particularly concerned with the production of milk from this cow since under a fall calving program the animals are usually close enough to headquarters that management can be intensified and the calves can be fed directly.

The calves are creep fed from the time they are born until they go out on range. The total cost of additional feed for the creep feed of the calf and the wintering of this cow has averaged approximately 15 dollars per cow-calf pair over that of wintering the spring calving cow. Our research has indicated that for the rancher that is capable and willing to take advantage of the opportunities in fall calving his return can be increased considerably. However, a program like this should be studied cautiously to determine if the operator has the willingness and the resources to intensify his management before entering this program.

INVESTIGATION OF EFFECTS OF CROSSBREEDING AND ADAPTATION TO ENVIRONMENT ON BEEF PRODUCTION

by
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Crossbreeding is one of the breeding approaches that may be used in beef production and one that has commanded a considerable amount of producer interest in recent years. Production responses of cattle when placed in environments differing materially from the environment in which they were bred and selected is also of interest. With our present transportation facilities, breeding cattle are moved quite freely among geographic localities and are thus required to perform under a relatively wide range of environmental conditions. Factors contributing to environmental differences among geographic localities include feeds available, climatic conditions and general management practices.

This report is for the purpose of presenting the objectives and procedures applying to present phases of investigations in crossbreeding and adaptation to environment at the U. S. Range Livestock Experiment Station. Results obtained from past and present phases of these studies are summarized briefly.

Crossbreeding

The crossbreeding study at the U. S. Range Livestock Experiment Station was organized in three phases. The Hereford, Angus and Charolais breeds are involved primarily. Brown Swiss breeding, introduced solely in the initial phase through Brown Swiss cows, has been carried through all phases for limited comparisons.

Phase 1 (Evaluation of data nearly complete):

Phase 1, initiated in the breeding season of 1961, was primarily for the purpose of measuring effects of hybrid vigor in first-cross (two-breed cross) calves obtained from all possible two-breed mating combinations of the three beef breeds. These calves were compared with straightbreds of the three beef breeds.

Hybrid vigor in weights and daily gains of steers from birth through a postweaning, feedlot test terminating at individual slaughter weights of 1000 to 1050 pounds ranged from 3.7% to 4.4% and was 2.2% for weaning grade. Hybrid vigor percentages obtained for efficiency of feed utilization and carcass grade of steers were 3.3 and 1.1, respectively. Crossbred steers reached the slaughter weight range of 1000 to 1050 pounds with an average of 11 days less time in the feedlot than did straightbreds. Effects of hybrid vigor on most carcass traits not closely associated with growth and on factors affecting palatability of rib roasts were relatively unimportant.

Hybrid vigor contributed little to most growth traits of heifers from birth to 18-months of age or to weaning grade (2.0% or less). Higher values were obtained for daily gain from weaning to 12 months (4.9%) and 18-month grade (4.7%).

First-cross beef X Brown Swiss calves were obtained by breeding bulls of the three beef breeds to Brown Swiss cows. The beef X Brown Swiss calves averaged about 70 pounds heavier than the beef X beef crossbreds at weaning, but this weight advantage was cancelled out by the relatively low reproductive performance of the Brown Swiss females. This suggests the possibility that the plane of nutrition under range conditions might be too low for efficient reproduction of cows that are relatively heavy milk producers.

Beef X Brown Swiss crossbreds tended to maintain their weight advantage after weaning, but postweaning rate of gain for the steers in the feedlot and the heifers grown out to 18 months of age was similar to the rate for the beef X beef crossbred steers and heifers. Beef X beef steers and heifers showed some advantage in live animal grades (weaning and postweaning), but carcass grades of beef X beef and beef X Brown Swiss steers were quite similar. Beef X Brown Swiss crossbreds compared favorably with beef X beef crossbreds in most carcass traits and in factors affecting palatability of rib roasts.

Phase 2 (Data collection complete):

Phase 2 was designed to study effects of crossbreeding on maternal qualities of first-cross dams. The first-cross females and the straightbreds with which they were compared were those produced in Phase 1. These females were bred to crossbred bulls in a scheme arranged so that all calves produced were three-breed crosses. Final analyses of the data are in progress. The following results are from a preliminary evaluation of the data collected.

In comparison with the straightbred females, the beef X beef crossbred females showed advantages of 2.0 percentage points in net calf crop weaned and 2.2% in all growth traits to weaning for the calves produced. In combination, these effects resulted in an advantage for crossbred females of about 5% more calf weight at weaning per exposed cow.

In comparison with beef X beef crossbred females, the beef X Brown Swiss females showed an advantage of 5.5 percentage points in net calf crop weaned. It is suspected, however, that chance may have made this advantage somewhat high, and verification is desirable. The beef X Brown Swiss dams also produced calves that were 6.7% heavier at birth and 11.0% heavier at weaning. It appears that Brown Swiss breeding in the beef X Brown Swiss dams contributed to milk production and to the preweaning growth of calves produced. Because of advantages in calf crop percentage and preweaning growth of calves, the beef X Brown Swiss females produced 19.8% more calf weight at weaning than did the beef X beef crossbred females.

Phase 3 (Now in progress):

Phase 3 is designed to estimate hybrid vigor obtainable from two-breed and three-breed rotational crossing and the level of hybrid vigor that can be maintained by following these schemes continuously. The merits of developing synthetic varieties from crossbred foundations are also under investigation. The breeding plan used to establish Phase 3 is shown in table 1. It is expected that this phase will be continued to at least 1974 or 1975.

The data have been collected on the first rotation. This permits the comparison of backcrossing and initial three-breed crossing with straightbreeding. A preliminary evaluation of data on male calves produced for the comparison of rotational systems have been made. The data on males from the synthetic varieties and female calves from all of the breeding schemes are yet to be evaluated.

TABLE 1. BREEDING PLAN TO INITIATE THE ROTATIONAL CROSSING PROGRAM AND DEVELOPMENT OF SYNTHETIC VARIETIES

Breed of sire[a]	Breed of dam[a,b] H	A	C	HA, AH	HC, CH	AC, CA	Synthetic Variety[b]	Approx. Total
				Rotational Crossing				
H	X			X	X	X		30
H	X			X	X	X		30
A		X		X	X	X		30
A		X		X	X	X		30
C			X	X	X	X		30
C			X	X	X	X		30
				Beef Synthetic Variety				
							Foundation dams:	
Crossbred[c]							HA,AH,HC,CH,AC,CA	30
Crossbred[c]							HA,AH,HC,CH,AC,CA	30
				Swiss Synthetic Variety				
							Foundation dams:	
H, A, C & Crossbred[d]							HB, AB, CB	30
H, A, C & Crossbred[d]							HB, AB, CB	30

[a]H, A, C and B are Hereford, Angus, Charolais and Brown Swiss, respectively. Bulls of each breed changed annually.

[b]Breeding of females initially used. Heifer calves produced to go back into the respective straightbred, rotational crossing and synthetic schemes as replacements.

[c]Initially two-breed crosses from Phase 1. A bull from the three-breed crosses and a bull produced in the synthetic variety selected each year, once they became available.

[d]Initially H, A and C bulls mated to produce calves with breeding of two beef breeds plus 25% Brown Swiss. Crossbred bulls selected each year from within the synthetic variety, once they became available.

Advantages of backcrossing and initial three-breed crossing as indicated by data on male calves is reported in some detail in another 1972 field day presentation, "Bulls vs. Steers--Growth and Carcass Performance--Preliminary Results" by J. J. Urick. Backcrosses and initial three-breed crosses excelled straightbreds in weaning weight, daily gain in the feedlot, carcass weight per day of age and trimmed retail cuts per day of age by 4.0% or more. The three breed crosses showed a somewhat greater advantage over straightbreds than did the backcrosses in weaning weight (7.3% vs. 5.6%) and in carcass grade (1.4%

vs. -1.4%). In other growth or carcass traits observed, advantages shown by backcrosses and three-breed crosses were about equal.

Data are now being obtained on the next rotation. The mating scheme is as shown for rotational crossing in table 1, with the backcross and initial three-breed cross females and their straightbred contemporaries serving as the breeding females.

Physiology and nutrition studies have been incorporated recently into the crossbreeding study described in this report. The physiology studies include investigation of differences in hormone levels in the various breeds and crosses and effects of stimulation of the female at time of mating as these factors relate to fertility. Nutrition work involves a study of differences in nutritional requirements of breeds and crosses, with blood metabolite levels serving as indicators. Some information on feed required by cows and their calves is being obtained by individual feeding. Straightbred and crossbred cows becoming excess to the rotational breeding study are rebred and used for this purpose.

Adaptation Study

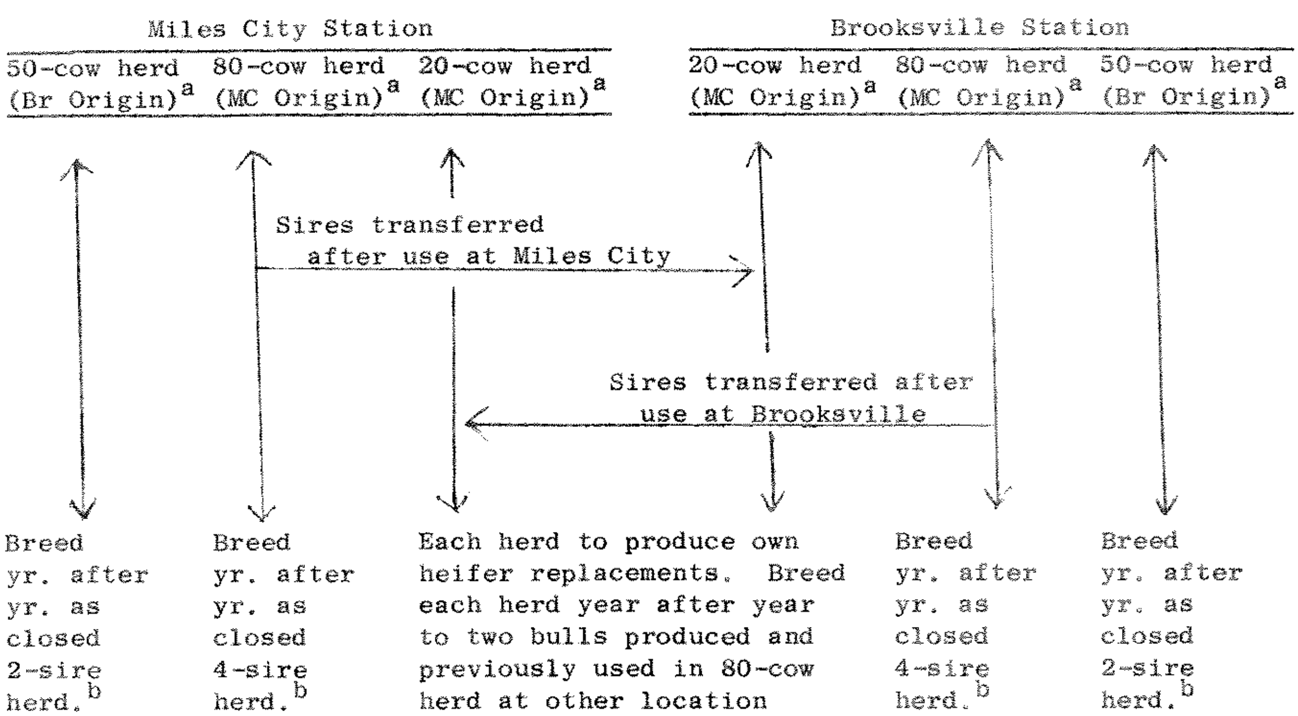
One of the main objectives of this study is to determine the importance of adaptation to a specific location as a factor affecting maximum or optimum productivity of beef cattle. This is a cooperative study in which the United States Department of Agriculture (Beef Cattle Research Branch--ASRD, ARS) and the Agricultural Experiment Stations of Montana and Florida are participating. Studies of like design are in progress at the U. S. Range Livestock Experiment Station near Miles City, Montana and at the Beef Cattle Research Station near Brooksville, Florida. The study was initiated with the transfer of cattle between the Miles City and Brooksville Stations from 1961 to 1963. The design of the project is illustrated in figure 1.

Hereford herds developed through performance selection at Miles City, Montana and Brooksville, Florida were divided (1961-1963) to provide the foundations for the 50, 80 and 20-cow herds at each location (figure 1). The 50-cow herd of Brooksville origin and the 80-cow herd of Miles City origin are maintained as closed herds at each location. The 80-cow and 20-cow herds were of the same foundation and, for all practical purposes, were essentially alike initially. Bulls produced in the 80-cow herd at each location are selected on their performance for use in the parent herd two years. They are then transferred to the other location where they are used in the 20-cow herd for one year.

The following are some of the situations that should exist or develop if influences of adaptation on productivity are important:

1. The relative performance of the 80-cow and 50-cow herds at Miles City should differ from the relative performance of the 80-cow and 50-cow herds at Brooksville.

2. The 80-cow and 20-cow herds within each location should perform essentially the same initially and become somewhat different as time progresses. The differences developed would result from introducing bulls selected on performance at the other location and presumed to be relatively well adapted to conditions at the other location as indicated by their performance.



[a]Br--Foundation stock from Brooksville Station.
MC--Foundation stock from Miles City Station.

[b]Closed herd--Both sire and female replacements to come from within the herd.

Figure 1. Long-term breeding plans for Miles City, Montana, and Brooksville, Florida, Stations.

To date, the performance of the 80-cow and 50-cow herds at both locations has been evaluated. Data collected during the first seven years subsequent to the original transfer were used. Relative performance of these herds within the two locations differed for birth weight, weaning weight and postweaning growth traits of progeny. Cattle of Montana origin performed best in Montana and cattle of Florida origin performed best in Florida.

The results described may indicate that each group of cattle was better suited genetically to the location of origin, but any necessity for physiological adjustment of the cattle initially transferred could have been influential. It is anticipated that a similar analysis of data, with early data eliminated so that effects of the original transfer will be farther removed, should help to explain the results described.

Whether the 80-cow and 20-cow herds will become different within location, due to transfer of bulls selected for performance at the other location, is yet to be determined. Data are not sufficient at this time to support a conclusion. Some of the meaningful data required by this project will not be available in sufficient quantity until about 1974 to 1975.

SELECTION AND LINECROSSING STUDIES AT THE MILES CITY STATION

by
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The genetic improvement of herds in the industry can be expected with the use of superior seedstock. The production of superior seedstock, however, will likely result only if the selection procedures practiced are accurate enough to bring about the desired genetic changes. Thus, there is a continued interest among stockmen for further research information which may contribute to selection accuracy for further herd improvement.

Traits such as weaning weight, gain and feed efficiency in the feedlot, lean to fat composition, and reproduction are all examples of important measures that will benefit to a varying degree through the use of improved seedstock. With these considerations in mind, selection studies are being continued at this Station with several mildly inbred lines to accumulate additional information of the effectiveness of selection procedures to increase production in traits that are economically important.

The first selection procedures used in the Station herds, with the intention of improving performance in the various lines, were determined to a large extent by the magnitude of the heritability of certain traits of economic importance. From the earlier studies at this Station, typical of Northern Great Plains range conditions, weaning weights in this herd were observed to be less than 30% heritable. In the follow-up feedlot tests, gain and final weight were observed to be more highly heritable. Therefore, in the Station herds, the greatest amount of selection pressure was placed on the postweaning traits. A small amount of direct selection was placed on weaning weight, and practically none on birth weight.

Starting as early as 1934 in one mildly inbred line that had sizeable numbers, estimates of genetic improvement for the more important traits (mostly related to growth) have been obtained up through 1959. During this period of time the magnitude of the estimated genetic responses obtained in the herd were encouraging and resulted in some important recommendations for the improvement of beef herds.

Presently three two-sire lines of 50-60 cows each are being used to gather additional information on the effectiveness of certain selection procedures as indicated by the response in traits considered. In these lines, somewhat more refined procedures are used than have been practiced previously, especially to obtain more accurate estimates of environmental trends which are necessary to measure genetic progress. While a primary objective in these lines is to measure responses to selection, another important consideration is to determine if selection actually becomes ineffective (reaching a plateau) for some traits. This may result because of natural forces operating against selection pressure--for example, this might happen under our range conditions with relatively sparse forage, more so in some years than others, when genetically superior cows would not obtain enough feed to allow a full expression of their genetic ability for weaning weights. In this case, they may tend to produce along with the average of the herd. Another possible reason for failure of some herds to respond to selection is that the herds may be relatively uniform genetically, thus limiting opportunities to select for genetic superiority.

Of these three lines in the present selection studies, Lines 12 and 14 were developed from linecross foundation, and have shown favorable production over the years when compared to other lines in the Station herds. Major selection emphasis in these two lines has been for yearling weight off feed in the bulls, and 18-month weight off the pasture in the heifers. Attention is also given to structural soundness. Major culling in the cow herds is mostly for physical defects, low fertility and age.

The third line included in the present selection studies is the Carcass line which is also a 60-cow, two-sire line. Selection of replacement herd sires in this line is on the basis of an index which includes yearling weight off feed test and fatness as measured over the ribeye muscle. In the initial stages of the development of this line favorable increases in yearling gain and weight are being obtained with an accompanying trend of lowered backfat thickness. That these responses are in the right direction is encouraging because selection emphasis for these traits will likely become more important as evidenced by industry trends. Added data from this line as well as from Lines 12 and 14 should be helpful in the overall evaluation of these selection procedures for increasing growth and obtaining desirable lean to fat proportions. Responses to reproduction in all three lines, as evidenced by maternal traits (conception rates, percent calves weaned, etc.), are being observed.

Linecrossing Studies

Linecross vs. straightline calf performance:

The crossing of inbred lines of cattle at this Station has provided a fairly large amount of data to evaluate the influences of hybrid vigor on production traits that the industry is concerned about. The first linecrossing study (Phase 1) to estimate hybrid vigor was initiated in 1961 when five inbred lines (Lines 1, 4, 6, 9 and 10) were crossed in all possible two-line combinations. Straightline matings were also made to produce straightline calves. When comparisons were made between linecross and the straightline calves, estimated percent hybrid vigor advantage for the bulls amounted to 3.0, 5.6, 5.1, 2.5, 2.9 and 4.5, respectively, for birth weight, preweaning daily gain, weaning weight, weaning score, 196-day gain on test and final weight. In the heifers, the estimated percent hybrid vigor advantages for birth weight, preweaning daily gain, weaning weight, weaning score, 12-month weight and 18-month weight, respectively, were 3.8, 10.6, 9.4, 2.7, 9.4 and 6.6. An explanation given for the smaller hybrid vigor response in the bulls, especially to weaning, was that they did not obtain enough milk from the inbred dams (all parents were inbred) to allow for a full expression of their genetic potential. The hybrid vigor estimates obtained from this study in both sexes seemed higher than expected. An explanation given for this is that part of the response in the linecross calves, as compared to the inbred calves, may have been due to recovery from inbreeding that tends to depress performance. Further information on the effect of inbreeding on all inbred lines in this study is needed for adjusting the present estimates of hybrid vigor to levels that may be more meaningful for industry purposes.

Linecross dam vs. inbred dam maternal performance:

A comparison of the maternal performance of the linecross and straightline heifers (Phase 2) was possible from heifer progeny produced in Phase 1. These

2-line cross and straightline heifers were all mated to 2-line cross sires to produce 3-line cross calves. The estimates of maternal hybrid vigor obtained from these calf traits were as follows: birth weight, 1.5%; preweaning daily gain, 5.4%; 205-day weaning weight, 4.7%; and weaning score, 0.4%. These estimates for maternal hybrid vigor were less than the estimates for calf hybrid vigor observed in Phase 1 where comparisons were based on linecross vs. inbred calf performance. The linecross heifers while producing two calf crops, showed 12 and 15% advantages, respectively, over the straightline heifers for percent calves born and weaned.

Postweaning performance in Phase 2 linecrossing was also evaluated and show the advantages for bulls from linecross dams to be as follows: 196-day feedlot gain, 2.3% and for 196-day final weight, 2.1%. The hybrid vigor estimates for maternal effects on the heifer progeny were as follows: 12-month weight, 1.7%; and 18-month weight, 2.3%. These estimates of maternal hybrid vigor were less than those for calf hybrid vigor obtained in Phase 1.

The results from Phase 1 and Phase 2 linecrossing experiments thus suggest that calf hybrid vigor may be more important than maternal hybrid vigor for the traits considered through yearling ages, at least as evidenced under these range and feedlot conditions. Careful appraisal of other similar studies should be made, however, before important conclusions can be drawn in regard to calf vs. maternal hybrid vigor influences.

A comparison of mating systems:

A present linecrossing study aims to compare straightline breeding with 2-way and 3-way rotational crossing systems. In addition, a synthetic variety (mating linecross sires with linecross dams) is being developed and maintained for comparison with the other mating systems. In this study the straightline breeding (using inbred Lines 1, 4, 6 and 10) serves as a base point and will be compared to the crossing systems for measuring hybrid vigor. An important consideration in these crossing systems is to determine if hybrid vigor can be produced and maintained over an extended period of time that would be important from the industry standpoint.

The original females used in this linecross experiment resulted from the Phase 1 linecrossing discussed previously. Straightline dams were mated to the same line of sires to produce straightline calves. The first-cross females were also mated to straightline sires to produce 2- and 3-way cross calves. The synthetic variety was initiated by crossing the first-cross females to 2-line cross sires produced in Phase 1. In later stages, sire replacements in this group are obtained either from 3-way rotation crosses or from within the crosses of the group.

The 2-line crosses produced in the first stages of this experiment were typical backcrosses and, thus, resulted in a 75% relationship to the sire line. The first 3-line cross calves produced were the result of the first-cross female being crossed to the third line of sire. Thus, these 3-line cross calves were 50% related to the sire line with the other two lines having a 25% representation. Preliminary comparisons thus at this stage are with the backcross and initial, 3-way cross calves. As the second phase rotational matings produce sufficient calves for comparisons, it will be possible to evaluate the effectiveness of the two rotational crossing systems to produce and maintain hybrid vigor over an extended period of time. An important consideration in this linecrossing study is that the observed hybrid vigor is the net effect of both dam and calf being linecrosses.

Preliminary results at this stage show advantages for bull calves from the 2- and 3-way crossing systems that are in close agreement with expectations, as might be determined from Phase 1 and 2 linecrossing studies discussed previously. Thus, for weaning weight the 2- and 3-way cross calves have shown average advantages of 8 and 12%, respectively, over the straightlines. There was less advantage through the postweaning period for both 2- and 3-line crosses as evidenced by final weight performance, which showed advantages of 3.3 and 8.7%, respectively, for the two crossline groups. At this stage, 3-line crosses are showing small growth advantage over the 2-line crosses. For the traits considered, the synthetic variety calves have been similar in performance to the 3-way crosses.

At this stage the results of the heifer calf performance is not completed, necessary for an overall evaluation of the crossing systems. Reproduction data being obtained in this study will also be important for an overall evaluation of these crossing schemes for total production.

SUMMARY OF NUTRITION RESEARCH AT THE U. S. RANGE LIVESTOCK EXPERIMENT STATION

by
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The primary objective of the beef cattle nutrition research program at the U. S. Range Livestock Experiment Station is to devise methods to increase beef production from the range resource through various nutrition and management system studies. This report contains summaries of preliminary data and shows experimental designs of studies started in 1971 and to be continued in 1972. No attempt will be made to discuss in any detail the various joint projects being conducted in conjunction with the genetics and physiology investigations groups.

Winter Management of Replacement Heifers

The objectives of this study are: (1) to determine the influence of size and breed of heifer upon feed requirements during the wintering period; (2) to study the effects of winter management upon subsequent summer pasture gains and reproductive performance; (3) to determine the feasibility of sorting replacement heifers at weaning according to weight and feeding them accordingly during the wintering period to reach a specified weight by the beginning of the breeding season. Fifty-nine crossbred (1/2 Charolais; 1/4 Hereford; 1/4 Angus) and 39 Hereford heifers were divided by breed and sire group into three treatment groups: Group 1 - random 1/3 (heavy and light heifers); Group 2 - heavy 1/3 (heifers above average weight); Group 3 - light 1/3 (heifers below average weight). Each group will be fed to gain at a rate so that at the end of the wintering period (about May 1) the Herefords will weigh at least 580 and the crossbreds at least 650. Preliminary results after 139 days are shown in table 1. These preliminary data indicate that it is feasible to sort heifers at weaning into heavy and light groups and feed the light group for a higher rate of gain so that a higher percentage of all heifers should be cycling normally by the beginning of the breeding season.

Supplemental Methionine Hydroxy Analog for Range Beef Cows

Feeding Methionine Hydroxy Analog (MHA) has been shown to increase milk production in dairy cows. This study was initiated in March, 1972 to determine if supplemental MHA will increase milk production of range beef cows and it is hoped that any increase in milk production will be reflected in increased calf weaning weights. Experimental design and data to be collected are shown in table 2.

Fertilization of Introduced and Native Forage Species

These studies were initiated in September 1971, to study the influence of fertilizer application to native and introduced grass species upon forage production and nutrient production, and to study the economics of fertilizer application to these species. Rates of application, grass and pasture types involved and data to be collected are shown in table 3.

Other Studies in Progress

These studies include: (1) an investigation of the nutritive value of major forage species in which major forage species will be clipped at regular intervals throughout the year to evaluate their nutritive value to the beef animal. Laboratory evaluation includes crude protein, energy, phosphorous and estimated digestibility; (2) a study of variation in blood metabolites of genetically diverse groups of cattle to determine if different breeds of cattle or lines within a breed differ in their nutrient requirements as indicated by blood metabolite levels. Laboratory evaluation of blood samples will include protein, amino acids, glucose, calcium, phosphorous, magnesium and lipids; (3) a study to determine if differences exist in blood metabolite levels of beef cows fed in confinement as compared to those maintained on native range. Similar groups of cows will be wintered in lots or on range and blood samples will be collected three times during gestation to determine if there are differences in blood metabolite levels of these two groups of cattle.

TABLE 1. WINTER MANAGEMENT OF REPLACEMENT HEIFERS[a]

	Crossbred[b]			Hereford		
	Heavy	Light	Heavy + light	Heavy	Light	Heavy + light
No. heifers	20	19	20	13	13	13
Initial wt., lb.	463	374	426	445	341	390
Projected daily gain[c], lb.	1.1	1.7	1.4	0.8	1.5	1.2
Actual daily gain[d], lb.	1.2	1.7	1.3	1.3	1.5	1.4
139 day wt., lb.	634	605	608	629	555	581
Total gain, lb.	171	231	182	184	214	191
Daily grain intake, lb.	6.8	9.0	7.7	7.5	6.3	6.1
Daily hay intake, lb.	8.7	7.5	7.4	9.0	6.4	6.5
	Initial measurements[e]					
Pelvic area, $in.^2$	17.4	15.2	16.3	15.2	13.5	14.3
Cannon bone length, in.	8.4	8.1	8.2	8.0	7.7	7.8
Fat thickness, in.[f]	0.05	0.01	0.05	0.07	0.04	0.06

[a]Results reported are for 139 days. Study projected to be complete in 160 days.
[b]1/2 Charolais; 1/4 Hereford; 1/4 Angus.
[c]Daily gain needed to reach target weight (650 lb. - crossbred; 580 lb. - Herefords).
[d]Daily gain for 139 days.
[e]Taken at beginning of experiment (11-19-71).
[f]Sonoray measurement between 12th and 13th rib.

TABLE 2. SUPPLEMENTAL METHIONINE HYDROXY ANALOG FOR RANGE BEEF COWS

Experiment Design

Treatment group	gm. MHA/ day[a]	No. cows
1	0	27
2	5	26
3	15	26

Data Collection

1. Cow weight and condition changes.
2. Calf birth weight, daily gain, weaning weight.
3. Estimated milk production and composition.
4. Blood metabolite changes
   a. amino acids
   b. glucose
   c. lipids
   d. minerals
5. Postpartum reproductive performance.

[a]Administered in 4 lb. of barley cake (13% crude protein). Supplement will be fed from 30 days before the predicted calving date to 60 days postcalving.

TABLE 3. FERTILIZATION STUDIES

Crested Wheatgrass

1. Nitrogen levels - 20, 40, 80, 100 and 200 lb. per acre.
2. 40 lb. Nitrogen + 40 lb. P_2O_5 per acre.
3. 80 lb. Nitrogen + 80 lb. P_2O_5 per acre.

Mixed Pastures

Crested Wheatgrass-Alfalfa; Russian Wildrye-Alfalfa

1. 50 lb. Nitrogen per acre.
2. 50 lb. Nitrogen + 50 lb. P_2O_5 per acre.

Western Wheatgrass

1. Rates from 100 lb. to 600 lb. of 28- 14-0 per acre in 100 lb. increments.

Data Collection

1. Estimated forage yield[a].
2. Changes in nutrient composition of forage.
3. Estimated forage digestibility[b].
4. Beef production per acre.

[a]Estimated by periodic clipping.
[b]Estimated by artificial rumen techniques.

WHAT CONTROLS THE ESTROUS CYCLE OF A COW?

by
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One of the major limiting factors in the efficiency (profit) of beef production is reproduction or fertility. Reproductive rate or fertility is affected by many factors such as breed, age, inbreeding, crossbreeding, feed level and lactation. We know very little about how these factors affect reproduction. If we knew more about the hows or whys of these effects on reproduction then it might be possible to design better breeding or management systems to maximize reproduction. However, answering the hows and whys is often difficult because our knowledge of how the reproductive cycle is controlled is too limited. Therefore, it is necessary to do a certain amount of background research to find out more about how a cow functions. Once this is known, then it may be possible to find out how such things as crossbreeding or feed level affect reproduction.

In explaining some of our basic or background research it would be easier to follow along on figure 1. First of all, we know that FSH (follicle stimulating hormone) secreted by the pituitary gland stimulates follicles to grow on the ovary. We have shown that by injecting extracts from pig or cow pituitaries the number of follicles which develop and ovulate can be increased. This has been shown in some of our work on inducing multiple pregnancies in cattle. After FSH has stimulated follicles to grow these in turn produce estrogen. Eventually the level of estrogen gets high enough so that the cow comes into heat (estrus) and LH (luteinizing hormone) is released to cause ovulation (release of the egg from the follicle).

One of the main questions regarding the control of the estrous cycle in the cow is, what regulates the amount of FSH and ovulation rate? We are doing some work in an attempt to answer this question. Experiments have been done where an ovary, the CL or a part of the CL is removed in an attempt to find out if estrogen or progesterone regulate FSH secretion. Apparently progesterone has little control over FSH release but it does appear that estrogen does. However, much needs to be done to answer this question. Some of our work has shown that an injection of estrogen in spayed cows (ovaries removed to prevent the cow from producing estrogen herself) will cause her to come into heat and release a spurt of LH. One thing we don't know at this point is why in the normal cow, follicles grow and produce increased estrogen levels just before heat.

Following ovulation the ruptured follicle develops into a corpus luteum (CL). The CL starts to secrete progesterone which prepares the uterus for pregnancy and maintains pregnancy if the cow conceives. Progesterone also prevents a cow from coming into heat and ovulating. This effect is used in "synchronizing" heat by giving progesterone or a similar compound which is injected or fed to prevent heat and ovulation. Then when injections or feedings are stopped a high proportion of the cows should come into heat in a short period of time. We are doing some work on estrus synchronization in conjunction with our multiple birth work and some with our other projects. One of the newer innovations that is being tried is putting the synchronizing compound in a piece of rubber or plastic and implanting this under the skin. These implants have the advantage of ensuring that each cow gets a given dose as in injections but is easier than feeding. Our work with this has just started.

In experiments to find out how a cow functions we often have to measure blood levels of some of the hormones such as LH and estrogen. Until quite recently this was impossible to do because these hormones are present in such small amounts. New developments in chemical analyses allow us to measure most of the reproductive hormones in small amounts of blood. This allows us to get repeated blood samples every day, every hour or even every minute! Then we can determine how hormone levels change with some particular treatment. These techniques are being used not only to find out how a cow works, but how such things as heterosis affect fertility.

Fertility is affected by hormone levels or changes in levels so it should be helpful to know how hormone levels or changes differ among animals, various breeds or breedcrosses. We are in the processes of collecting additional reproduction data from the existing crossbreeding experiment. These data include age at puberty for bulls and heifers, breeding and conception dates and various hormone levels up to puberty and during the breeding season. The hormone levels will be related to fertility in an attempt to find out how breed or breed crossing affects fertility.

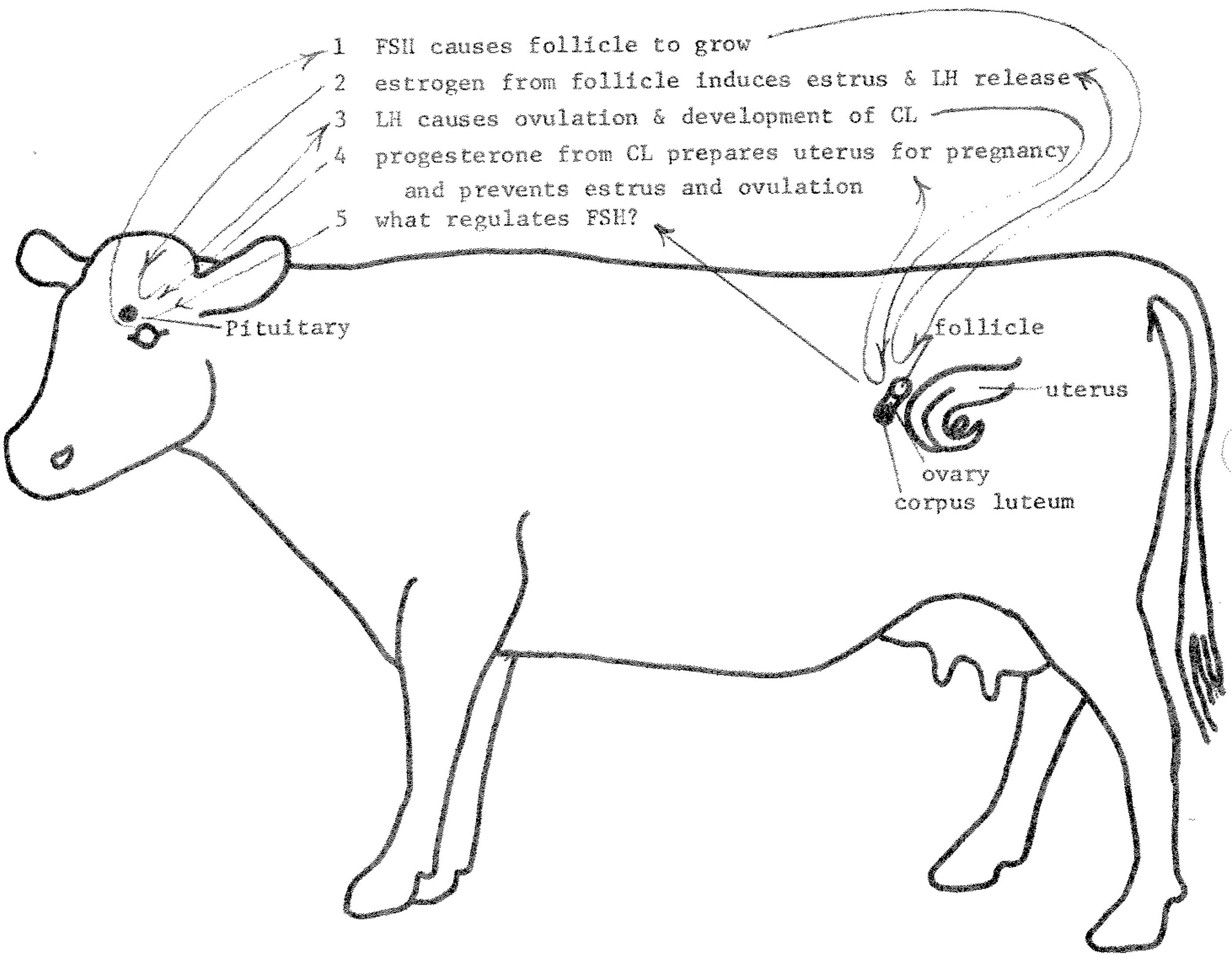

Figure 1. Hormonal control of the estrous cycle in the cow.

PLANNED RESEARCH AND SOME RESULTS ON THE EFFECT OF MATING STIMULI ON LH AND OVULATION IN THE COW

by
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The primary objective of my research is to increase the productivity of cattle through increased reproductive efficiency. This research varies from study of basic endocrine mechanisms controlling reproductive processes to more applied research aimed at increasing reproductive efficiency.

Timing of artificial insemination in reference to ovulation is quite critical in the cow in order to obtain high conception rates. We have found that various mating stimuli affect the timing of LH release and ovulation time in the cow. In this experiment 39 beef cows from 2 to 6 years of age were randomly divided into five treatment groups (table 1).

TABLE 1. THE EXPERIMENTAL DESIGN

Stimulus	Group I	II	III	IV	V
Number of animals	8	5	8	9	9
A Estrogenized cows for detection of estrus	Yes[a]	Yes	Yes	Yes	No
B Cervical stimulation	No[b]	Yes[c]	Yes[c]	Yes	Yes
C Clitoral stimulation	No	No	Yes[d]	Yes	Yes
D Bred by male three times	No	No	No	Yes	Yes
E Estrus detected by male	No	No	No	No	Yes

[a]Received stimulus.
[b]Received no stimulus.
[c]Artificial insemination.
[d]Manual stimulation for 10 seconds.

Estrous cycles were controlled by group feeding of 180 mg Repromix, medroxyprogesterone acetate (MAP), in 2.0 lb. grain mix daily for 11 days (first day of MAP feeding equal day 1) during the fall of 1971. Corpus luteum regression was induced by an intramuscular injection of 5 mg estradiol benzoate given on day 2. All cows were detected in estrus and subsequently ovulated and developed a corpus luteum as determined by rectal palpation.

Cows in Groups I, II, III and IV were maintained in a lot with estrogenized cows under constant observation for detection of first standing estrus and all cows in Group V were maintained in a lot with an epididymectomized bull under constant observation for detection of first standing estrus (table 1).

At detection of first standing estrus cows were removed from the lots and were given the appropriate mating stimuli. Group I received no further stimulus, Group II received artificial insemination with no clitoral stimulation, Group III received artificial insemination with 10 seconds of manual stimulation of the clitoris, Group IV was immediately bred to different bulls in succession and Group V received no further stimulation (table 1).

Venous blood was collected via indwelling jugular cannulae which were inserted after first detection of estrus, and when cannula failure occurred, samples were collected by venipuncture of the tail vein. Blood sampling was begun at first detection of estrus and continued at hourly intervals for the first 24 hours and at 2 hour intervals thereafter until ovulation was detected by rectal palpation. Serum from these samples was assayed for luteinizing hormone (LH) content using double antibody radioimmunoassay.

In this experiment we found that the ovulatory surge of LH occurred at 9.9 hours after the onset of estrus in controls as compared to 5.4 hours in cows artificially inseminated with no clitoral stimulation ($P<.10$, table 2).

TABLE 2. TIME FROM ESTRUS TO THE LUTEINIZING HORMONE PEAK

Group[a]	Time (hours)	Standard error
I	9.9	2.0
II	5.4	0.6
III	6.2	1.6
IV	5.9	1.8
V	4.7	1.5

[a]Defined in table 1.

Ovulation time was found to differ significantly ($P<.005$) between cows not receiving clitoral stimulation which ovulated at 32.8 hours after onset of estrus, as compared to cows receiving clitoral stimulation which ovulated 27.6 hours after onset of estrus (table 3).

TABLE 3. TIME FROM ESTRUS TO OVULATION

Group[a]	Time (hours)	Standard error
I	33.2	1.6
II	32.0	0.6
III	29.0	1.2
IV	27.9	1.6
V	28.7	1.1
III, IV and V	27.6	1.6
I and II	32.8	1.0

[a]Defined in table 1.

The difference of 5.2 hours in ovulation time between cows receiving a lesser stimulation (Groups I and II) and those receiving a greater stimulation (Groups III, IV and V) could have an effect on conception rate as timing of artificial insemination relative to ovulation is quite critical. These data indicate that clitoral stimulation at artificial insemination may be beneficial.

The endocrine relationships during the period from onset of estrus until ovulation have not be elucidated. In addition, clear cut data are not available on the effects of mating stimulation intensity upon conception rate. We feel that the answers to some of these questions may be answered in the experiments which are underway or planned for the very near future.

Some research projects which are underway or which are planned for the very near future are:

1. A study of the effect of various mating stimuli on hormone relationships in cattle.

2. Determining the effect of clitoral massage at artificial insemination on conception rate in cattle.

3. The effect of anti-estrogen serum on estrus, luteinizing hormone release by the pituitary and ovulation in cattle.

4. Determination of release rate of radioactive labeled estrogens in corn oil injected intramuscularly and the distribution of these estrogens in the blood constituents.

These experiments will give us information needed in our efforts to increase reproductive efficiency in cattle by altered hormone levels and relationships as in induced multiple births and estrus synchronization.

STUDIES ON CALVING DIFFICULTY AND MULTIPLE BIRTHS

by
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Calving Difficulty

Calf losses at calving result in a multimillion dollar reduction in the potential calf crop from beef cattle. Studies on causes of these losses and methods of prevention have been conducted at this Station since 1962. This work has shown the following:

1. 80% of the normal calves lost at birth died as a result of difficult birth.

2. 50% of the calf losses at birth could be prevented by giving assistance during difficult deliveries.

3. Dams with larger pelvic openings have less calving difficulty.

4. High calf birth weight is the most important factor contributing to calving difficulty.

Based on these results we have been studying the effects of gestation feed level on calf birth weight and calving difficulty. Results from three-years' studies are summarized in table 1. This work has shown high levels of feeding during the last 90 days of gestation resulted in only small increases in calf birth weight and essentially no effect on calving difficulty. However, more cows on high feed levels during late gestation returned to heat by the beginning of the breeding season and had a higher October pregnancy rate than cows on the low feed level.

This year we are studying the effects of exercise during gestation and induced calving on calf birth weight and calving difficulty. All dams were bred to a single Charolais sire selected to produce moderate birth weights. Ninety days prior to calving, dams were divided into two groups. One group was placed in feedlots where activity was restricted. The second group remained on range and was fed approximately one mile away from the water source, thus forcing a minimum walk of two miles daily.

Calving is being induced at approximately 271 days of gestation in 50% of the dams by injecting an adrenal steroid. This will shorten gestation by approximately 10 days and may reduce calving difficulty through a reduction in calf birth weight.

Multiple Births

Developing successful methods of producing multiple births in cattle is another area of work under study. The most promising treatments appear to be those involving repeated injections of porcine follicle stimulating hormone (FSH). However, use of pregnant mare serum (PMS) also results in superovulation and may have the advantage of reducing the number of hormone injections required.

Two studies have been completed involving treating either heifers or lactating cows with FSH. The animals were allowed to calve and results are summarized in table 2. It can be seen that the net calving percentages (net % = $\frac{\text{No. cows calving}}{\text{No. cows treated}}$) ranged from 75 to 111%. Net percentages of live calves weaned (net % = $\frac{\text{No. live calves weaned}}{\text{No. cows treated}}$) ranged from 67 to 104%.

One of the areas we are now working on is trying to increase the number of cows maintaining viable, multiple pregnancies to term. The major problem that must be overcome is the high rate of embryonic or fetal loss that occurs during gestation. It is not difficult to treat cows and get them to shed 2 to 5 eggs. However, in many cases they will produce only one or sometimes no calves. The magnitude of this loss is shown in bar-graph form in figure 1. Values summarized were obtained by averaging results of five of our more recent studies. This shows that the potential calf crop from a single breeding in control animals dropped from 100% at breeding to 67% at calving. However, the potential in the superovulated animals dropped from 240% at breeding to 84% at calving. This clearly shows the need for additional work.

Results of some of our recent studies suggest feeding an orally active progestogen will decrease the early embryo loss in superovulated animals. This may indicate that the pregnancy maintenance mechanism is not adequate to maintain a high percentage of multiple pregnancies. However, supplying additional pregnancy maintaining hormones may correct at least a portion of this deficiency. We are presently studying blood hormone levels in an attempt to clarify this question.

TABLE 1. EFFECTS OF GESTATION FEED LEVEL ON CALVING DIFFICULTY AND REPRODUCTION

Year and sire	Feed level last 90 days of gest.	No.	Calf birth wt.	Calving difficulty %	Calving difficulty Avg.[a] score	Cows in heat by 6/15[b]	Pregnant in October
			(lb.)			(%)	(%)
1969 Angus	Low[c]	30	59	37	1.5	47	60
	High[c]	32	63	37	1.6	78	79
Difference			4	0	0.1	31	19
1970 Hereford	Low[d]	11	63	60	1.9	27	78
	High[d]	12	72	58	2.0	58	85
Difference			9	2	0.1	31	7
1971 Char. 1[e]	Low[f]	14	73	86	2.9	--	--
	High[f]	14	72	78	2.4	--	--
Difference			1	8	0.5		
1971 Char. 2[g]	Low[f]	10	79	100	2.8	17[h]	58[h]
	High[f]	10	76	90	2.7	36	84
Difference			3	10	0.1	19	26
3 year avg.	Low	65	66	61	2.1	33	62
	High	68	68	57	2.0	60	82
Difference			2	4	0.1	27	20

[a] Scores range: 1 = no difficulty to 4 = extreme.
[b] Beginning of breeding season.
[c] Feed levels: Low = 7.5 lb. TDN; High = 13.8 lb. TDN.
[d] Feed levels: Low = 7.0 lb. TDN; High = 14.0 lb. TDN.
[e] Moderate birth weight sire (81 lb.).
[f] Feed levels: Low = 8.0 lb. TDN; High = 15 lb. TDN.
[g] High birth weight sire (97 lb.).
[h] Values averaged over both sire groups

TABLE 2. CONCEPTION AND CALVING SUMMARY

Animal group	No. treat.	Conc. first serv.	Cows calv. No.	Cows calv. %	No. calves born Sing.	No. calves born Twin	No. calves born Trip.	No. calves born Tot.	Net calv. %	Live calves weaned[a] No.	Live calves weaned[a] Net %
Heifers											
Control	9	70	8[b]	89	8	--	--	8	89	6	67
6.2 mg FSH	43	54	34[b]	79	29	10	--	39	91	34	79
Lact. cows											
6.2 mg FSH	28	75	20[a]	71	19	2	--	21	75	19	68
9.4 mg FSH	27	74	24[a]	89	19	8	3	30	111	28	104

[a] Calves artificially reared on cold whole milk or cold milk replacer.
[b] Total two services. Cows not retreated with FSH. Bred via natural service.

Figure 1. Potential Calf Crops From A Single Breeding.