BEEF CATTLE FIELD DAY

U.S. Range Livestock Experiment Station

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Miles City, Montana

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ADDITIONAL INFORMATION ON STATION RESEARCH NOT PRESENTED AT THE FIELD DAY PROGRAM

SUPPLEMENTING DIETS OF BEEF COWS WITH METHIONINE HYDROXY ANALOG[1]

by

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Introduction

It is generally accepted that the ruminant animal does not have a dietary requirement for amino acids, since many studies have demonstrated that feeding supplemental amino acids usually does not give a positive response even when the majority of the dietary nitrogen is derived from urea. However, it has been postulated that high producing ruminants could suffer an amino acid insufficiency at the tissue level because of the limitation that rumen metabolism places upon the nitrogen utilization of the animal. It is suggested that if plasma levels of certain amino acids could be increased at the tissue level, an increase in performance could result. Increasing plasma amino acid levels could be accomplished via two routes: (1) administering the amino acid directly into the bloodstream or into the digestive tract posterior to the rumen or (2) supplying the amino acid in a form that is resistant to degradation in the rumen but available to the animal posterior to the rumen.

Because of ever increasing economic pressure to attain higher levels of production, the amino acid requirements of ruminants have become areas of particular research emphasis in the last several years. Jacobson, Van Horn and Sniffen, (1970) and Chandler and Miller (1970) have reported that methionine is the first limiting amino acid for dairy cows, especially high-producing cows.

Methionine hydroxy analog (MHA) has been reported to be more resistant to degradation in the rumen than methionine and MHA can be converted to methionine in the liver (Belasco, 1972). Therefore, considerable interest has developed in supplementing diets of dairy cows with methionine in the form of MHA.

Griel et al. (1968) reported an average 7% increase in milk production in dairy cows of four breeds by feeding 40 g of MHA per head daily from 3 weeks prepartum to 8 weeks postpartum. Feeding of MHA has been reported to reduce the incidence of ketosis in dairy cows (McCarthy, Porter and Griel, 1968) and improve the growth rate of lambs (Burroughs and Trenkle, 1969). However, feeding MHA to finishing steers has not resulted in a consistant increase in performance (Bolsen, 1971).

Little or no information is available on the influence of MHA feeding upon the performance of range beef cows. Therefore, a study was conducted at the U. S. Range Livestock Experiment Station, Miles City, Montana, to determine the influence of supplemental MHA upon milk production, cow weight and condition changes, plasma amino acid levels and calf performance in range beef cows.

[1]Appreciation is expressed to E. I. DuPont De Nemours & Company for providing methionine hydroxy analog and supplements used in the experiment.

Plan of Experiment

Seventy-eight straightbred Hereford cows bred to a single Hereford sire were stratified by age of cow and predicted calving date and assigned at random to one of three treatment groups. Each treatment group consisted of 26 cows. Treatment groups were further subdivided into two subgroups. One subgroup consisted of cows 3 years old and older (16 head per treatment) and the other subgroup consisted of first-calf heifers (10 head per treatment). First-calf heifers were fed separately from the cows during the supplement feeding period. The data from the two subgroups are averaged for presentation since there were no age effects in the various parameters measured.

Supplements fed in the experiment are shown in table 1. Each group was fed 4 pounds of the pelleted supplement per head daily for a period from March 11 which was 30 days before the average predicted calving date (April 11) to June 10 which was an average of 60 days postcalving. Cows in Group 1 received supplement containing no MHA. Cows in Group 2 received supplement containing 1.25 g MHA per lb. (5 g/head/day) and cows in Group 3 received supplement containing 3.75 g MHA/ lb. (15 g/head/day). Sulfur level in all supplements was equalized with Na_2SO_4. Cows were fed in feedlots from March 11 to calving. During this time period, they received grass hay (9.3% crude protein) free choice in addition to their supplement. As each cow calved, she was moved to native range and the groups continued to receive supplement in separate pastures until June 10. After supplement feeding was discontinued, cows in all groups were pastured together until calves were weaned at an average of 190 days of age.

Results

Cow performance is shown in table 2. There were no significant ($P>.05$) differences among treatment groups for initial weight, postcalving weight, which was taken within 12 hours of calving, or weight of cows when calves were weaned. Condition score, which is an estimate of fleshing over the ribs and back, was not different among treatments. Days from calving to first estrus were slightly less for cows fed MHA but were not significantly ($P>.05$) different among treatment groups. Also, percentage of cows which became pregnant during the subsequent breeding season was similar among treatment groups. Average hay intake during the time that cows were in the feedlot was not different among treatments.

All cows were milked on June 6 which was an average of 56 days postcalving. Cows were milked with a portable milking machine following an IV injection of 20 IU of oxytocin after a 12 hour period away from the calves. Milk protein level (table 3) was similar among treatments although it did tend to be slightly lower in cows fed 15 g MHA/day as compared to other treatment groups. Butterfat content of the milk was 4.6% for cows receiving 15 g MHA/day *vs*. 3.8% for cows receiving no MHA. This was a significant ($P<.05$) increase. Total solids and solids-not-fat content of the milk was similar for all treatment groups. Milk production for the 12 hr. period was 8.6 lb. for cows receiving no MHA, cows receiving 5 g MHA/day milked 9.5 lb. and the cows receiving 15 g MHA/day milked 10.8 lb., which was significantly ($P<.05$) greater than the 8.6 lb. Milk production converted to a 4% fat-corrected basis shows a similar significant ($P<.05$) difference.

Plasma amino acid levels are shown in table 4. Cows were bled just prior to the morning feeding before being milked, which again was at an average of 56 days postcalving. Plasma urea and ammonia, also shown in table 4, were significantly ($P<.05$) lower for cows fed MHA than for cows fed no MHA. A reduction in these two plasma parameters indicates a more efficient use of dietary nitrogen by the animal (Varner, 1970). Taurine, hydroxyproline, cystine, threonine, histidine and tryptophan levels were not different ($P>.05$) among treatments. Other amino acids, in addition to total amino acids, total essential amino acids and total nonessential amino acids were significantly less ($P<.05$) for cows fed MHA as compared to cows fed no MHA. The reduction in plasma amino acid levels when MHA is fed is indicative of an increase in protein synthesis at the cellular level. Since cows fed MHA were giving a greater quantity of milk, the mammary requirement for plasma amino acids for casein synthesis would be higher and should be reflected in a lower level of plasma amino acids. Askonas, Campbell and Work (1954 and 1955) have demonstrated in the lactating ruminant that milk protein is synthesized from plasma amino acids and not from plasma protein.

Any increase in milk production by the cow should be reflected in increased weaning weight and daily gain of her calf since milk production of the cow is the most important factor influencing these parameters. Actual, unadjusted weaning weight at an average age of 190 days was 389 lb. for calves from cows fed no MHA, 407 lb. for calves of cows fed 5 g MHA and 431 lb. for calves from cows fed 15 g MHA. Adjusted 205-day weight and adjusted daily gain of calves from birth to weaning was significantly ($P<.01$) greater for calves from cows fed 15 g MHA as compared to calves from cows fed no MHA. Calves from cows fed 5 g MHA were intermediate between the other two treatments in all parameters measured. Calf birth weight adjusted to a male calf basis was not different ($P>.05$) among treatments although calves from cows fed MHA tended to be slightly heavier at birth.

Summary

This study indicated that feeding beef cows MHA at a level of 15 g/head/day for a period of from 30 days prior to calving to 60 days postcalving resulted in an increase in calf daily gain and weaning weight-milk production of the cow and butterfat content of the milk. There were no differences in cow weight or condition changes or subsequent cow reproductive performance among dietary treatments. Plasma levels of amino acids, urea and ammonia were lower for cows fed 5 or 15 g MHA/head/day as compared to cows receiving no MHA.

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TABLE 1. SUPPLEMENT COMPOSITION[a]

Ingredient	MHA/day, g 0	5	15
	(%)	(%)	(%)
Trace mineral	0.15	0.15	0.15
Dicalcium phosphate	1.00	1.00	1.00
Urea (281)	1.00	1.00	1.00
Salt	1.00	1.00	1.00
Beet molasses	9.00	9.00	9.00
Barley	81.98	81.95	81.89
Na_2SO_4	0.801	0.534	---
MHA[b]	---	0.296	0.889
Vitamin A[c]	0.07	0.07	0.07
Dehy	5.00	5.00	5.00

[a] Calculated composition in % of dry matter: Prot., 14.96; Ca, 1.04; P, 0.61; S, 0.39; N:S ration 6.1:1.
[b] Methionine hydroxy analog-calcium (93%).
[c] 30,000 IU/g.

TABLE 2. COW DATA

Item	MHA/day, g 0	5	15
No.	26	26	26
Initial wt., lb.	1038	1021	1049
Postcalving wt., lb.	1014	1003	1030
Wt. at weaning, lb.	990	999	1054
Condition score[a]			
Initial	6.5	5.7	7.0
Final	9.9	9.2	10.7
Postpartum interval, days	48.5	47.5	44.5
% Pregnant in October	96	96	92
Avg. hay intake, lb./day[b]	27.7	28.4	29.0

[a] 1 = thinnest to 10 = fattest.
[b] Intake during feedlot period only.

TABLE 3. MILK DATA

Item	MHA/day, g 0	5	15
% Prot. (NX 6.38)	4.2	4.2	3.7
% Butterfat	3.8[b]	4.5[b,c]	4.6[c]
% Solids-not-fat	9.3	9.1	9.4
% Solids	13.1	13.6	13.9
Milk prod., lb.[a]	8.6[b]	9.5[b,c]	10.8[c]
4% fat corrected milk, lb.[a]	8.8[b]	10.8[b,c]	11.4[c]

[a] Avg 56 days lactation.

[b,c] Figures in same row with unlike superscripts are different at $P<.05$.

TABLE 4. PLASMA AMINO ACIDS (uMoles/100/ml)

	MHA/day, g		
	0	5	15
Urea	562.14[a]	376.68[b]	322.60[b]
Ammonia	259.38[a]	221.38[b]	210.05[b]
Taurine	12.65	9.50	8.64
Hydroxyproline	7.30	5.97	4.57
Aspartic acid	2.79[a]	2.04[a,b]	1.51[b]
Serine	16.51[a]	11.16[a,b]	9.88[b]
Asparagine	28.08[a]	13.31[b]	11.79[b]
Proline	13.93[a]	9.96[b]	9.21[b]
Glumatic acid	26.06[a]	24.97[a,b]	20.60[b]
Citrulline	9.03[a]	5.86[b]	5.19[b]
Glycine	72.93[a]	53.03[b]	46.83[b]
Alanine	52.83[a]	35.58[b]	30.21[b]
Cystine	1.64	1.45	1.12
Tyrosine	7.98[a]	5.14[b]	4.83[b]
Ornathine	11.86[a]	7.70[b]	7.07[b]
Arginine	11.79[a]	9.26[b]	8.24[b]
Total nonessential AA[c]	275.39[a]	193.07[b]	169.52[b]
Threonine	9.66	6.89	6.41
Valine	42.47[a]	30.62[b]	28.65[b]
Methionine	3.91[a]	2.58[b]	2.12[b]
Isoleucine	17.84[a]	12.61[b]	11.94[b]
Leucine	23.58[a]	17.38[b]	16.02[b]
Phenylalanine	9.94[a]	6.70[b]	5.68[b]
Lysine	16.80[a]	12.10[b]	11.35[b]
Histidine	6.42	4.85	4.61
Tryptophan	2.74	1.93	1.72
Total essential AA[c]	133.38[a]	95.68[b]	88.52
Total AA[c]	408.77[a]	288.74[b]	258.04[b]

[a,b] Means in same row with different superscripts are different at $P < .05$.

[c] AA = amino acids.

TABLE 5. CALF PERFORMANCE DATA

Item	0	5	15
Adj. birth wt., lb.[a]	75.9	79.4	80.9
Actual weaning wt., lb.	389[c]	407[c,d]	431[d]
Adj. 205-day wt., lb.[a]	436[c]	460[c,d]	484[d]
Adj. daily gain, lb.[a,b]	1.74[c]	1.87[c,d]	1.96[d]

[a] Adjusted to steer calf basis.

[b] From birth to weaning.

[c,d] Means in same row with different superscripts are different at $P<.01$.

INTEGRATING INTENSIVE BEEF PRODUCTION METHODS INTO A RANCHING OPERATION

by
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The necessity to increase ranch size to cope with present day economic structures and increased cost of rangeland, leads to more intensive type production on existing ranching units. This is made possible by the use of new technology in irrigation, plant varieties, fertilization and cultural practices.

Increased competition for the use of public, as well as private lands also indicates the need to intensify production on those areas that are suited primarily for livestock production. This will be necessary to hold our livestock production at a constant rate and even more necessary if there is a need to further expand livestock production. In conjunction with this there are shifts in the location of livestock production. The cornbelt area and the southeastern United States are both calf producing areas as a result of increases in beef cow numbers in the last ten years. These areas are picking up the slack that is being created by the reduced carrying capacity of our public lands. However, this does not answer the question of the individual operator who is faced with expansion of his unit in some means or another to cope with the cost-price squeeze that faces him continually. Some of these units may have also been involved in the cutback of carrying capacity on Federal lands. Thus they have been pressed from both sides.

With this background the need to explore intensification on existing units is necessary. The first thing one thinks of is irrigation. The use of irrigation is very dependent upon the availability of water, either from deep wells, lakes or rivers. Actually any of these sources of water can be utilized in modern types of irrigation equipment on land that heretofore was not considered irrigable. In most cases a rancher would be interested in either irrigated pasture, alfalfa or a crop which could be harvested for grain or silage. In the latter case corn would probably be preferred. These are the crops that will complement and extend the use of range forage and this is what the rancher should be thinking about.

Considerable work has been done at the University of Nebraska North Platte Station during the past six years on the use of irrigated pasture as a complement to native range. It has been shown that establishing irrigated pasture on what was previously rangeland can increase the carrying capacity of the area by as much as twenty fold (table 1). It has also been shown that it is ideal for lactating young cows being prepared for rebreeding.

In the latter study performance of cows on cool-season irrigated pasture, beginning approximately May 1, was compared to that of cows maintained on grass hay and two pounds of a 20% protein supplement until native range was ready to graze, the last week in May. Both groups of cows were wintered on range, grass hay and supplement. The cows and calves on irrigated pasture gained more weight than their counterparts in drylot between late April and late May (figures 1 and 2). From that time on their weight gains paralleled each other. This was after the drylot group had gone to native pasture. The two groups were summered together in a previously ungrazed native pasture after July 17 in 1968 and 1969. By weaning time, the calves on irrigated pasture had a weight gain advantage of 10 pounds in 1968 and 17 pounds in 1969. In 1970 the cows and calves were on irrigated pasture until September 14 and then non-irrigated cool season pasture until weaning. At weaning time, the calves on irrigated pasture had gained 15 pounds more than those on native range. In 1968 and 1969 the cows on irrigated pasture had shorter intervals from calving to first heat and a higher percent had cycled by the start of the breeding season (June 5) than those in drylot and on native range. Likewise, the cows on irrigated pasture had higher conception rates (table 2). In 1970 the data on calving to first heat and percent having heat by June 5 may be misleading, because the heat detecting bull in the irrigated pasture became lame in May and was replaced with a dairy steer. It was doubtful if he was doing a good job of heat detection. This conclusion was drawn because 94% of the cows on irrigated pasture were bred the first 21 days of the breeding season, although only 51% had been detected before June 5. By June 5 the regular heat detection bull had recovered and was put back into use. Eighty-seven percent of the cows on native range were bred the first 21 days.

The use of irrigated pasture in a ranching situation adds flexibility to the management of the unit. For example, if cows and calves are used on irrigated pasture early in the spring and even through part of the breeding season, then removed to native range the rest of the summer, the irrigated pasture can be used for hay production or possibily yearling sale cattle the latter part of the summer. It will hold up weight gains, whereas they are markedly reduced on dry mature native range. Irrigated pasture is also an ideal place for weaning calves in the fall. Nebraska data shows they will gain one to 1.2 pounds per day from late October until the forage is utilized.

Alfalfa hay production may be of more interest to some ranchers and would be the preferred crop to put into an ongoing program. If he is short of hay then alfalfa would be appealing. It is as good a source of energy as grass hay but contains twice as much protein and can replace the purchase of protein supplements. Alfalfa production may not increase the potential size of a unit as much as it may decrease feed cost creating a more favorable return.

It becomes very apparent at this point that each rancher may be interested in a little different aspect as how to use irrigation. It may be that a given operator would choose to increase production by keeping ownership of his cattle longer rather than attempting to run more cows. In this case he may wish to intensify by raising corn silage or grain and winter his calves at a rather high level of nutrition and prepare them for sale to a feedlot in the spring or even feed them out himself. This program would not require more cow numbers but would require more feed and should have a higher return for the ranch unit if the production cost of the feed were in line with the sale value of the extra gain he put on the calves he produced. There probably is no way to get more beef production from an acre of irrigated land than through silage fed to calves (table 3).

Concern is expressed when rangeland is taken out of range forage production and put in crop production in that this reduces further range livestock production. However, the point that must be considered is that in most cases where crops have been produced on rangeland that was put under irrigation the livestock carrying capacity has increased. For example, if a person raises corn and harvests the grain for feeding to calves or even cash cropping he still has the cornstalks which provide an excellent place for wintering cows. In fact, an acre of cornstalks has more carrying capacity for wintering cows than does an acre of native range in most instances (table 4).

Another approach that should be given serious consideration is that which has been extensively researched at the U. S. Great Plains Field Station at Woodward, Oklahoma. The premise was that complementary use of rangeland, tame pasture, and farmed forage can give beef producers the opportunity to develop a highly stable, easily managed, and highly productive livestock economy that will be two to four times as productive as the one with only the rangeland component. Four systems were compared: 1) One hundred percent of the land used was native range continuously grazed. 2) Ninety percent of the total land used was native range and 10% lovegrass. Livestock were rotated from one to another on a flexible basis as needed for optimum cattle gain and for optimum growth of both forage types. 3) Seventy-five percent of the total land used for the system was native range and 25% was fenced and double cropped by planting wheat each October and sudan each June. Within this system the steers were rotated in a flexible manner as forage utilization indicated. 4) Fifty percent of the total land use for the system was planted to lovegrass and 50% was planted to double cropped wheat-sudan. In this system, no native range was involved. Six years data are summarized in table 5 and very dramatically demonstrate that under their conditions they could increase greatly the production potential of a given unit of land by intensification and the use of complementary forage crops. It is not intended to assume that these same systems would work in other areas, however, it does demonstrate a principal in which it is obvious that other systems may have merit when adapted to given situations.

In conclusion it is clear that integration of cropping practices within a ranching situation is feasible on many ranches and will increase the production potential of a given land area. The intensification with or without diversification may require more capable management but could provide flexibility in use of facilities and labor. It would appear that many ranching areas will move in this direction with each individual operator deciding what program best fits his need. There are many alternatives.

TABLE 1. RELATIONSHIP OF NATIVE RANGE AND IRRIGATED PASTURE FOR YEARLING STEERS

	Sandhills range	Irrigated pasture
Grazing capacity, AUM/A	.6	13.0
Avg daily summer gain, lb	1.5	1.5[a]
Summer gains per acre/lb	40-50	800-1100

[a] If 2 to 4 lb of grain were fed per head daily, the average daily gains would be near 2 lb.

TABLE 2. REPRODUCTIVE PERFORMANCE OF 2-3-AND 4-YEAR-OLD COWS ON IRRIGATED PASTURE PRIOR TO AND DURING BREEDING

	No. of Cows	Calving to 1st heat	1st heat by June 5	Conception rate[a]
		days	%	%
Drylot and range				
1968 (2-yr-olds)	78	71	55	94
1969 (3-yr-olds)	32	62[b]	44	84
1970 (4-yr-olds)	80	48	71	94
Average		60	57	91
Irrigated pasture				
1968 (2-yr-olds)	81	54	89	99
1969 (3-yr-olds)	33	56	76	88
1970 (4-yr-olds)	80	57	51	98
Average		56	72	95

[a] Forty-two days artificial insemination and 18 days of cleanup bulls.
[b] Does not include six cows that had not shown heat by the end of the 42 day artificial insemination period.

TABLE 3. PERFORMANCE OF GROWING CALVES FED A FULL FEED OF CORN SILAGE SUPPLEMENTED WITH PROTEIN, MINERALS AND VITAMINS AT THE UNIVERSITY OF NEBRASKA NORTH PLATTE STATION

Silage dry matter per acre, tons	7.03[a]
Avg daily gain of calves, lb	1.75[b]
Gain per acre, lb	1661.[b]

[a] Average of eight corn varieties over four years.
[b] These values are the average of eight corn varieties produced and fed over a four year period involving 320 calves.

TABLE 4. COMPOSITION OF AND PERFORMANCE OF COMING 3-YEAR-OLD COWS WINTERED ON CORNSTALKS[a] (ADAPTED FROM DATA COLLECTED BY J. WARD, ANIMAL SCIENCE DEPARTMENT, UNIVERSITY OF NEBRASKA-LINCOLN)

Dry matter digestibility, %	40.0
Crude protein, %	4.2
Carrying capacity, AUM/A	1.9[b]
Avg daily gain, lb	1.0

[a] The cows received one pound per head per day of a 40% protein supplement and a total of 700 pounds of hay per head during inclement weather in a 112 day grazing period.

[b] Comparable carrying capacity of native range with this much hay fed would be near .8 AUM/A.

TABLE 5. AVERAGE ANNUAL RETURNS FROM FOUR GRAZING SYSTEMS IN NORTH WESTERN OKLAHOMA, 1966-72 (ADAPTED FROM DATA OF McILVAIN AND SHOOP AT U. S. SOUTHERN GREAT PLAINS FIELD STATION, WOODWARD, OKLAHOMA)

System	Acres per steer	Gain per steer	Returns per acre[a]
Native range (NR)	8.8	44	$3.85
NR + lovegrass	5.0[b]	72	$6.40
NR + wheat-sudan	4.5[c]	93	$10.00
Lovegrass + wheat-sudan	2.0[d]	185	$13.50

[a] Net returns to labor and risk based on prices in 1971-72 starting with 400 lb steer calves in October at $60.00/cwt = $240; plus expenses of $12 cake, $4/acre NR, $14/acre lovegrass, $24/acre wheat-sudan, $18 interest, $12/ton haying costs, $8 death and vet, $6 buy-sell-haul, $1 taxes, or $80 total expenses on NR; and sale price of $45 cwt on 760-770 lb steers, $44.75 on 790 lb steers, and $44.50 on 820 lb steers.

[b] 4.5 acres NR plus .5 acre lovegrass.

[c] 3.5 acres NR plus 1 acre wheat-sudan.

[d] 1 acre lovegrass plus 1 acre wheat-sudan.

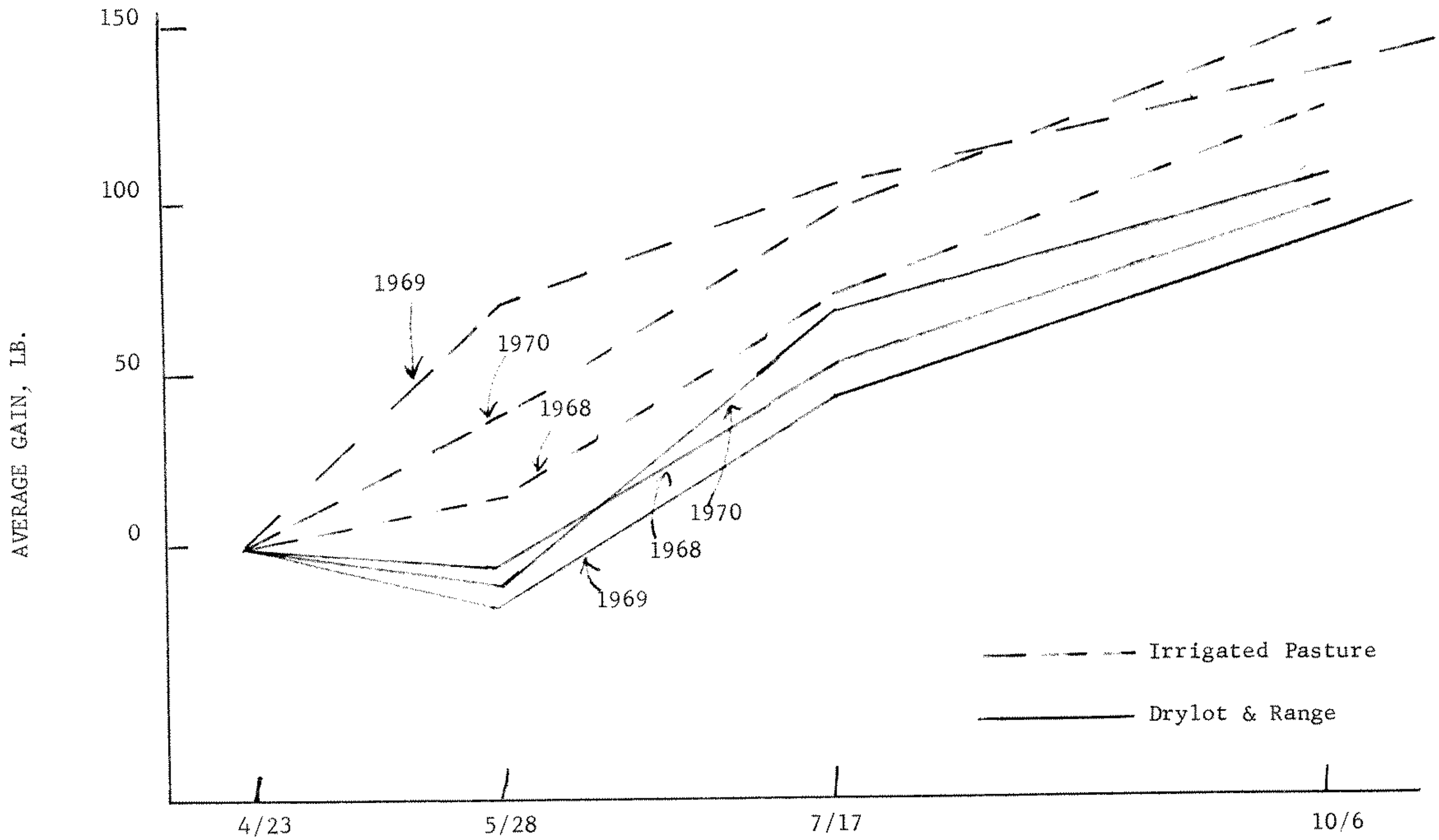

FIGURE 1. AVERAGE WEIGHT GAIN OF COWS ON IRRIGATED PASTURE OR DRYLOT AND RANGE AT THE NORTH PLATTE STATION

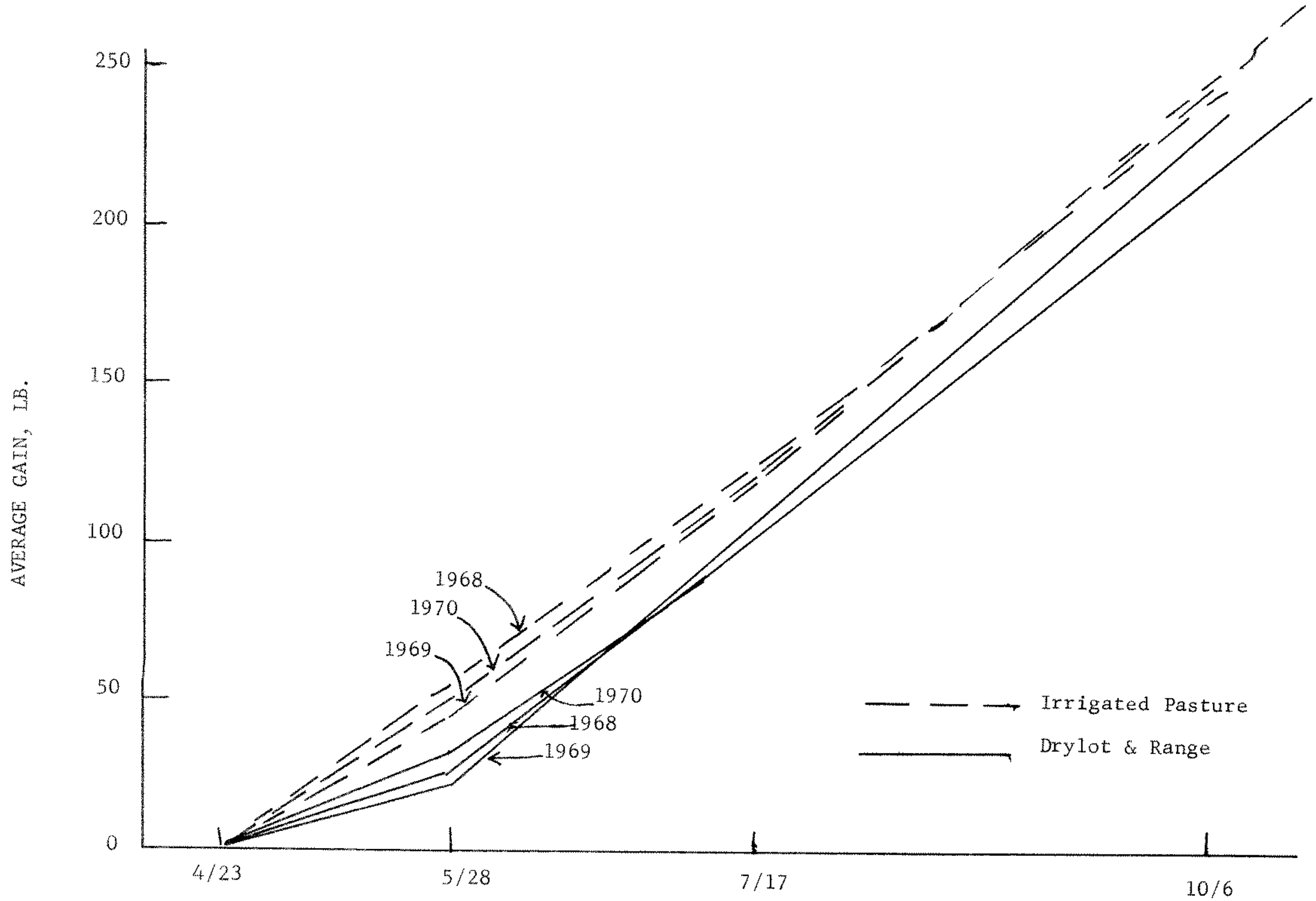

FIGURE 2. AVERAGE WEIGHT GAINS OF CALVES ON IRRIGATED PASTURE OR DRYLOT AND RANGE AT THE NORTH PLATTE STATION

OUTLINE OF PRESENTATION

by
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Custom Calving

1. The Heifer
2. Nutrition
   a) Pre-calving
   b) Post-calving
3. Calving
   a) Crews
   b) TLC
   c) Santitation
   d) Mechanics
4. Post-calving

Wintering

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2. Weaning
3. Receiving
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Ova Transplant

1. Surgical
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ADDITIONAL INFORMATION ON STATION RESEARCH

NOT

PRESENTED AT THE FIELD DAY PROGRAM

A NEW PROJECT:
GROWTH, DEVELOPMENT AND MATERNAL PERFORMANCE OF DIFFERENT BIOLOGICAL TYPES OF BEEF CATTLE

by

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With the addition of exotics to the list of breeds used for beef production in the United States, cattlemen now have a rather wide array of breeds and types represented by these breeds from which to select beef producing stock. Evaluation of the performance of different biological types under Western range conditions can contribute to guidelines useful in selecting appropriate types and managing them for optimum production under range conditions. These types must be evaluated for their suitability as cows in the breeding herd and for traits exhibited up to slaughter age that influence the production and quality of market beef.

This report provides a brief description of a new project that will be started in the breeding season of 1974 at the U. S. Range Livestock Experiment Station to evaluate different biological types. The new project will replace a genetic-environmental interaction project that will be terminated when data on the calves dropped in 1974 have been collected.

The new project will involve the cooperation of the U. S. Range Livestock Experiment Station at Miles City, Montana, the U. S. Meat Animal Research Center at Clay Center, Nebraska and the State Experiment Stations of Montana and Nebraska. Geneticists, nutritionists and physiologists will be involved.

Cattle from which information will be obtained will be located at Miles City (U. S. Range Livestock Experiment Station) and at Clay Center (U. S. Meat Animal Research Center). The procedure that will be followed at the Miles City location is described in the following paragraphs and is designed to evaluate the cattle types for their suitability under range conditions similar to those at the Miles City location. The procedure followed at Clay Center will be similar to the Miles City procedure. This will permit comparisons of the relative merits of the cattle types in two environments that differ considerably. Conditions differing between locations include topography, weather, quantity and type of vegetation, and certain management procedures influenced by factors that are not alike at both locations.

Procedure--Miles City Location

Phase 1:

A herd of 240 Hereford females will be bred artificially to Angus, Red Poll, Pinzgauer and Simmental bulls over a period of three years or until at least 60 first-cross females of each type have been produced for breeding purposes. Eight to ten bulls of each breed will be used annually, to obtain a broad sample of each sire breed. The same bulls will be used at both the Miles City and Clay Center locations.

Data collected in Phase 1 will include breeding dates, services per conception, prenatal mortaility, calving difficulty scores, stillbirths, calf mortality from birth to weaning, growth data of calves from birth to weaning, weaning condition scores of calves, and calf disorders that occur from birth to weaning. Heifer calves (postweaning) will be developed for breeding as yearlings. Data to be collected will include growth from weaning to the beginning of the first breeding season, disorders encountered during this period and age of first estrus. Steer calves (postweaning) will be fed for slaughter. Data collected will be that indicative of feedlot performance, carcass quality and carcass yield.

Phase 2:

As the first-cross heifers produced in Phase 1 reach yearling age (average age about 13 to 14 months) they will become the breeding females for Phase 2 and are expected to represent types differing in size and level of milk production. These heifers will be bred artificially during their first breeding season to bulls of at least two comparatively small breeds. The bulls will be of breeds other than those involved in Phase 1. In the following years, the first-cross females will be bred artificially to bulls of at least two comparatively large breeds and these bulls will be of breeds other than any of those previously used. In Phase 2, the same bulls of each breed will be used at both the Miles City and Clay Center locations.

Females in Phase 2 will be bred for a minimum of four calf crops to compare productivity between types and the ability of the different types to remain productive over a period of time. Cows in Phase 2 will be removed only for severe sickness, for unsoundnesses rendering them unserviceable and for being open after two consecutive breeding seasons. The females of each breed group will be divided and managed under two nutritional regimes in the precalving and postcalving periods. Results of prior studies at Miles City will be used as guides to nutritional treatments and duration of these treatments.

Data to be collected on the cows and their calves up to weaning time will be as described for Phase 1. In addition, cow weights will be taken periodically, the number of cows removed with reasons for removing will be kept and measurements of milk production are contemplated. Heifers produced in Phase 2 will be available after weaning for other studies. Steer calves (postweaning) will be fed for slaughter and the data to be collected will be as described for Phase 1.

IMPROVING BEEF CATTLE THROUGH SELECTION

by
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High quality beef breeding stock generally can be expected to transmit their desirable traits to their offspring resulting in economic benefits to producers. The extent of improvement depends on the accuracy of criteria used in selecting breeding stock and the extent to which offspring inherit the desirable traits of the parental lines (known as heritability).

Economically important traits that can be improved through use of superior breeding stock include weaning weight, yearling weight, gain and feed efficiency in the feedlot, and lean-to-fat ratio.

The breeding herd at the Miles City Station has served as a source of data for making heritability estimates for the traits listed above. Data has been collected on this herd since 1934. The heritability estimates shown in table 1, which are based on data from this herd, served as useful guidelines in formulating selection criteria for improving this herd and for the industry.

TABLE 1. HERITABILITY ESTIMATES FOR GROWTH TRAITS AND WEANING SCORE AT THE U. S. RANGE LIVESTOCK EXPERIMENT STATION, MILES CITY, MONTANA

Trait	1946	1950	1955	1963
Birth weight	0.23	0.53	0.72	0.54
Weaning score		0.28	0.18	0.23
Weaning weight	0.12	0.28	0.23	0.24
Feedlot gain	0.99	0.65	0.60	0.48
Final weight	0.81	0.86	0.84	0.64

Early studies at this Station indicated that weaning weights were less than 30% heritable. In followup feedlot tests, gain and final weight were observed to be more highly heritable, table 1. Therefore, weight at the end of the 196-day feedlot period for bulls and the 18-month weight off pasture for heifers received greatest emphasis in the selection criteria. A small amount of consideration was placed on weaning weight and practically none on birth weight.

Birth to Weaning Performance

From one mildly inbred line started in 1934 and which expanded to approximately 150 breeding females, estimates of genetic improvement in 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 for growth obtained in the herd were encouraging and resulted in some important recommendations for the improvement of beef herds. The estimated genetic responses for the birth to weaning traits in this herd from 1943 through 1959 are shown in table 2.

TABLE 2. THE AMOUNT OF IMPROVEMENT ESTIMATED IN BIRTH AND WEANLING TRAITS PER GENERATION[a] (SEXES COMBINED).

Trait	Expected improvement[b]	Estimated improvement obtained[b]
Birth weight (lb.)	1.75	1.85
Gain from birth to weaning (lb.)	7.24	10.04
Weaning weight (lb.)	8.99	11.72
Weaning score (%)	0.94	1.09

[a]The average generation interval for birth and weaning traits was 4.9 years.
[b]Estimated as genetic gains.

The values in table 2 show that the estimated genetic improvement for the listed traits was larger than expected. Thus, the selection (with greatest emphasis on postweaning gain and weight) as practiced in this herd gave sizable increases in preweaning growth. These responses were obtained where selection on the sire side was based on much higher standards than on the dam side. For example, the sires used in this line of cattle during the study represented the top 18% of the population while the females were from the top 89%.

These increases in preweaning growth (mostly resulting from indirect selection for these traits) per generation, when considered over several generations, resulted in a total response which was of a sizable magnitude with important economic benefits.

The estimates of genetic response in this herd were obtained over a period when inbreeding increased. In 1934 when the line was started, the average inbreeding was 0.7% and increased to 21.6% by 1959. The average inbreeding for this period was 16.1%. It was concluded that the actual response to selection would have been considerably larger without the effect of inbreeding.

Postweaning Performance

The expected responses for postweaning traits studied from 1943 through 1959 are shown in table 3. In this postweaning period, it was not possible to measure the environmental effects necessary to estimate the actual genetic responses for bulls and heifers. The total improvement includes both the genetic and environmental factors. Factors such as changes in feed, weather and overall management, are mentioned as important environmental influences that could have contributed to the total responses shown in table 3. While the environmental factors influenced total responses, the overall results indicate that there was a greater rate of genetic improvement for these traits than for those evaluated in the birth to weaning period. This was expected due to the higher heritability of postweaning traits (table 1).

TABLE 3. THE AMOUNT OF IMPROVEMENT ESTIMATED IN POSTWEANING TRAITS PER GENERATION[a]

Trait	Expected improvement[b]	Total improvement obtained[c]
Bulls:		
196-day gain (lb.)	10.14	15.24
Final weight off test (lb.)	19.13	18.87
Females:		
12-month weight (lb.)	14.62	26.27
Gain 12 to 18 months (lb.)	8.67	5.60
18-month weight (lb.)	23.29	31.79
18-month score (%)	0.75	1.58
Mature fall weight (lb.)	23.58	35.67

[a] The average generation interval for postweaning traits was five years.
[b] Estimated as genetic improvement.
[c] Estimated as phenotypic improvement and includes the genetic and environmental factors.

From a practical viewpoint, the industry benefits greatly by production of feeder type animals that have the ability to grow rapidly and efficiently to desired slaughter weights. Selection for growth traits to maximize efficiency of beef production should be strongly encouraged, providing herd reproduction has been at an acceptable level and that it can be continued at this level or improved. The reproduction in this herd in more recent years has been comparable to earlier years, indicating that there was no serious antagonism between growth and reproduction qualities.

In summary, it can be concluded that accurate selection criteria are likely to produce superior breeding stock from which the industry can benefit economically. However, to maximize benefits, the breeding stock used must rank ahead of the average performance of the herd into which it is introduced for at least the more important traits.

PRESENT STATUS OF BASIC REPRODUCTION RESEARCH AT MILES CITY

by

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The overall objective of our research at Miles City is to explore ways to increase profits in a range cow-calf operation. The inputs into a ranching enterprise are mainly land, labor and capitol; and of these, land is probably the most limiting because very little new land is available for beef production. Output is the most easily measured by the number of calves weaned or, even better, by the pounds of calf weaned. Therefore, our objective could be narrowed somewhat by including input-output measures to read: to increase the pounds of calf weaned per acre of land at the least cost. Profits can be increased by running more cows per acre, by having more calves per cow and by having heavier calves.

There are many ways we are attacking this problem and there is much information obtained that is directly useful to the rancher. Examples of this are the two papers I will be presenting later on calving difficulty and feeding heifers. Our research also includes experiments on anything from ways to increase range forage production to ways of getting more and bigger calves. In addition, we are gathering data from experiments that are not as directly useful to the producer although they often are as important or necessary.

Many times we need to obtain background information to find out how things work. Then we can apply this knowledge to solving actual production problems. A good example where this method was not used is estrous synchronization. Literally hundreds of attempts have been made in the last 20 years to develop treatments to synchronize estrus in cattle. The vast majority of these fall short of the desired goal. Probably the main reason these attempts were unsuccessful is that not enough was known about how the estrous cycle is controlled by the cow and man's attempts to control it were mere educated guesses or stabs in the dark. Now that we have gone back and found out more about how a cow functions, the prospects for a useable synchronization treatment are much better.

I would now like to go over some of our research at Miles City which is primarily related to finding out the mechanisms that control reproduction in the cow. In each area covered, I will try to point out a possible use for the answers obtained in solving a practical production problem. Before going on, I would like to point out one more reason why we need to do this basic type of research. Many large research institutes at universities and hospitals are doing basic reproduction research. However, they are primarily concerned with humans and laboratory animals. They are not interested in cows so the burden falls back on research centers such as ours to find out what makes a cow tick.

Some of the first basic reproduction research at Miles City was involved with the induction of multiple ovulations and multiple births. The incidence of naturally occurring multiple births in cattle is very low and attempts to select for this trait have been unsuccessful. However, the fact remains that if the incidence of multiple births could be increased the possibilities for increasing profits are tremendous! Calf crops of 100 percent or over could increase pounds of calf markedly without appreciably affecting investments in land or cattle.

The first step in this research was to devise a treatment to induce cows to have more than one ovulation (more than one egg shed) at the heat period when they are bred. It is known that the number of ovulations is mainly controlled by a hormone called follicle stimulating hormone which is commonly abbreviated FSH. FSH is produced in the pituitary gland located at the base of the brain. Then at the appropriate time, the pituitary releases FSH into the blood to travel to the ovary where it stimulates follicular development. Unfortunately, cow pituitaries don't have much FSH so the only good source commercially is a preparation made from swine pituitaries called FSH-P[1]. The only other FSH preparation available is pregnant mare serum (PMS). It was discovered many years ago that blood from pregnant mares had a very high level of an FSH-like compound. We have tried both FSH-P and PMS and have preferred not to use the latter because of variability in response.

Some work that was published in 1969 shows the treatment that was eventually settled on for inducing multiple ovulations. Table 1 shows that heifers were synchronized by feeding 180 mg of MAP[2] for eleven days. Five mg of estradiol was given on the second day of feeding and FSH-P was injected twice a day for five days from days eight through 12. Most cows were in heat and bred on days 13 or 14.

TABLE 1. TREATMENT SEQUENCE FOR INDUCED MULTIPLE OVULATIONS.

1	2	3	4	5	6	7	8	9	10	11	12	13	14
5 mg estradiol valerate								2 times per day FSH injections					
-------- 180 mg MAP per day feed each cow -----------												--------- cows in heat	

Table 2 shows that as FSH-P dose is increased ovulation rate increased. From this work we have found that the best dose is from 6.5 to 10 milligrams.

TABLE 2. EFFECT OF FSH-P DOSE ON OVULATION RATE.

Total FSH-P dose (mg)	No. cows	Ovulations per cow No.	Ovulations per cow Range	Percent eggs fertilized
0	8	1	---	100
3.1	8	1.1	1-2	93
6.2	8	2.1	1-4	94
12.5	8	8.0	3-14	79
25.0	7	14.6	1-32	84

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1 FSH-P supplied by Armour-Baldwin Laboratories.

2 Repromix containing 33 gm MAP/kg was supplied by the Upjohn Company, not available commercially.

The next step was to find out how many calves we could get from cows treated in this manner. As we can see from Table 3 in an experiment to test this, the only group that exceeded a 100 percent calf crop was the mature cows given 9.5 mg of FSH-P. These calving rates are not as high as we expected from ovulation rates and conception rates. Pregnancy losses from conception to calving were higher than in normal cows. Then the next step became, how can this high rate of pregnancy loss be prevented?

TABLE 3. EFFECT OF FSH-P TREATMENT ON CALVING RATES.

Age	FSH-P dose	No. animals	1st service conc. (%)[a]	No. cows calved	No. calves	Calving rate (%)
Heifers	0	9	70	8	8	89
	6.2	43	56	34	39	91
Cows	6.2	28	75	20	21	75
	9.4	27	74	24	30	111

[a] Cows were bred by AI for two services but were treated with FSH-P only at the first service.

Progesterone is a hormone produced by the ovary that maintains pregnancy. If multiple pregnancies require more of this hormone than the cow has available, then supplementing cows with it may increase survival rate of multiple pregnancies. An experiment was conducted to find out if feeding a progesterone-like compound called melengesterol acetate (MGA®)[3] would increase embryo survival. Table 4 shows that when four mg of MGA were fed to heifers treated with FSH the survival rate was increased from 0.30 embryos per corpus luteum (CL) to 0.53. This was at either 34 or 44 days of pregnancy. However, subsequent work has shown that feeding MGA later in pregnancy can be detrimental. Therefore, increasing embryo survival cannot be attained by simply feeding MGA all during pregnancy. We are continuing this research to find ways to increase the rate of embryo survival in multiple and single embryo pregnancies.

TABLE 4. EFFECT OF FEEDING MGA ON EMBRYO SURVIVAL TO DAY 34 OR 44.

Treatment	No. cows	No. CL on day 4	No. live embryos per CL[1]
FSH-P, no MGA	22	3.0	0.30
FSH-P + 4 mg MGA per day	58	2.4	0.53

[1] Some embryos were observed on day 34 and some on day 44.

Thus far, I have been talking about controlling reproduction through increased ovulation rates. We are also interested in the other extreme of trying to get heifers and cows to come into heat and ovulate that are not cycling and that have an ovulation rate of zero. In both cases, we need to know more about how the estrous cycle is actually controlled in order to change or alter the estrous cycle correctly.

[3] MGA supplied by the Upjohn Company.

It was mentioned earlier that FSH controls the number of ovulations but little is known about what controls the levels of FSH. According to the most common theory, as FSH increases, the number of follicles and amount of hormones (progesterone and estrogen) produced by the ovary increases. These higher levels of ovarian hormones then feed back to cause the pituitary to decrease FSH output. The extent that this theory is applicable to the cow is not known but in either trying to get cows to ovulate that aren't or increasing ovulation rates above one, it would be useful information.

One way this mechanism has been studied in other species such as the pig and rat is to remove one ovary. This is commonly referred to as unilateral ovariectomy. Apparently what happens in the rat or pig when one ovary is removed is that the amount of ovarian hormones is cut in half. This allows the pituitary to release more FSH which in turn increases the number of follicles and ovulations on the remaining ovary. The remaining ovary then has about the same number of ovulations as two did before one was removed.

We have used this same approach of removing one ovary to study ovarian control mechanisms in the cow. In our first attempts it didn't seem to make much difference to the cow if an ovary or a CL was removed. The other ovary seemed to stay pretty much the same. However, further analysis of the data suggested it might make a big difference depending on which ovary was removed. Only one of the ovaries has a CL which is a big difference; but, also, there is generally only one large follicle on only one of the ovaries. When one ovary is removed, the CL may or may not be removed and the largest follicle may or may not be removed.

Next, we ran an experiment in which we intentionally either removed the CL containing ovary or the non-CL ovary. Also we intentionally removed either the ovary that had the largest follicle or the one that didn't. We arbitrarily called the ovary with the largest follicle the active ovary. The interpretation of the data became somewhat complicated but one thing was clear. As shown in Table 5, when the inactive ovary was removed and the active ovary observed three days later, the follicular development of this active ovary was much the same as that of the active ovaries in control cows. However, if the <u>active</u> ovary was removed, three days later the <u>inactive</u> ovary was also <u>very similar to</u> that of the active of the controls. The inactive ovaries became active if the active ovary was removed and the active ovary remained the same if the inactive was removed. Therefore, we would conclude that there is some control mechanism between the ovaries and the pituitaries of cows to regulate follicular development. This must be a finely tuned mechanism since a cow very rarely makes a mistake and ovulates more than one follicle.

TABLE 5. EFFECT OF UNILATERAL OVARIECTOMY ON FOLLICULAR DEVELOPMENT.

	Control ovaries		Inactive ovary removed, active meas. 3 da. later	Active ovary removed, inactive meas. 3 da. later
	Active	Inactive		
Follicular fluid wt. (g)	2.39	1.55	2.23	2.76
Dia. largest follicle (mm)	11.4	6.2	10.4	12.8

One big problem that faces producers is that cows take a long time to return to estrus following calving. In fact in many cases the interval from calving until estrus and breeding (postpartum interval) can become so long that it's impossible to calve every twelve months. To a large degree, this long postpartum interval is caused by improper feeding and we have done a lot of research in studying the relationship between feed levels and postpartum intervals. But, it still takes a fairly long time for a cow to come back in heat following calving even if proper nutritional management is used.

It is known that nursing and lactation delay estrus in other species but less is known about this effect in cows. Therefore, we set up an experiment to study how nursing affects postpartum reproduction in cows. In the first group, the cows were suckled. In the second group, the calves were removed at birth and the cows were not milked or suckled; and in the third group, the calves were removed and the cows had their mammary glands surgically removed (mastectomy) four months earlier. The mastectomies were to prevent any lactation or nursing from taking place. Removing calves at birth reduced the interval to first estrus from 65 days to 25 days. Mastectomy shortened the interval even further to 12 days. From these data, we can see that suckling very markedly delays a cow from coming into estrus. Also, cows which do come in very early do not conceive until 40 days or later.

TABLE 6. EFFECT OF SUCKLING ON POSTPARTUM REPRODUCTION IN THE COW.

	Suckled	Non-suckled	Mastectomized
No. cows	12	13	9
Interval from calving to: (days)			
First estrus	65	25	12
Conception	61	50	44
No. cows conceived	6	11	8
Services per conception	1.7	2.2	3.0

As a result of this work, we and other people are exploring the possibility of using early weaning as a management tool to increase reproductive efficiency. Early weaning becomes more essential as a management tool when multiple births are considered. Also, from our work on suckling, we have tried to find out why nursing or lactation delays estrus and why cows that come in heat very early following calving are so infertile. Neither of these questions have been answered at present. In fact, it would be more accurate to say we have only found things which are not the answers.

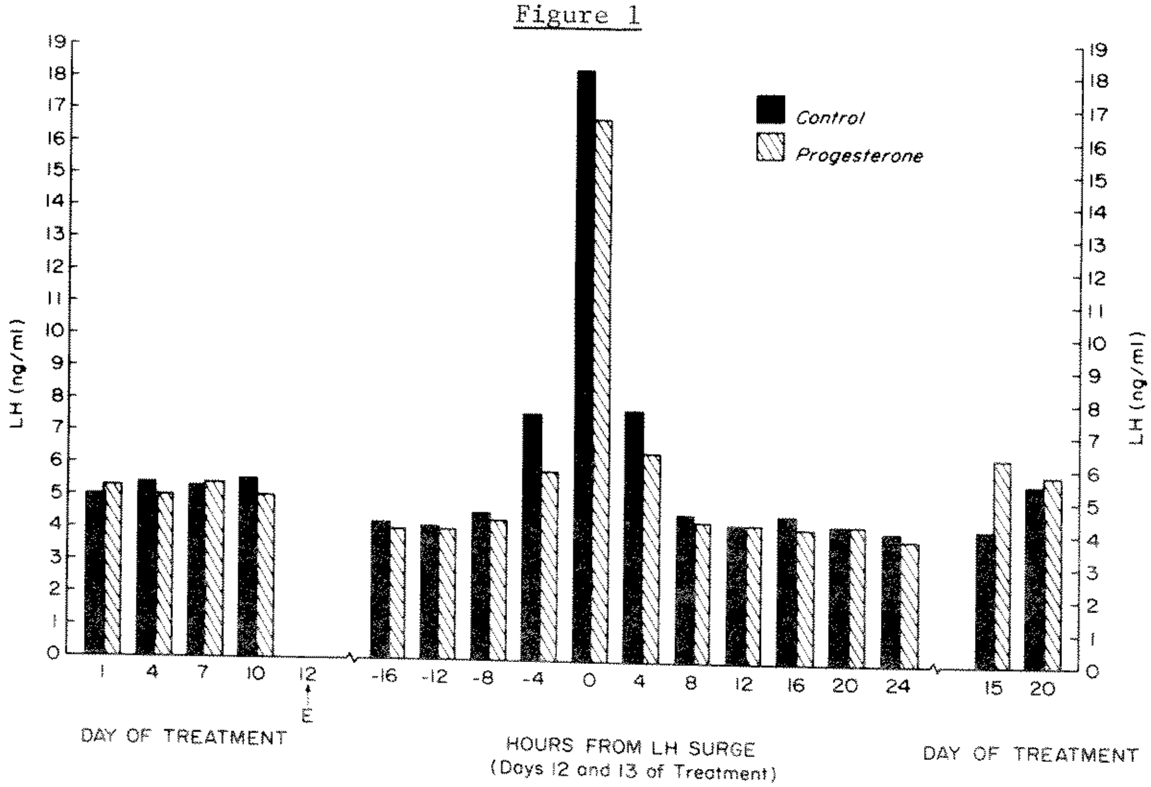
The next area of research I want to discuss is still involved with trying to find out how a cow functions. This research is a little different in that we are using some fairly sophisticated techniques in the laboratory to measure blood hormone levels. The procedure used is usually some form of a radioimmunoassay. This procedure allows us to take repeated small samples of blood from cattle. This allows us to find out what changes take place in the levels of several hormones throughout the estrous cycle and pregnancy without killing the animal.

Either in our laboratory or in others we cooperate with, assays are being done for luteinizing hormone (LH), FSH, prolactin, progesterone, estrogen and testosterone.

Luteinizing hormone or LH is another hormone released by the pituitary. We now know it is released at low levels through most of the cycle but at the beginning of estrus a large spurt is released. This acute release of LH causes ovulation of any mature follicles (follicles rupture and release eggs). We do not know exactly what regulates this release of LH. This knowledge would be useful in either trying to induce ovulations in young heifers and postpartum cows or synchronizing ovulation in cycling cows.

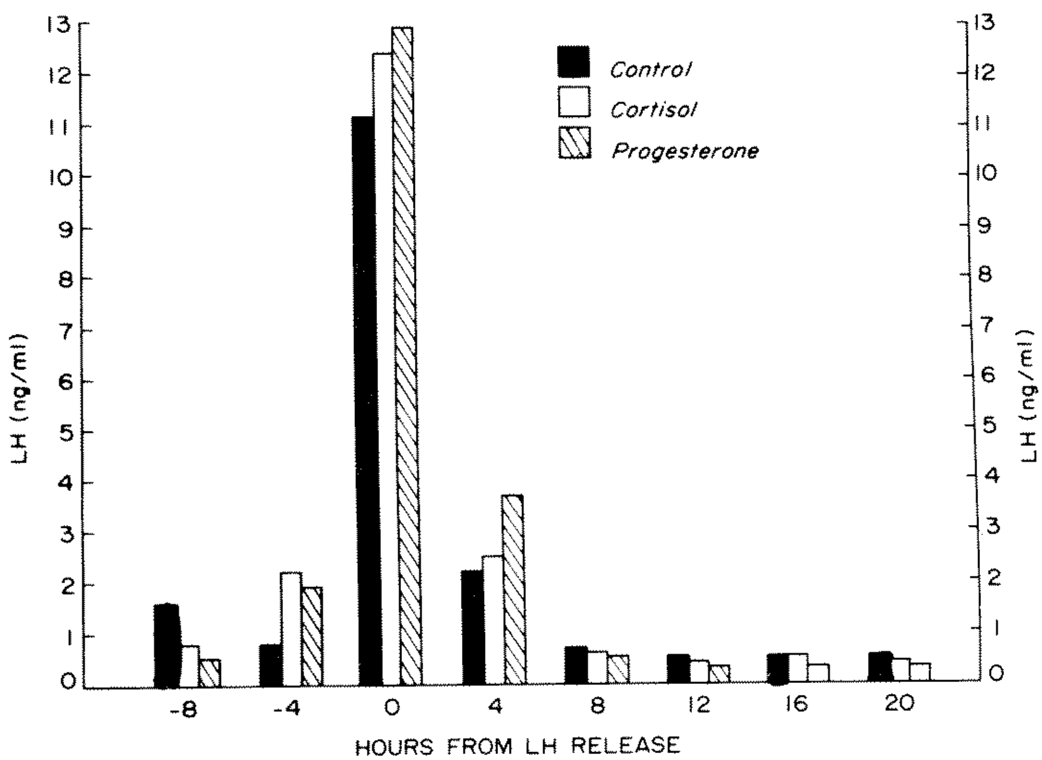
It has been shown that estrogen levels are high in the cow just prior to estrus. In sheep and monkeys, estrogen injections will cause a release of LH. Therefore, the rise in estrogen levels prior to estrus may induce both estrus and LH release. To test this possibility, several experiments were conducted to see if an estrogen injection would cause LH release in spayed (ovaries removed) cows and, if so, could it be prevented by some other treatment? Figure 1 shows that when 10 mg of estradiol-17β are injected, there is a release of LH (solid bars) at 22 hours after the E injection. Also, estrus was induced in all cows at the same time. Pretreatment with progesterone (crosshatched bars) did not affect this response. Then two experiments were run to see if we could block the estrogen induced LH release.

Figure 1



In the first experiment, we tested to see if progesterone or cortisol acetate (a compound similar to one released by the adrenal in excited animals) injections would block the induced LH release. The data in Figure 2 show that neither of these treatments blocked the release of LH.

Figure 2



Since suckling will inhibit a cow from coming into heat and ovulating, it may inhibit the effect of estrogen on LH release. There is some data in monkeys that this is so and we had some preliminary data from three cows which suggested that suckling inhibited estrogen induced LH release. However when we ran a complete experiment, we were unable to block the induced LH release with suckling. From this series of experiments, we can conclude that increased estrogen levels do indeed induce the ovulatory LH release but we don't know what situations prevent it.

The last area of work I want to discuss is a good illustration of using some basic knowledge we have obtained to answer a production problem. It is known that stimulation of various parts of the reproductive tract either manually or by a bull will result in increased muscle contractions of the uterus. Neural impulses from the reproductive tract cause the pituitary to release oxytocin which in turn stimulates the uterus. If a neural pathway exists to control oxytocin release, it may also exist to some degree for LH release. The proper timing of estrus, LH release, ovulation and sperm transport are necessary to have the highest probability for conception. The amount of stimulation the reproductive tract receives is quite different between natural service and artificial insemination (AI). If this difference in stimulation also causes changes in the relationships among estrus, LH release, ovulation and sperm transport, conception rate could be altered. To see what effect different stimuli have on estrus, LH release and ovulation time, the following experiment was conducted.

As shown in Table 7, there were five groups of cows that received different kinds of stimuli. In general, the amount of stimulation increases progressively in going from Groups I to V. The data are shown in Table 8. The stimuli in Groups II to V reduced the interval from the beginning of estrus to the LH peak. Clitoral stimulation either by the bull or manually (Groups III, IV and V) was necessary to reduce the interval to ovulation. None of the treatments affected the height of the LH peak.

TABLE 7. EXPLANATION OF STIMULI BY TREATMENT GROUPS.

Stimulus	Treatment Group				
	I	II	III	IV	V
A. Estrogenized cows to detect estrus	Yes	Yes	Yes	Yes	No
B. Cervical stimulation[a]	No	M	M	B	B
C. Clitoral stimulation[b]	No	No	M	B	B
D. Bred by bull	No	No	No	Yes	Yes
E. Estrus checked by bull	No	No	No	No	Yes

[a] M = manual stimulation by AI, B = stimulation from mating by bull.
[b] M = 10 seconds manual stimulation, B = stimulation from mating by bull.

TABLE 8. EFFECT OF DIFFERENT REPRODUCTIVE STIMULI ON LH RELEASE AND OVULATION TIME.

Measurement	Treatment Group				
	I	II	III	IV	V
Time from beginning estrus to LH peak (hr.)	9.9	5.4	6.2	5.9	4.7
LH peak (ng/ml)	9.7	8.1	8.0	7.4	8.7
Time from beginning estrus to ovulation (hr.)	33.2	32.0	29.0	27.9	28.7

Now we know that stimulation of the reproductive tract can alter time of LH release, time of ovulation and uterine contractions; all of which can affect conception. Now the question is, will stimulation such as manual massage of the clitoris increase conception rates when artificial insemination is used? Use of AI in beef cattle production is increasing by leaps and bounds and any increases that can be obtained in conception rate is a real economic advantage. As shown in Table 9, clitoral stimulation increased first service conception rates by 6.2 percent. However, the conception rate for both services was almost the same. These data suggest that clitoral stimulation may increase first service conception rates with AI but not total conception rates. If this is true, stimulation has an advantage because calves would be older and fewer ampules or straws of semen would be used. Also, it has the beauty of costing absolutely nothing. This work is being continued on about 750 cows but results are not yet available.

TABLE 9. EFFECT OF CLITORAL STIMULATION ON CONCEPTION RATES USING AI.

	Stimulated	Non-stimulated
No. cows	188	189
No. pregnant first service	135	124
% pregnant first service	71.8	65.6
No. pregnant, 2 services	154	157
% pregnant, 2 services	81.9	83.0

In summary, I would like to stress that the effort we are making in answering some of these basic questions is being done in order to get useful information to answer real production problems. We and other research stations (both Federal and land grant colleges) are continuing this research to enable us to work towards the goal of increasing pounds of beef produced per acre.