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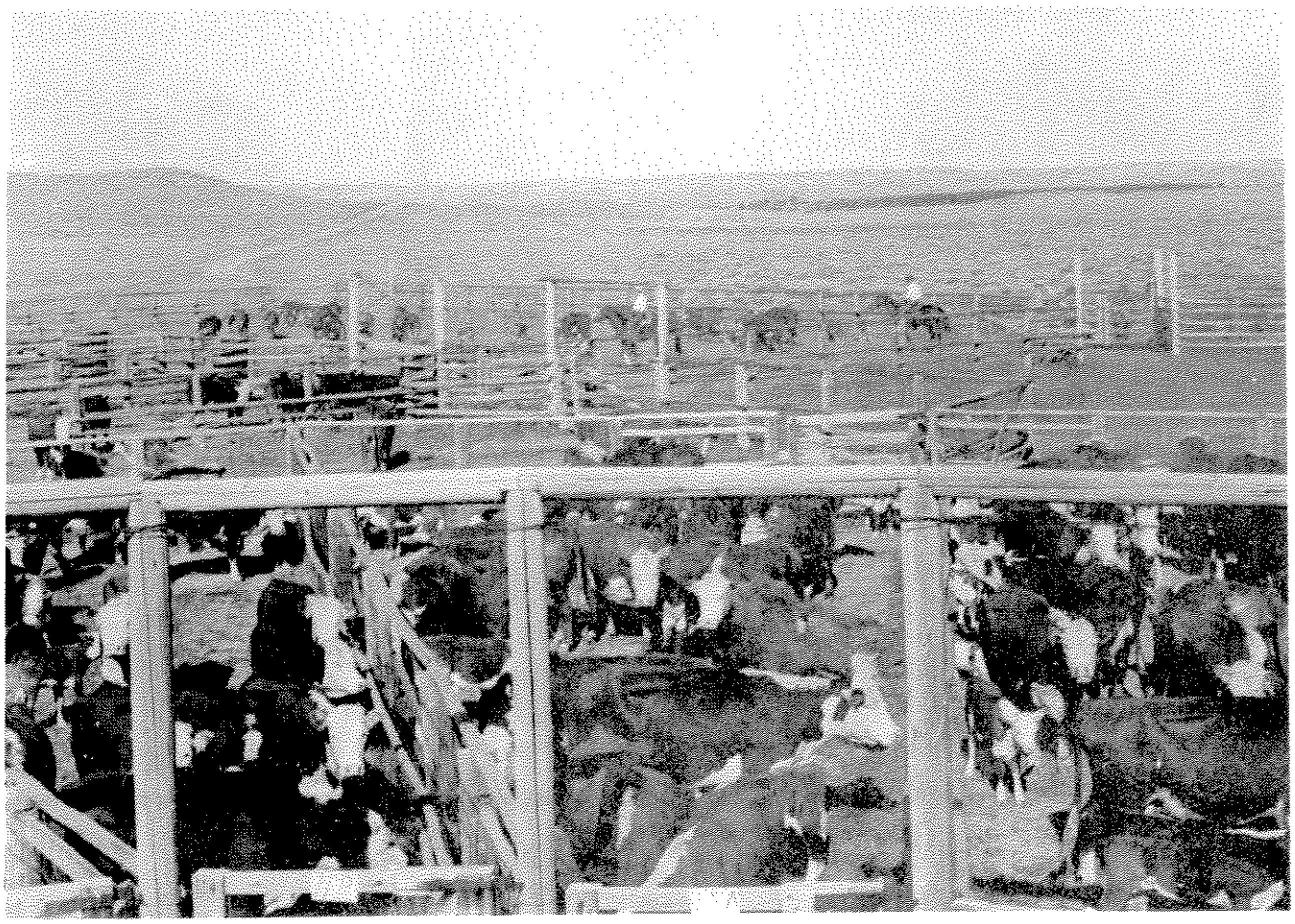
BEEF CATTLE FIELD DAY

U.S. Range Livestock Experiment Station

May 20, 1976

Miles City, Montana



Agricultural Research Service
United States Department of Agriculture
in cooperation with
Montana Agricultural Experiment Station
and
Cooperative Extension Service of Montana

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RECENT PHYSIOLOGY RESEARCH AT THE U. S. RANGE LIVESTOCK EXPERIMENT STATION

by
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Spaying.

Over the past year we have received numerous inquiries regarding the effects of spaying on weight gains in heifers. We have not conducted studies on spayed heifers at this Station so results discussed are those obtained from scientists at other locations. The results are interesting and producers should be aware of these findings.

Spaying is the surgical removal of the ovaries in the female. This means the spayed heifer will not come in heat and will not become pregnant. In searching through the scientific papers, 11 studies have been reported where rate of gain in the feedlot of spayed and intact heifers have been compared. In all 11 studies, the spayed heifers gained more slowly than did the intact heifers. The daily gain of the intact heifers averaged 1.89 lb. compared to 1.72 lb./day for the spayed heifers--a reduction of 9.9 percent. In addition, in 10 of the 11 studies, weight gains of the spayed heifers were less efficient. Spayed heifers required 8.5% more feed for each 100 lb. gain than did the intact heifers.

The University of Wyoming conducted a study in 1960 to determine the effects of spaying on summer weight gains of heifers on pasture. Spayed heifers gained 1.28 lb. per day during the 120-day summer grazing period compared to 1.47 lb. per day for the intact heifers. This was a reduction in gains of 14.8 percent.

There are some figures recently made available to me by Mr. Roger Moul, County Agent at Buffalo, South Dakota. These concern the effects of premiums being paid for spayed heifers and the effect of growth-stimulating implants on gains of cattle on grass. First look at table 1, which shows the effects of selling spayed heifers for a premium price. These values are calculated on the basis of a 400 lb. starting weight and the spayed heifers gaining at a slower rate than the intact heifers. It can be seen that the price returns range from a $6.60 loss to a $~~12.10~~ 27.70 profit. These figures also assume no death loss, which frankly is a very poor assumption.

TABLE 1. EFFECTS OF PREMIUM PRICE ON RETURNS REALIZED FROM HEIFERS

Class of heifer	Sale wt. (lb.)	Selling price per Lb.	Selling price per Head
Intact	625	33¢	$206.25
Spayed	605	33¢	$199.65
		35¢	$211.75
		37¢	$223.85
		39¢	$235.95

[a] Mention of trade names does not constitute a warranty by USDA.

Thus, if sufficient premiums can be obtained for spayed heifers, the practice can return a profit.

There are other figures you should be aware of. Table 2 shows summaries of some additional data supplied by Roger Moul.

TABLE 2. EFFECT OF STILBESTEROL IMPLANTS ON WEIGHT GAINS OF SPAYED HEIFERS

	Spayed heifers	
	No implant	Implant[a]
No. heifers	19	19
Initial wt. (5/12)	420	423
Final wt. (9/5)	613	628
Total gain (lb.)	193	205
Avg daily gain (lb.)	1.66	1.77

[a] 12 mg stilbesterol on 5/12.

You will note that the rate of gain and final sale weight can be increased by use of a 12 mg implant of stilbesterol. Use of DES is legal at this time but its use may be banned in the future. In addition, there may be marketing restrictions encountered, especially if you plan to ship the cattle to Canada.

Data from California indicate that implanting heifers with RAL (Ralgro) can also increase gains. This work showed that intact heifers receiving a 36 mg implant gained an additional 21 lb. during the summer grazing period for an increase of 8.5 percent.

Thus, it appears that spaying can return a profit under: (1) marketing conditions where premium prices are paid for spayed heifers; (2) if the animals are treated with growth stimulants. We are currently studying rate of gain and carcass traits in spayed and intact mature cows grazing range forage. One-half of the animals in each group have been implanted with Ralgro. Results of this study will be reported at a later date.

Organophosphate Systemic Insecticides.

An extensive study of the effects of organic phosphate pesticides (Ruelene and Co-Ral) on embryo survival and development has been completed. The studies were conducted at Miles City; Crawford, Nebraska; Clay Center, Nebraska, and Beltsville, Maryland. A total of 726 heifers were involved and treated animals received dosages at recommended one-time doses, one-time doses at double or triple the recommended level or treatments at recommended one-time dose levels repeated each day for 10 days. None of the treatments gave evidence of increasing embryonic loss or causing abnormalities in calves or calf growth *in utero*.

Calving Difficulty.

It is common thinking among beef producers that exercise in the pregnant female is of prime importance in preventing calving difficulty. The reasoning is that without sufficient exercise, muscle tone is not maintained. Without this, muscles involved in labor do not exert sufficient force to expel the calf. This has been studied in work at Miles City.

Heifers and cows assigned to this study were Angus-Hereford crossbreds and were all bred to the same Charolais sire. Ninety days prior to the predicted calving date, pregnant dams were divided into two groups. One group was placed in small feedlots where activity was restricted and maintained on a feed level equivalent to 10 lb. TDN. The second group was maintained under pasture conditions and was fed the same type of feed supplied in amounts necessary to obtain the same weight gains observed for animals in the feedlot. Animals maintained under pasture conditions were fed one mile from the only water source in the pasture. This forced the animals to walk a minimum of two miles a day. All dams were calved in the feedlots and dams assigned to the exercise group remained in pasture areas until approximately 5 days prior to calving.

Results obtained are summarized in table 3. The effects of forced or restricted activity during gestation gave little or no effect on gestation length, calf birth weight, incidence of calving difficulty or calving difficulty score. These results are in general agreement with those reported by other scientists. But, note there was an estimated 31% increase in feed requirement of the exercise group.

TABLE 3. EFFECTS OF EXERCISE DURING GESTATION ON CALVING DIFFICULTY IN HEIFERS

Activity	No. heifers	Gestation length[a] (days)	Birth wt. (lb.)	Calving difficulty (%)	Calving difficulty (score)[b]	Estimated feed level (lb. TDN)
Forced[c]	30	280	74	24	1.3	13.1
Restricted[d]	31	280	71	26	1.5	10.0

[a] All heifers bred to single Charolais sire.
[b] Walk of two miles daily last 90 days of gestation.
[c] Held in feedlots last 90 days of gestation.
[d] Score: 1 = no difficulty to 4 = greatest including cesarean delivery.

We have recently completed a study that has given additional interesting results. Ninety-six heifers were assigned to a 2 X 2 factorial study, involving natural vs induced calving and early vs late obstetrical intervention or assistance. Calving was induced with 10 mg flumethazone approximately 6 days prior to the predicted calving date.

Heifers assigned to receive late obstetrical assistance were allowed to calve by themselves or go as long as was judged possible before assistance was given to save the calf. All females in the early assisted group had the calf pulled--whether the delivery was difficult or not. The assistance was given just as soon as it was judged that labor had progressed to the second stage defined as the appearance of the fetal membranes or calf feet at the vulva. All we required was that the cervix was fully dilated. Preliminary results are summarized in table 4.

This summary shows the October pregnancy rates of the 96 heifers following the described experiment. Heifers were bred via artificial insemination during a

45-day breeding season. These results show a small reduction in fall pregnancy rate following induced calving. This has been found by many workers. But, the most striking difference was in the pregnancy rates of the early and late assistance groups--a difference of 17.6 percent. These results are based on small numbers and we are following this study with a larger study involving 150 head this year.

TABLE 4. PRELIMINARY RESULTS OF CALVING DIFFICULTY STUDY

Time of obstetrical assistance	Type of calving				
	Natural		Induced		
	No.	Oct. preg. %	No.	Oct. preg. %	
Early	16	93.8	7	100.0	95.7[a]
Late	39	79.5	34	76.5	78.1
Avg		83.6		80.5	

[a] P=.06.

Studies are underway on factors affecting age at puberty. A recent study involved 41 Hereford heifers that averaged 410 lb. at weaning. The heifers were divided into two weight groups at weaning: (1) those above the average weaning weight [equal to or more than 410 lb.]; (2) those less than the 410 lb. weaning weight. Each group was then wintered in feedlots for 176 days on two levels of feeding. The feed levels were determined by establishing target weights that the heifers were to reach by the beginning of the breeding season (June 1). Feed levels were then calculated to provide a rate of gain necessary for each group to reach its target weight. These target weights were 800 lb. for the high feed level heifers and 650 lb. for the low feed level heifers.

Values in table 5 show marked differences in the costs of wintering the heifers (77¢ vs 43¢ for the high and low feed level, respectively). There was also an effect on the number of heifers in heat by June 1 traceable directly to the winter feeding level. But, notice the differences between the heifers that were heavy at weaning vs the light heifers. Even though the light group was fed a high feed level (essentially ad lib.) and cost $139 per head to winter, they were still 47 lb. lighter than the heavy group and only 50% had reached puberty by June 1. You may want to consider this when you select heifers to be considered as potential replacement heifers in your herd.

Basic Research Studies.

Previous reports from this Station have shown suckling by the calf and lactation by the dam have a major delaying effect on when a cow comes back in heat after calving. If the calf is weaned or if the mammary gland is removed to terminate or eliminate suckling and milk production, the cow will come back in heat rapidly. It is important that we know what effects early weaning has on the cow so that we can develop methods to shorten the interval from calving to heat in range cows.

TABLE 5. FEED COST AND PUBERTY PERCENTAGE IN HEIFERS

Winter feed level	Weight category at weaning: Above avg weaning wt.	Below avg weaning wt.
High		
No. heifers	10	10
Avg weaning wt. (Oct. 20)	459	362
Target wt. (June 1)	800	800
Actual prebreeding wt.	762	715
% in heat by June 1[a]	90	50
Wintering cost/head/day	76¢	79¢
Low		
No. heifers	11	10
Avg weaning weight (Oct. 20)	462	368
Target wt. (June 1)	650	650
Actual prebreeding wt.	647	628
% in heat by June 1[a]	27	30
Wintering cost/head/day	36¢	51¢

[a] High vs low fed, P<.01.

One of the possibilities existing is that stimulation of the udder by the calf during nursing could have an effect on the cow's nervous and endocrine systems and delay return to heat. This has been tested in a study involving 15 cows. Five cows had their calves running with them and nursing was not restricted. Five cows also had their calves with them and nursing was free choice but nerves to the udder and teats were destroyed surgically and chemically 3 to 5 days after calving. The last group of five cows had the calves weaned at 3-5 days after calving to eliminate suckling and milk production. Results are summarized in table 6.

TABLE 6. EFFECTS OF UDDER DENERVATION ON POSTPARTUM INTERVAL AND MILK PRODUCTION

Cow group	No.	Postpartum interval (days)	Calf wts. (lb.): Birth	Calf wts. (lb.): 11 weeks	Milk production in 6 hr period (lb.)
Intact, suckled control	5	76	75	220	4.20
Denervated, suckled	5	81	74	215	4.05
Nonsuckled	5	28	72	---	----

This study indicates that destroying the nerves to the udder had no effect on postpartum interval, calf weight gains or milk production. Thus, the suckling effect is apparently due to other factors.

Many studies have shown that high or low feed levels at essentially any stage of the reproductive life of the animal can have marked effects on reproductive performance. But, just what goes on in the animal? These changes must be reflected in changes in body chemistry and hormone levels in the tissue and blood. We are currently conducting studies to determine these changes. This knowledge will give us a clearer picture of how beef females should be fed to obtain optimum reproduction.

Preliminary results are summarized in table 7 and indicate that low feed levels reduce the amount of luteizizing hormone (LH) in the pituitary gland. The weight of the corpus luteum was also reduced by low feed levels. These findings may prove to be important because LH and the corpus luteum and its production of progesterone are necessary for normal estrous cycles and for maintenance of pregnancy.

TABLE 7. EFFECTS OF FEED LEVEL ON BEEF COW ENDOCRINOLOGY

Feed level	No. cows	Avg daily gain (lb.)	Pituitary LH (mg)	Serum LH (ng/ml)	Corpus luteum wt. (gm)
High[a]	14	0.79	4.0*	1.5	4.7*
Low[b]	14	-0.82	3.2	1.6	3.6

[a] 118% of NRC requirements.
[b] 61% of NRC requirements.
* $P<.05$.

PLANS FOR A STUDY OF BIOLOGICAL TYPES OF BEEF CATTLE UNDER RANGE AND OTHER ENVIRONMENTS

by
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With the newly introduced breeds from other countries entering into the beef cattle production picture, cattlemen now have a wide array of breeds and types from which to select beef producing stock. It is desirable that the performance of different biological types be evaluated under Western range conditions to provide guidelines to selection and management practices appropriate for optimum beef production.

An important objective is to evaluate these types for their suitability as cows in the breeding herd, on the basis of their reproducing ability and the performance of their progeny from birth to market age. Evaluation of preweaning and postweaning records on these types themselves, as they are developed for breeding or for market beef, is another objective and will yield useful information.

This report contains the research plan for a project started in the breeding season of 1974 at the U. S. Range Livestock Experiment Station to evaluate different biological types. The report also contains preliminary results from records on the first crop of calves (1975) produced in the project.

The biological type study involves 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.

One of the objectives of the study is to compare results obtained at the U. S. Range Livestock Experiment Station with results from the U. S. Meat Animal Research Center to determine if the different types perform in the same relative way in different environments. There is evidence that breeds, types or groups within breeds that perform best in one location may not be the best performers in another location where climate, vegetation, management and other conditions are materially different.

Phase 1 Plan--Miles City

A herd of up to 280 Hereford females (table 1) is being bred annually by artificial insemination to Angus, Red Poll, Pinzgauer and Simmental bulls for production of F_1 crossbreds to represent the different biological types. Considerably fewer than the 280 females were available for breeding the first year, with more than the desired number of yearling and aged females. The mating program will be repeated yearly until at least 60 serviceable F_1 females by each sire breed are obtained.

It is anticipated that the sire breeds will produce F_1 females of different biological types based on mature size and milk production. Existing information from European sources suggests that the Simmental and Pinzgauer breeds should be, characteristically, the largest of the four sire breeds in mature size, with the Simmental being somewhat larger and higher in milk production than the Pinzgauer. Available information suggests that the Angus and Red Poll breeds should be smaller than the other two breeds in mature size, with the Red Poll being higher than the Angus in milk production. It is possible, of course, that characterization based on size and milk production may be revised somewhat when progeny from sires of the four breeds are all compared uniformly under range conditions of the Northern Great Plains.

The Hereford cows used in the initial breeding program, and their F_1 calves, from birth to weaning age, are managed under conditions representative of range cattle management procedures commonly used on the U. S. Range Livestock Experiment Station. Data collected up to weaning age include birth weights, calving difficulty scores, loss records, weaning weights and weaning scores.

After weaning, a representative half of the heifer progeny of each sire breed is placed in one of two treatment groups to evaluate the effects of these treatments on factors associated with fertility. One group is fed a growing ration in dry lot confinement in an amount necessary to produce individual daily gains averaging at least 1.25 lb. per day to approximately 12 months of age. The other group is placed in a pasture situation permitting greater activity and is fed an amount of the growing ration necessary to produce an average daily gain comparable to the gain of the group in dry lot to 12 months of age. The described treatment will be used until adequate green grass is available, at which time the two groups will be combined on pasture only. The heifers then will remain on pasture or range forage during their lifetime in the project, except when forage and weather conditions are such that supplementation on pasture or feeding of hay is necessary.

During the period from weaning to the breeding season (October to May 31), records kept on the heifers include group consumption of the growing ration by treatment groups identified above, 28-day weights to 12 months of age, date of puberty and age of puberty.

Steer calves are individually fed for slaughter. Individual feed consumption and 28-day weights are recorded. The steers will be fed until 60% of the Angus-Hereford steers are estimated to grade choice. At that point, a random one-third of the steer progeny of each sire breed will be slaughtered. One-third will be slaughtered at each of two 28-day intervals thereafter. Carcass data necessary for evaluating quality and cutability characteristics will be taken.

Phase 1 Preliminary Results--Miles City

The first crop of calves produced in Phase 1 of the experiment described was born in 1975 (March, April and May). The cows and calves were on the range until the October weaning date, after which the calves were treated as described earlier in this report. The data presented at this time are not considered conclusive and are presented as a progress report that may provide broad indications of future results over the same period of growth and development.

Heifers:

Growth records on the F_1 heifer calves from birth to 365 days of age are summarized in table 2. These are records on heifer calves with 50% Angus, Red Poll, Pinzgauer and Simmental breeding, respectively.

Heifer calves of Simmental and Pinzgauer breeding were the heaviest at birth, followed by those of Red Poll and Angus breeding, respectively. The heifers of Angus and Simmental breeding were highest and essentially alike in preweaning daily gain per head, while those of Red Poll and Pinzgauer breeding both averaged about 0.1 lb. lower. As the net effect of growth prior to and after birth, Simmental breeding resulted in the heaviest weaning weights, followed in descending order by Angus, Pinzgauer and Red Poll breeding.

Although half of the heifers in each breed group was assigned to a dry lot and half to a pasture group for the feeding period after weaning, both the dry lot and pasture groups received a ration of corn silage, barley and protein-mineral supplement which was varied to hold the average gains of both groups about the same. For this reason, the growth records of the two treatment groups were combined to obtain the breed group averages for postweaning gains and weights shown in table 2.

The postweaning daily gains per head (table 2) for the groups of Simmental and Pinzgauer breeding averaged 0.07 lb. higher than the 1.42 lb. per day for each of the other two groups. Simmental breeding was associated with the heaviest average weight at 365 days of age, followed in descending order by Pinzgauer, Angus and Red Poll.

Steers:

The growth records of the male calves by breed group are shown in table 3. These are records on male calves with 50% Angus, Red Poll, Pinzgauer and Simmental breeding, respectively. The calves were castrated at the end of the calving season. Rankings of the steers by breed groups on birth weight and adjusted weaning weight (table 3) were essentially the same as the rankings of the heifers by breed groups (table 2). Ranking of the steers on rate of gain deviated from the ranking of heifers only in that steers of Pinzgauer breeding gained 0.11 lb. per day more than steers of Red Poll breeding. Heifers of these two groups gained approximately the same prior to weaning.

After weaning, the steer calves were placed in individual feeding pens and are being fed for slaughter on a test that is yet incomplete. The ration consists of corn silage (74.4%), dry rolled barley (20.0%) and a protein-mineral supplement (5.6%). A period of 20 days was allowed for adjustment of the steers to the ration and individual feeding conditions prior to the beginning of the feedlot test. Records through the first 140 days of the feedlot test still in progress are shown in table 4.

On the average, steers of all breed groups gained in weight during the adjustment period. All groups averaged in a range of 15 to 21 lb., except the Red Poll group with a 5 lb. average. Rate of gain during the 140-day test period averaged highest for the group of Simmental breeding, intermediate and essentially alike for the groups of Pinzgauer and Red Poll breeding and somewhat lower for the group of Angus breeding. Average weights of steers by breed group at 350 days of age and heifers by breed group at 365 days of age ranked in the same order. The feed consumed per unit of gain was slightly higher for steers in the Angus group than for the steers in the other three groups.

It would be premature to conclude that the records on the F_1 animals studied to date are adequate in number to characterize breed groups or biological types over the growth periods covered in this report. Additional data is needed for this, and records to date offer, at best, only indirect indications of how the heifers observed at present can be characterized by type as they mature and are used as breeding animals. The limited data available do, however, offer suggestions of variation that make the prospects for characterization of biological type encouraging with increased animal numbers.

Phase 2 Plan--Miles City

Heifers produced in Phase 1 will be exposed as yearlings, in a multiple sire herd, to 8-10 Shorthorn bulls (table 5) for a 45-day breeding season. These females will be bred during at least four subsequent years to bulls of one or more terminal sire breeds. The Shorthorn bulls and bulls of the terminal breeds will be replaced each year.

Records obtained on F_1 females used for breeding will include: prebreeding, postbreeding, fall and precalving weights and condition scores (May, August, October and February); prebreeding pelvic measurements on yearling heifers; postbreeding and October pregnancy status; and periodic milk production measurements until the calves are weaned. Records to be obtained to weaning age on the calves produced will be as previously described for the F_1 calves in Phase 1.

Heifer and steer progeny of the Shorthorn bulls and heifer progeny of the terminal cross bulls will be available for other studies after weaning. Steer progeny of the terminal sires will be individually fed under the procedure described for F_1 steers.

The F_1 females representing the different biological types will be culled from the breeding herd if they fail to conceive in two consecutive years or if they show unsoundness that would seriously affect future performance. Examples of serious unsoundnesses are stifle, genital abnormalities, prolapse and cancerous eye. Cows of the different biological types will be evaluated on their ability to survive culling and on their calf production records during their first five calving seasons (cows calving at two through six years of age). Additional calf crops will be produced if experimental results show that more production records will contribute useful information.

TABLE 1. ANNUAL MATING SCHEME. PHASE 1.

Sire Breed[a]	Breed of cow. No. of matings.[b] H	H	H	H
Angus (A)	70			
Red Poll (R)		70		
Pinzgauer (P)			70	
Simmental (S)				70

[a]Semen from ten sires per breed to be used annually and changed annually as semen availability permits. As far as possible, these will be sires used simultaneously or earlier in the mating scheme at USMARC

[b]H = Hereford.

TABLE 2. GROWTH RECORDS FOR F_1 HEIFERS. PHASE 1.

Breed Group[a]	Hd.	Birth wt.	ADG birth-wean.	190-da. wean. wt.[b]	ADG 190-365-da.	365-da. wt.[c]
	No.	lb	lb	lb	lb	lb
AH	18	76	1.74	407	1.42	656
RH	19	84	1.65	397	1.42	646
PH	15	91	1.63	401	1.49	662
SH	16	91	1.73	420	1.49	681

[a]A = Angus, R = Red Poll, P = Pinzgauer, S = Simmental, H = Hereford.

[b]Adjusted for age and age of dam.

[c]Adjusted 190-day weight plus postweaning gain.

TABLE 3. GROWTH TO WEANING, F_1 STEERS. PHASE 1.

Birth Group[a]	Hd.	Birth wt.	ADG birth to Wean.	190-da. wean. wt.[b]
	No.	lb	lb	lb
AH	21	81	1.72	408
RH	13	89	1.46	366
PH	19	96	1.57	394
SH	18	94	1.69	415

[a]A = Angus, R = Red Poll, P = Pinzgauer, S = Simmental, H = Hereford.

[b]Adjusted for age and age of dam.

TABLE 4. POSTWEANING GROWTH, F_1 STEERS. PHASE 1.

Breed Group[a]	Hd.	Total 20-da. gain[b]	140-day feedlot test ADG	350-da. wt.[c]	DM/lb gain
	No.	lb	lb	lb	lb
AH	21	16	2.44	766	6.77
RH	13	5	2.52	724	6.08
PH	19	21	2.54	771	6.23
SH	18	15	2.60	794	6.23

[a]A = Angus, R = Red Poll, P = Pinzgauer, S = Simmental, H = Hereford.

[b]Adjustment period prior to feedlot test.

[c]190-day wean. wt. plus total 20-day and 140-day gains.

TABLE 5. ANNUAL MATING SCHEME. YEARLING HEIFERS. PHASE 2.

Sire Breed[a]	Breed of cow.[b] No. of matings.[c] AH	RH	PH	SH
Shorthorn	21	21	21	21

[a]Shorthorn sires will be obtained from different sources each year. Heifers will be bred each year in a multiple sire herd (6-10 sires).

[b]A = Angus, R = Red Poll, P = Pinzgauer, S = Simmental, H = Hereford.

[c]Estimated minimum numbers of F_1 heifers per year.

SUPPLEMENTING MONTANA BARLEY FOR GROWING-FINISHING PIGS

by

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Introduction:

Barley is the major feed grain fed to swine in Montana as well as in several other western states and western Canada. Concepts of ration formulation for swine in North America are based on the nutrient composition of corn. However, barley differs greatly from corn in several nutrients that are important in planning swine rations. A comparison of the two grains illustrates the differences in total protein, amino acids, metabolizable energy and mineral content (table 1). It is important that these differences be accounted for in planning a swine feeding program in order to take advantage of the strong points of barley and compensate or understand its comparative deficiencies.

The average barley contains 21.5% more total protein, 126.1% more lysine and 81.8% more methionine than the average corn. Lysine and methionine are generally the most deficient of all amino acids in cereal protein in relation to animal requirements. Cystine can replace approximately 50% of the methionine requirement of the growing pig therefore it is considered when calculating the methionine level in a feedstuff.

Swine rations are generally planned using average values since barleys of several origins are usually purchased and stored in bulk. This can have serious consequences if the barley actually incorporated into a ration is lower in total protein than the average. If the barley is higher in total protein than the average, there will be little effect nutritionally. The most efficient and economical ration is one balanced for the essential amino acids as well as total protein. Generally, one need consider only lysine and methionone + cystine in a ration based on barley and soybean meal. This is because the remaining essential amino acids and nitrogen for synthesis of non-essential amino acids are supplied when the total protein, lysine and methionine + cystine requirements are satisfied.

Protein level in barley is more variable than in any other ceral grain. Ranges of 10 to 20% crude protein are not uncommon in barleys with variety and environment being major controlling factors. Available soil nitrogen will affect protein storage in barley as will available soil moisture. Environmental conditions such as temperature, date of planting, other essential nutrients in soil, etc., will possibly alter protein storage also. Although total protein in barley is increased by nitrogen fertilization, the amino acid composition is not uniformly increased. This is because barley protein is composed of four major fractions, albumin, globulin, glutelin and hordein, that differ markedly in amino acid content. The albumens and globulins are rich in the essential amino acid lysine whereas glutelins are intermediate and the hordeins are quite low in this amino acid. Hordein is the major storage

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protein and is the fraction most increased by nitrogen fertilization. Therefore, protein quality as reflected by amino acid composition is not improved in a linear fashion with an increase in total protein. Low-protein barleys generally have higher quality protein than high-protein barleys. There are exceptions to this, as certain varieties do not follow this pattern, however, none of these are commercially produced at this time.

Barley also contains more calcium and phosphorus but has less available energy than corn due to more fiber and less oil. Although there is twice as much calcium in barley as in corn, it is of little importance since the total amount is relatively small compared to animal requirements and calcium supplements are inexpensive. Phosphorus, which is in good supply in barley, is an important element in animal nutrition and is one of the more expensive ration ingredients. However, a major portion of the phosphorus in barley is incorporated in an organic ring structure called phytic acid that cannot be broken by digestive enzymes in the pig. Therefore, it is normal to consider only one-half or less of the barley phosphorus in planning a ration for swine. Phosphorus does not vary in barley as much as protein but less is known about the differences in barley phosphorus content due to variety, fertilization or other environmental factors. General observations would indicate that varietial differences in total phosphorus do exist and differences may be positively correlated with protein level.

For the past five years our research efforts in swine nutrition at the U.S. Range Livestock Experiment Station have been concerned with greater utilization of the protein and phosphorus in barley. This report will cover the major accomplishments comparing barley and corn and supplementing all barley and low-soybean barley rations with lysine and methionine.

Corn vs. barley:

Corn is the most common cereal grain fed to swine in the major pork producing areas of the United States. Corn is considered to be unsurpassed for growing and finishing pigs although it requires protein, minerals and vitamin supplements as do the other cereals. Morrison states that barley is worth 91% as much as corn in pig rations. Other authors suggest that barley must be pelleted and constitute not more than one-third of a pig ration for maximum gain and feed efficiency. It is generally felt that the reduced feeding value of barley compared to corn is due to its relatively higher crude fiber content, lower oil percentage and the apparent inability of the pig to consume enough net energy to gain at a maximum and efficient rate. This study was planned to compare corn and Montana barley for growing-finishing pig rations under practical Montana conditions.

Growing (15.6% protein) and finishing (13.6% protein) rations were prepared with either barley or corn as the basal grain (table 2). The corn growing and finishing rations required 51.1 and 104.1%, respectively, more soybean meal to equalize protein levels with the respective barley rations. Fifty pigs averaging 57.0 lbs initially were allotted equally to each of the two rations on the basis of initial weight, sex and litter. Pigs were changed to finishing rations at a pen average of 120 lbs and removed from test individually when they weighed 220 ±5 lbs. Average daily gains were computed and analyzed by least-squares analysis of variance. Feed consumption was measured and feed/gain ratios calculated for each group. Feed data were not analyzed statistically. The experiment was duplicated the following year (trial 1A) with the exception that 90 pigs were fed each ration in replicates of 45 pigs each and they weighed 54.2 lbs initially.

There were no differences in rate of gain between pigs fed corn or barley rations in trial I, however, corn fed pigs in trial IA gained 5.5% faster ($P < .01$) than those pigs on the barley rations (table 3). There was a tendency for the barley fed pigs to eat more total feed in each trial. Corn fed pigs were 5.2 and 9.1% more efficient in trials I and IA, respectively.

Differences between trials in pig response to rations may be partially explained by the differences in protein content of the barleys fed in each trial. The barley fed in trial I contained 17.2% protein (dry matter basis) and the barley used in trial IA averaged 14.1% protein. The corns in the respective trials I and IA contained 9.9 and 10.1% protein. The higher energy content of the corn rations probably accounted for the differences in feed efficiency between rations in both trials.

Lysine and methionine supplements:

The addition of lysine to barley diets containing limited supplemental protein has been reported to increase daily gains and in some instances, improve feed efficiency of pigs. A barley ration without added protein but supplemented with adequate minerals and vitamins (all-barley protein) is limiting in the amino acids lysine, methionine, isoleucine, and threonine for the growing pig according to NRC and the average amino acid composition of 12 Montana barleys. Addition of 8.8% soybean meal (44% protein) to barley (11.5% protein) makes a 14% protein mixture that provides sufficient or an excess of essential amino acids other than lysine for the growing pig. An all-barley protein ration meets or exceeds the amino acid requirements of finishing pigs except for lysine and methionine but could be low in total protein. The following experiment was conducted to study the effect of supplemental lysine or lysine + methionine in barley-soybean growing and all barley protein finishing rations on the performance of pigs fed in outside drylot and on alfalfa pasture under Montana conditions.

Four diets were prepared with 44% protein soybean meal and barley (calulated at 11.5% protein) or barley alone as follows: 1) basal control, 16% and 14% protein barley-soybean growing and finishing rations, respectively, (BC); 2) negative control 14% protein barley-soybean growing and all-barley protein finishing rations (NC); 3) negative control + L-lysine; and 4) negative control + L-lysine + DL-methionine. The amino acids were added to equal the respective levels in the BC diets (table 4). Each ration was fed crossbred weanling pigs at two locations, drylot and alfalfa pasture. Pigs weighed an average 52.0 lbs initially, were changed to finishing rations at an average 125.0 lbs and removed individually at 218.0±5 lbs. Average daily gains were analyzed in a 4 x 2 factorial arrangement by least-squares analysis of variance and adjusted for the regression on initial weight by covariance. Feed consumption and efficiency were measured but not analyzed statistically as pigs were group fed by treatment. The trial was repeated (trial IIA) except that pigs were started on test at 67.7 lbs and there were 60 pigs per ration in drylot and 50 pigs per ration on alfalfa pasture.

Pigs grazing alfalfa pasture gained faster ($P<.01$) in each trial compared to pigs fed in drylot (table 5). No major differences in feed consumption due to location were noted and pigs on alfalfa were more efficient. There was a significant interaction ($P<.01$) between diet and location for rate of gain in both trials, thus the results are discussed by location.

Pigs fed the BC ration in drylot gained faster ($P<.05$) than pigs fed the other three rations in both trials (table 6). There was no difference in rate of gain between pigs fed rations supplemented with lysine or lysine + methionine in either trial and pigs fed amino acid supplemented rations gained faster ($P<.05$) than those fed the NC ration. Pigs tended to consume equal amounts of each diet in trial II and more of the BC ration in trial IIA. Pigs fed the rations supplemented with both amino acids were equally efficient in trial II and more efficient in trial IIA than pigs fed the BC ration. Pigs fed the rations supplemented with only lysine were more efficient than the NC pigs but were less efficeint than those fed BC or the NC diet supplemented with lysine and methionine in both trials.

No significant differences in rats of gain due to ration were observed in trial II in pigs fed on alfalfa pasture (table 7). However, in trial IIA pigs fed the ration supplemented with lysine and methionine gained faster ($P<.05$) than those fed either the BC or NC rations, although the gain was no faster than pigs fed the ration supplemented with lysine alone. The latter pigs (trial IIA) gained faster ($P<.05$) than the NC pigs but their gains were not statistically different from those made by pigs on the BC ration. The NC ration (trial IIA) produced slower ($P<.05$) gains than the other three diets. Feed efficiency favored the BC and NC rations in trial II, although there appeared to be no differences in feed efficiency in trail IIA due to ration.

Summary:

Barley rations were worth 90 to 95% of comparable corn rations on the basis of feed efficiency. Barley rations required 51.1 and 104.1% less soybean meal than corn for equivalent protein levels. It appeared that alfalfa pasture provided certain missing and possibly unknown nutrients for pigs fed barley based rations. The addition of lysine and methionine to low-soybean meal barley growing and all-barley finishing rations improved rate of gain and feed efficiency. The greatest effect was noted in pigs fed in drylot and less definite effects were noted in pigs on full feed and grazing alfalfa pasture.

TABLE 1. SELECTED NUTRIENT COMPOSITION OF BARLEY AND CORN, DRY MATTER BASIS[a]

	Barley (4-00-549)[b]	Corn (4-02-861)[b]	% Difference
Protein, %	13.0	10.7	21.5
Lysine, %	.52	.23	126.1
Methionine, %	.20	.11	81.8
Cystine, %	.21	.11	90.9
Tryptophan, %	.18	.11	63.6
Threonine, %	.40	.34	17.7
Fat, %	1.9	3.6	47.2
Fiber, %	6.0	2.3	160.9
Metabolizable energy			
Calories/lb	1485	1753	15.3
Calcium	.08	.03	166.7
Phosphorus[c]	.45	.31	45.2

[a] Atlas of Nutritional Data on United States and Canadian Feeds, National Academy of Sciences, Washington, D. C., 1971.
[b] International reference number.
[c] Total phosphorus; 30 to 50% of total phosphorus is available to the pig.

TABLE 2. BARLEY AND CORN RATIONS FED IN TRIAL I

Ration	Barley Growing	Barley Finishing	Corn Growing	Corn Finishing
Ingredients, %:				
Barley	82.46	89.78	--	--
Corn	--	--	75.36	82.18
Soybean meal (44%)	13.90	7.30	21.00	14.90
Sodium phosphate	1.00	0.70	1.00	0.70
Limestone	1.70	1.45	1.70	1.45
Salt	0.50	0.50	0.50	0.50
Premix[a]	0.40	0.25	0.40	0.25
Antibiotic[b]	0.04	0.02	0.04	0.02

[a] Contained the following per one (1) lb: 500, 000 IU vitamin A, 100, 000 IU of vitamin D, 1,000 IU of vitamin E, 45 mg vitamin K, 4 mg vitamin B_{12}, 700 mg riboflavin, 4, 000 mg niacin, 2,000 mg d-pantothenic acid, 100, 000 mg choline, 13.6 g zinc, 6.8 g iron, 3.75 g manganese, 0.75 g copper, 68 mg cobalt and 102 mg iodine.
[b] Contained 50 g oxytetracycline per lb.

TABLE 3. COMPARISON OF CORN AND BARLEY - TRIAL I

Ration	Trial I		Trial IA	
	Corn	Barley	Corn	Barley
No. of pigs	50	50	90	89[a]
Avg. initial wt, lbs	58.0	56.0	54.0	54.4
Avg. final wt, lbs	219.8	218.9	221.4	220.5
Avg. daily gain, lbs	1.72[b]	1.71[b]	1.92[b]	1.82[c]
Avg. daily feed, lbs	5.96	6.22	6.47	6.69
Avg. feed/gain ratio	3.46	3.64	3.40	3.71

[a] One pig died in this group.
[bc]Means in the same line within trial with different superscript letters are significantly different $P<.01$.

TABLE 4. BARLEY RATIONS SUPPLEMENTED WITH AND WITHOUT SOYBEAN MEAL, L-LYSINE AND L-LYSINE + DL-METHIONINE FED IN TRIAL II

Ration[a]	Basal Control		Negative Control		Negative Control+Ly		Negative Control+Ly&MET	
	G	F	G	F	G	F	G	F
Ingredients, %:								
Barley	82.06	88.93	88.16	97.48	87.96	97.25	87.86	97.16
Soybean meal (44%)	15.00	8.60	8.80	--	8.85	--	8.90	--
Limestone	0.50	0.60	0.50	0.55	0.50	0.55	0.50	0.55
Rock phosphate	1.50	1.10	1.60	1.20	1.60	1.20	1.60	1.20
Salt	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
L-lysine[b]	--	--	--	--	0.15	0.23	0.15	0.23
DL-methionine[b]	--	--	--	--	--	--	0.05	0.07
Premix[c]	0.40	0.25	0.40	0.25	0.40	0.25	0.40	0.25
Antibiotic[d]	0.04	0.02	0.04	0.02	0.04	0.02	0.04	0.02

[a] G=growing ration and F=finishing ration; Ly-lysine and Ly&MET=lysine and methionine.
[b] 99% pure L-lysine and Dl-methionine.
[c] See footnote b, table 2.
[d] Contained 50 g oxytetracycline per lb.

TABLE 5. PERFORMANCE OF PIGS FED IN DRYLOT OR ON ALFALFA PASTURE IN TRIAL II

	Trial II		Trial IIA	
Location	Alfalfa pasture	Drylot	Alfalfa pasture	Drylot
No. of pigs	188	160	200	240
Avg. initial wt, lbs	51.1	52.9	66.9	68.5
Avg. final wt, lbs	215.4	218.2	219.7	216.0
Avg. daily gain, lbs	1.63[a]	1.52[b]	1.72[a]	1.59[b]
Avg. daily feed, lbs	6.02	6.00	6.13	6.26
Avg. feed/gain ratio	3.69	4.07	3.54	3.98

[ab] Means in the same line within trial with different superscript letters are significantly different P<.01.

TABLE 6. PERFORMANCE OF PIGS FED SOYBEAN MEAL AND AMINO ACID SUPPLEMENTS IN DRYLOT IN TRIAL II

	Trial II				Trial IIA			
Ration	Basal Control	Negative Control	Negative Control+Ly	Negative Control+Ly&MET	Basal Control	Negative Control	Netative Control+Ly	Negative Control+Ly&MET
No. of pigs	40	40	40	40	60	60	60	60
Avg. initial wt, lbs	53.6	52.9	52.1	53.1	68.5	67.5	68.7	69.2
Avg. final wt, lbs	218.7	218.5	218.2	217.2	220.6	212.1	215.6	215.8
Avg. daily gain, lbs	1.68^{a}	1.32^{c}	1.54^{b}	1.59^{b}	1.72^{a}	1.41^{c}	1.61^{b}	1.61^{b}
Avg. daily feed, lbs	6.04	5.93	6.02	6.02	6.68	6.22	6.31	5.93
Avg. feed/gain ratio	3.82	4.63	4.02	3.84	3.84	4.50	3.93	3.66

[abc]Means in the same line within trial with different superscript letters are significantly different P<.05.

TABLE 7. PERFORMANCE OF PIGS FED SOYBEAN MEAL AND AMINO ACID SUPPLEMENTS ON AN ALFALFA PASTURE IN TRIAL II

	Trial II				Trial IIA			
Ration	Basal Control	Negative Control	Negative Control+Ly	Negative Control+LY&MET	Basal Control	Negative Control	Negative Control+LY	Negative Control+Ly&MET
No. of pigs	47	47	47	47	50	50	50	50
Avg. initial wt, lbs	49.7	52.1	51.8	50.9	67.6	66.5	66.5	66.9
Avg. final wt, lbs	214.8	210.4	217.4	218.9	222.0	219.4	219.0	218.3
Avg. daily gain, lbs	1.61^{a}	1.61^{a}	1.68^{a}	1.65^{a}	1.72^{b}	1.63^{c}	1.76^{ab}	1.81^{a}
Avg. daily feed, lbs	5.75	5.70	6.11	6.46	6.19	5.82	6.19	6.28
Avg. feed/gain ratio	3.58	3.59	3.69	3.90	3.54	3.56	3.54	3.52

[abc]Means in the same line within trial with different superscript letters are significantly different P<.05.

MANAGEMENT PRACTICES FOR INCREASING RANGE FORAGE PRODUCTION

by
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Introduction:

Availability of range forage is a controlling factor in livestock production. The efficiency with which grazing animals utilize forage has been greatly enhanced through improvements in the grazing animal in terms of higher conversion (forage to meat) and reproduction efficiencies and improvements in animal health and survival. However, with the exception of possible breakthroughs in multiple birth research, animal performance in terms of genetic and physiological potentials is approaching a ceiling and further improvements are going to be relatively small. For example, a weaned calf crop of 100% is the maximum that can be expected without multiple births and this is only 5 to 15% higher than can be expected with current technology. In contrast, forage production increases of 100% or more are possible on many range sites in the northern Great Plains. Also, to take advantage of genetic and physiological improvements in livestock performance, the forage base needs to be increased with improvements in quality and seasonal distributing of forage supplies.

There are several management practices available to livestock producers for increasing range forage supplies. The oldest and most basic is proper grazing management. While proper grazing management is essential for the protection and optimum use of the range resource and is fundamental in any grazing system, it does not provide the magnitude of increases associated with management practices such as range fertilization and seeded pastures. Livestock management is more important in terms of animal performance and the protection of the range resource, both vegetation and soils, than for total pounds of beef produced. Increasing the number of animals in a moderately-stocked pasture often increases total pounds of beef, but at a cost of decreased gain per animal and also deterioration of the range.

The purpose of this paper is to discuss three management practices that when used singly or in combination have the potential of increasing forage production 100% or more. The three management practices--land surface modification, fertilization, and seeded native and introduced pastures--are intensive management practices and provide maximum benefits when used for complementary forage systems.

Land Surface Modifications:

Land surface modifications are primarily water conservation treatments that include such practices as bench terracing, contour furrowing, and pitting. In our semiarid climate, water is the overall controlling factor in plant growth. Thus, any treatment that increases the amount of water available for plant use is likely to increase forage production. Surface modification treatments increase soil water supplies by reducing runoff through impoundment or retention of rainfall and snowmelt. These treatments may also increase soil water supplies by trapping additional snow during the winter months. In addition to conserving water, land surface modification treatments also temporarily increase soil fertility as the disturbed soil and sod weather and decompose and may beneficially alter the species composition as the disturbed areas are reinvaded by desirable forage species.

There are several land surface modification treatments that have been successful in the northern Great Plains. Level bench terracing is probably the most severe and expensive. Level benches are best described as long flat terraces, diked at both ends to provide storage for water, most of which comes from trapped snow. Bench widths can vary from as little as 10 feet to as much as 100 feet with narrow benches being required on the steeper slopes. McMartin, Haas, and Willis (1970) at Mandan estimated construction costs of $25.00 and $40.00 per acre for bench widths of 14 and 70 feet, respectively, on 1% slopes, to $77.00 and $353.00 per acre for the same width benches on a 10% slope. Topsoil removal in bench construction is a major problem, and in some cases, stockpiling and redistributing topsoil is necessary to obtain satisfactory levels of production. In nearly all cases, fertilization is necessary in order to effectively utilize the increased supply of water. Level bench terraces are especially effective for producing high quality hay and yield increases of 1- to 2-ton forage per acre are common. To date, however, level bench terracing has not been widely used by ranchers and farmers as a management practice for increasing forage.

Contour furrowing is a land surface modification treatment that has been used extensively by the Bureau of Land Management as a water conservation and erosion control treatment on fine-textured range sites. It has required specialized equipment for treatment application and has not been utilized extensively by ranchers and farmers. The most commonly used contour furrower (the Arcadia Model B) constructs furrows at 5-foot intervals which are 20 inches wide and 6 to 10 inches deep. Interfurrow dams are constructed every 15 to 50 feet from loose, unconsolidated soil materials scraped from the bottom of the furrows. Breakdown and erosion of these interfurrow dams results in the inability of furrows to hold water and has greatly reduced the effective life of contour furrowing treatments. A recent innovation by Mr. Frank Sparks of Plevna, Montana, appears to effectively overcome this problem. In his furrower design, furrows are constructed by large lister shovels consisting of two moldboard plows butted together and interfurrow dams can be constructed by raising the shovel out of the ground at desired intervals leaving 2 to 3 feet of undisturbed sod as the interfurrow dam. This furrower creates a flat-bottom furrow of widths up to 30 inches and depths of 2 to 5 inches. These shallow furrows leave more topsoil in place and create a better seedbed for seeding or reinvasion of desirable species than the Arcadia Model B type furrows. Also, a furrower of this type can be constructed locally for minimal costs and can be pulled by a much smaller tractor than the D-7 or D-8 required by the Arcadia Model B. With this type implement, contour furrowing becomes much more available for use by farmers and ranchers than with the Arcadia Model B furrower.

Results from contour furrowing have varied with yield increases of 100% or more being common. Best results have been obtained when furrows are seeded to introduced species such as crested wheatgrass and when fertilized with nitrogen (N) (Table 1). However, on many fine-textured range sites where contour furrowing has been applied, yield increases of 100% or more still only amount to a few hundred pounds per acre because of the inherent low productivity of these sites.

Range pitting is another land surface modification treatment designed primarily to conserve water by reducing runoff. Simplicity of equipment and ease and low cost of application have made range pitting a popular practice. The conventional pitting implement is a one-way disc modified either by re-drilling and mounting on eccentric centers or by cutting away a part of the disc and leaving the original mounting position on the shaft. Such an implement will typically form pits that are approximately 30 inches in length, up to 8 inches wide, and about 4 inches deep. In eastern Montana, pitting has been most successsful on clubmoss-infested sites where the pitting treatment improves species composition by decreasing clubmoss. On clayey sites, pits tend to be short-lived because they rapidly refill with sediment. On normal upland range sites with good infiltration and low runoff, they have only limited value as a water conservation treatment. On sites where pitting is effective, yield increases of 50 to 100% are common.

Range Fertilization:

Results of considerable research in the past two decades indicate that nutrient deficiency, primarily N is a major plant growth limiting factor on northern Great Plains rangelands. Thus, to obtain maximum forage production within this climate, the soil has to be enriched by fertilization or by use of plants such as legumes that have the ability to fix N from atmospheric sources. Range fertilization has not been extensively used as a management practice because of two important questions that have not been adequately answered. The first question is economic: Does it pay to fertilize? The second question is more of an ecological nature: What are the long-term effects of fertilization on the species composition and total range resource? There is now enough research results available to begin to satisfactorily answer these questions.

In regard to the economic question, research can discover the type and degree of responses to fertilization treatments, but fertilizer costs and product values are determined in the market place. A summary of range fertilization research in the northern Great Plains indicates that when N is applied at rates of 30 to 50 lb/acre annually or in annual rate equivalents, the expected returns will be about 20 lb of dry matter per lb N applied or, under a grazing situation, about 1 lb beef/lb N applied (Wight, 1976). Thus, when the price of beef exceeds the cost of applying fertilizer, fertilization becomes an economic management practice. Over a 6-year period, a mixed prairie range near Sidney, Montana, produced average annual forage yields of 914, 1308, and 1934 lb/acre on plots treated with a single application of 0, 100, 300 lb N/acre. Table 2 shows some preliminary results obtained on a Burlington Northern Inc. range north of Miles City fertilized with N and phosphorus (P).

In regard to the ecological question, our research results to date do not indicate that range fertilization is a hazard to the species composition or range resource when N is applied at rates of less than 300 lb N/acre. In most cases, fertilization has not increased weed species in a greater proportion than desirable species. When fertilizer material is present in the soil in the spring, those species that begin to grow earliest will derive the most benefit. Western wheatgrass, a cool-season species, is perhaps the most responsive to N fertilization. It begins growth early in the spring; it is rhizomatous; and it can rapidly increase its number of culms or shoots. The weedy annual brome-grasses such as cheatgrass and Japanese bromegrass also start growth very early in the spring, having begun establishment in the fall, and respond vigorously to N fertilization.

Perhaps the biggest unanswered portion of this question is what are the long-term effects on species composition under grazing situations. The answer to this is currently being sought in experiments being conducted at the Miles City Range Livestock Experiment Station. Preliminary results indicate that under proper grazing management and timing, range fertilization is not a hazard to the range resource. There are, however, some constraints when utilizing range fertilization. It is generally necessary to fertilize and manage on complete pasture units; otherwise the fertilized portion of a pasture will be completely overgrazed while the nonfertilized portion may be almost completely neglected. Such a situation can rapidly destroy vegetation on the fertilized portion of a pasture. There are, however, situations in which N fertilization can be used to induce cattle to eat unpalatable species such as porcupine grass and little bluestem and, in this case, fertilization is useful as a management tool to improve livestock distribution and forage utilization.

A few other comments are appropriate concerning range fertilization. Associated with increases in forage yields are also increases in palatability and protein content. To date, P is the only fertilizer element other than N found to be deficient. Yield response to P has occurred mainly at high rates of N fertilization or after a few years of continuous N fertilization. Research results also indicate that nitrate toxicity is not a problem when N is applied at reasonable rates. To date, there is no evidence of nitrates being leached through the profile to contaminate ground water supplies or being washed off the range in runoff to contaminate surface water supplies.

Seeded Pastures:

Seeded pastures, particularly crested wheatgrass, have been used extensively in the northern Great Plains both as a means of protecting abandoned cropland and as a means of supplying forage for livestock. Several forage species are well adapted to soil and climatic conditions of the northern Great Plains, and when properly managed, will out-produce native range 2- to 3-fold (Table 3). Crested wheatgrass is by far the most commonly seeded species and currently occupies thousands of acres in eastern Montana on sites that were seeded in the 1930's and 1940's. Crested wheatgrass is a cool-season grass that is palatable and nutritious in the early spring but loses palatability rapidly as it matures. It is excellent for early spring grazing and has been harvested extensively for hay. It has also been very productive when seeded in a mixture with alfalfa. Other wheatgrasses including tall wheatgrass, intermediate wheatgrass, pubescent wheatgrass, thickspike wheatgrass, and slender wheatgrass have also been used with varying degrees of success. Each has characteristics useful for specific situations and conditions. Russian wildrye is a very competitive cool-season grass that is palatable both in spring and fall. In the past, establishment difficulty has reduced the popularity of this species. Regar bromegrass and Altai wildrye are two recently developed grass species that show promise for use on converted range.

There are several varieties of alfalfa that appear to be well adapted to dryland conditions. Alfalfas are palatable; nutritious; have a deep-rooting system which effectively utilizes soil water; and as legumes, they are able to fix atmospheric nitrogen. This feature makes them especially valuable on rangelands which are nearly all N deficient. Alfalfas have been grown successfully in combination with grasses like crested wheatgrass and Russian wildrye. There is always the question of bloat associated with alfalfas, but this appears to be primarily a problem of management and has not prevented the use of alfalfa pastures by many livestock producers. Development of low bloat-hazard varieties and bloat-tolerant animals is a problem for future research. Two other legumes, cicer milkvetch and sainfoin, are currently being evaluated as sources of forage on dryland sites. Both species have not been found to cause bloat but, as yet, have not shown the ease of establishment or the longevity of the dryland alfalfa varieties. Drylander and Rambler alfalfa varieties developed in Canada appear to be particularly well adapted to eastern Montana rangelands.

Combination Treatments:

Recent research conducted at the Sidney, Montana, USDA-ARS Research Station indicated that the benefits from fertilization and use of seeded species are greatly enhanced when used in combination with water-conserving land surface modification treatments. This has been especially true on low productive, fine-textured range sites (Table 1). Fertilization is generally more efficient and economical on seeded species than on native range (Table 3). Using data from Lorenz and Rogler (1971), nitrogen-use efficiencies (lb beef produced/lb N applied) of 1.0, 1.7, and 2.2 were calculated for native, crested wheatgrass, and Russian wildrye, respectively, fertilized annually with 40 lb N/acre.

Integration of Complementary Forage Systems:

Land surface modification, fertilization, and seeded pastures are intensive management practices that are applicable to only a small portion of native rangelands. These management practices can best be used to develop forage supplies to complement native range or used for special purposes such as flushing or breeding pastures. Effective use of these managment practices on small portions of a ranching unit can increase the productivity not only of the land area to which they are applied but to the overall ranching unit. The data presented in Table 4 shows some of the combinations in which these management practices can be utilized to enhance carrying capacity of a ranch unit. This data is based on actual research results and is discussed by Lorenz (1976) as follows:

> "Example A, shown in Table 4, assumes that 320 acres of land are available. If it is all native range, 6.5 acres will carry a yearling steer for 140 days. Thus, 49 head could be run on 320 acres (Case 1). If 62 of the 320 acres are crested wheatgrass (or Russian wildrye or a smooth brome-crested wheatgrass mixture or other grasses), it will carry a yearling on slightly less than an acre/head for 40 days in the spring. By deferring the native range for the 40-day period in the spring, carrying capacity of the native range is increased to

4.0 acres/head for the next 100 days. Therefore, the 320 acres will now carry 65 yearlings for the 140-day season (Case 2). If N fertilizer is used on the crested wheatgrass, only 0.62 acres is needed to carry a yearling for 40 days. Therefore, less crested wheatgrass is needed, and the additional acres of native range will allow grazing 69 head on the 320 acres (Case 3). By using fertilized crested in the spring, and fertilized Russian wildrye in the fall, the grazing season can be extended to 170 days rather than 140; the native can be grazed at a heavier intensity because of the short time cattle are on it, and the 320 acres will now carry 91 head (Case 4). A final step would be to fertilize the native, too. This would provide grazing for 104 head on 320 acres, at an average intensity of 3.1 acres/head for 170 days (Case 5) compared with 6.5 acres/head for 140 days in Case 1. There are some management problems to be solved, particularly in Case 5, but this example does emphasize the potential for increased production on a given acreage."

Thus, in evaluating management practices, it is necessary to look beyond the benefits obtained only on the areas treated and consider them in terms of how they affect the total ranching operation. Little research has been done toward developing and integrating complementary management systems and such is the goal of some of the range research programs currently underway at Mandan, Sidney, and Miles City Agricultural Research Service Centers.

Summary:

Land surface modification treatments, fertilization, and seeded pastures are effective tools for increasing forage production on rangelands in the northern Great Plains. They are especially effective when used in combinations and when used as complementary forage systems integrated into a ranching operation. These management practices do not replace the need of good livestock management practices, but used effectively, they can relieve the grazing pressure on large acreages of native range on which livestock management is the only practical and effective management tool available. Application of these management practices depends on site characteristics and the treatment economics based on their total effect on the ranching operation. Annual applications of 30 to 50 lb N/acre or the equivalent in periodic applications on normal upland and similarly productive range sites can be expected to produce 1 lb beef/lb N applied. With seeded pastures, this efficiency can be increased to as much as 2 lb beef/lb N applied. There are several grasses and alfalfas that are adaptable to the environment in the northern Great Plains and will significantly out-produce native vegetation. Contour furrowing which currently appears to be the most practical of land surface modification treatments is an effective water conservation practice, particularly on the fine-textured range sites, and has consistently increased forage production 100-200% on these sites. Contour furrowing also appears to be a very effective way of enhancing the environment for the establishment and growth of high-producing species such as alfalfa and Russian wildrye.

Table 1. Forage yield responses (lb/acre) to contour furrowing, fertilization[1], and/or seeding.

Treatment	Period of Measurement	Average Annual Yields
Saline Upland Range Site - Ekalaka		
Check	1968-1974	164
Contour furrowed	1968-1974	268
Check	1973-1975	137
100 lb N/acre	1973-1975	881
300 lb N/acre	1973-1975	1265
Furrowing + 100 lb N/acre	1973-1975	1196
Furrowing + 300 lb N/acre	1973-1975	1950
Panspot Range Site - Ekalaka		
Check	1968-1974	296
Contour furrowed	1968-1974	643
Check	1971-1975	416
100 lb N/acre	1971-1975	930
300 lb N/acre	1971-1975	1681
Furrowing + 300 lb N/acre	1971-1972	4752
Panspot - Miles City		
Check	1974-1975	503
Contour furrowed	1974-1975	1064
Furrowing + green needlegrass + western wheatgrass	1974-1975	1237
Furrowing + crested wheatgrass	1974-1975	1316
Furrowing + Russian wildrye	1974-1975	1935
Furrowing + Regar brome	1974-1975	2052
Furrowing + alfalfa	1974-1975	1241

[1]All fertilizer treatments were single applications and yield responses represent the average of the initial and residual effects.

Table 2. Response of yearling on a silty range site near Miles City, Montana treated in 1973.

Treatment	ADG[1] 1974	lb/beef/ acre 1974	ADG[1] 1975	lb beef/ acre 1975	Total lb beef/acre
lb N/acre					
0	2.28	20.1	2.70	29.6	49.7
100	2.44	44.7	2.44	53.4	98.1
200	2.67	73.3	2.34	76.0	149.3
400	2.85	104.2	2.40	78.8	183.0
Contour furrowing	--	--	2.14	50.7	--
Contour furrowing + 100	--	--	2.48	58.8	--

[1]ADG = average daily gain.

Table 3. Eight-year average carrying capacity and beef production from various treatments on Russian wildrye compared with crested wheatgrass and native mixed prairie when grazed by yearling steers (Lorenz and Rogler, 1971).

Species	Spacing	Grazing period	N	Carrying Capacity: Days grazed	Carrying Capacity: Steerday per acre	Beef Production: Daily gain	Beef Production: Beef production[1]
			(lb/acre)			(lb)	(lb/acre)
R. wildrye	Rows	Spring	0	46	104	2.07	211 b
R. wildrye	Rows	Spring	40	48	123	2.14	253 c
R. wildrye	Solid	Spring	0	49	77	2.20	160 a
R. wildrye	Solid	Spring	40	54	122	2.12	250 c
Cr. wheat	Solid	Spring	40	41	90	2.82	251 c
R. wildrye	Solid	Full season	40	143	87	1.87	163[2]
Native range		Full season	40	140	59	1.87	106[2]
Native range		Full season	0	140	25	1.83	48[2,3]

[1]Means followed by the same letter do not differ significantly at the 5% level.
[2]Not included in statistical analysis.
[3]Calculated from 6 years of data.

Table 4. Examples of methods for increasing livestock numbers on northern Great Plains grasslands, based on data from grazing investigations at the Northern Great Plains Research Center, Mandan, North Dakota (Lorenz, 1976).

Grassland combinations		Acres	Acres/ head[1]	Days grazing	Number of yearling steers	Avg. acres/ head
Example A:						
Case 1	Native	320	6.50	140	49	6.5
Case 2	Crested wheatgrass	62	0.96	40		
	Native	258	4.00	100		
	Totals	320		140	65	4.9
Case 3	Crested wheatgrass + N	43	0.62	40		
	Native	277	4.00	100		
	Totals	320		140	69	4.6
Case 4	Crested wheatgrass + N	56	0.62	40		
	Native	199	2.18	80		
	Russian wildrye + N	65	0.71	50		
	Totals	320		170	91	3.5
Case 5	Crested wheatgrass + N	64	0.62	40		
	Native + N	182	1.75	80		
	Russian wildrye + N	74	0.71	50		
	Totals	320		170	104	3.1

[1]Based on long-time averages from grazing studies at the Northern Great Plains Research Center, Mandan, N. Dak., except for the native in Case 5 in which the 1.75 acres/head was extrapolated from other production data.

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WHAT'S NEW IN RANGE NUTRITION?

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How much does a range cow eat? What are the nutrient "requirements" of a range cow? To what extent are her needs met by the range forage? How is forage intake and utilization affected by forage quality and availability and the demands placed on the cow for maintenance, growth, reproduction and lactation? These and other areas of interest are being or will be investigated as the range nutrition research program at this Station develops.

In the past, much of this type of information was evaluated on the basis of performance (e.g., weight changes, calving percentage, etc.) or gathered in confinement trials. It is becoming increasingly apparent that we need to refine our measurements to better understand what is happening with our cattle under range conditions and why it happens. With the pressing need of increasing beef production from our ranges, we can no longer be satisfied with having only the end result and wondering, in retrospect, why events occurred as they did and what we could do to alter these events to effectively and efficiently increase production.

We need to realize, however, that information that is readily obtainable using confined animals is often obtained only with difficulty and using specialized techniques when working with grazing livestock. Let's take feed quality, for example. It is relatively simple to select feedstuffs and mix a ration to specifications for a steer in a feedlot. As a check, individual ingredients, as well as the ration itself, can be sampled and sent to a laboratory for analysis. That same steer on native range, however, at any given time of the year may have access to dozens of different plant species in varying quantities. Species will differ in availabliity, palatability, nutritive value and will be constantly changing in quality during certain seasons. Even the different parts of a given plant will vary widely in the type and amounts of nutrients that will be made available to the animal.

It is known that the grazing animal can "select" a diet higher in nutritive value (e.g., higher in protein and phosphorus content) than the average of the available forage. In order to know what the animal is eating, both in terms of nutritive value and the species consumed, methods have been devised in which the grazing animal is used to collect a sample of "cattle selected forage".

We have surgically established a permanent opening (esophageal fistula) in the esophagus of each of several heifers. Most of the time these animals function normally with the fistula closed by a plug. When the plug is removed and a bag suspended from the neck below the opening, whatever the animal eats falls through the opening into the bag. The animals thus fitted are allowed to graze for 30 to 60-minute periods, and what they consume is collected in the bag. This "grazed forage" sample is then taken to the laboratory to be analyzed chemically for such components as protein and fiber. Digestibility of sample forage is determined in an artificial rumen, a laboratory simulation of the microbial digestion of feed that takes place in the rumen of the cow. The sample can also be examined microscopically to determine the identity and amounts of the different forage species that were consumed.

We are currently using these fistulated animals to sample and obtain estimates of the nutritive value of our range forages throughout the year and to better understand the contribution that the different plants make in the grazing animals' diet.

The quantity of forage a grazing animal consumes is another value that is somewhat difficult to come by. It is, however, only by knowing how much a cow eats of a feed of known quality that we can determine the actual quantity of nutrients made available to the animal for maintenance or productive purposes.

If we have an animal in confinement, it is no problem to weigh the feed given to the animal and, if necessary, weigh back any uneaten feed to determine actual feed intake. We have not, as yet, devised any comparable method for directly measuring the forage consumed by a grazing cow. We can, however, measure the fecal output and relate this to the indigestible portion of the consumed feed, thus indirectly measuring forage intake.

Although we do not currently have any intake trials underway, projects planned for the near future will include forage intake measurements to help us better understand oberved performance and reproductive phenomena in range cattle.

We are currently conducting studies to better understand the role of milk in cow-calf production. Just how important is milk to the calf as it grows and develops? What is the cost of this milk in terms of the forage necessary to produce it; or the delayed and/or reduced conception in the dam? A project is being developed to clarify the relationships between prepartum body condition, quantity and quality of forage consumed, level of milk production by the dam and postpartum interval to first estrus and conception.

Other projects underway include two large-scale grazing studies to evaluate the effects of fertilizing native range with nitrogen. Data are being collected on total forage production, changes in species composition, animal performance (reproductive performance of cows, body weight changes) and stocking rates.

We are excited about the nutrition program here and anticipate a lot of information will be forthcoming that will be of real value to the livestock producers in this area as well as in other parts of the country.