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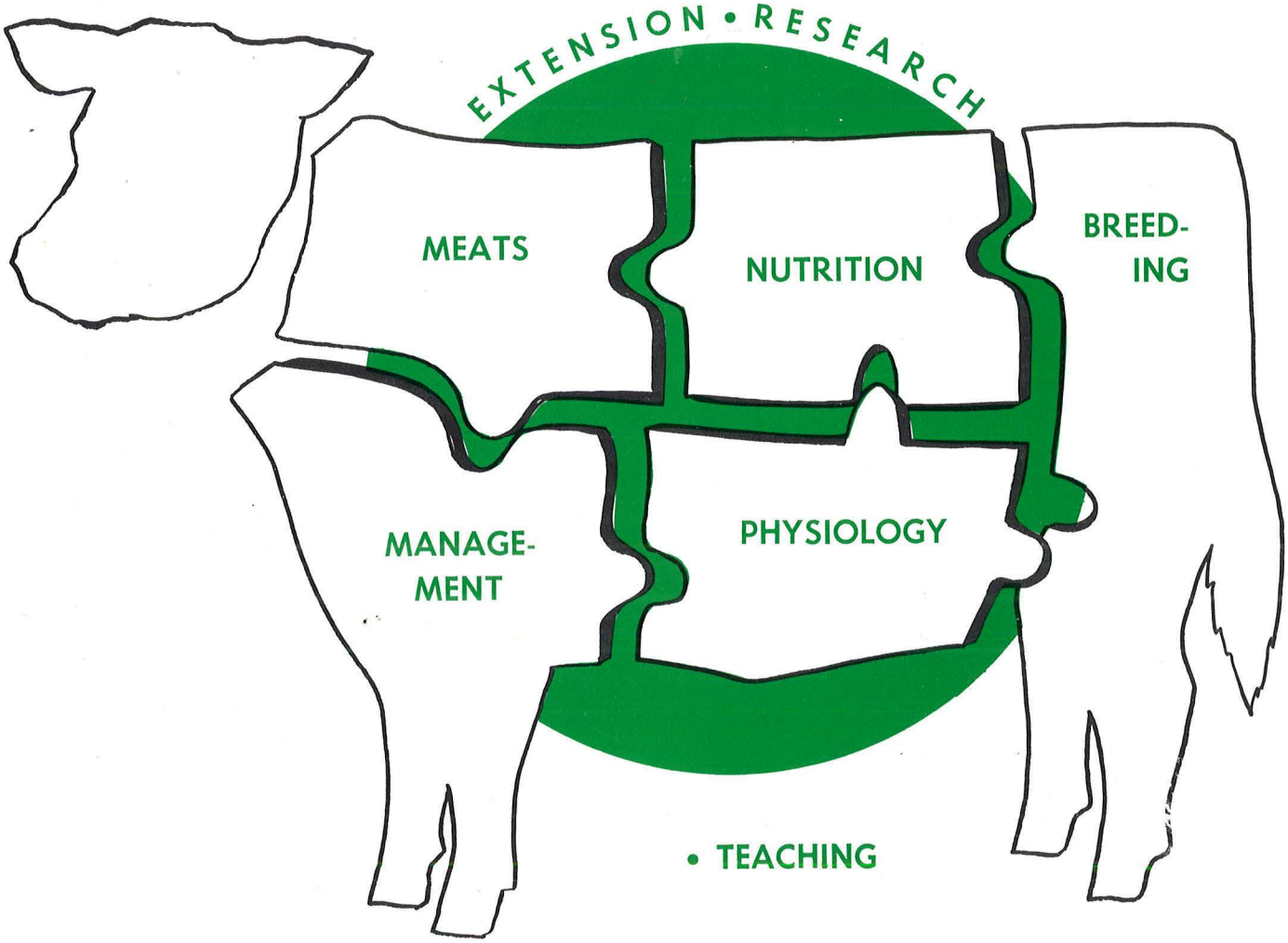

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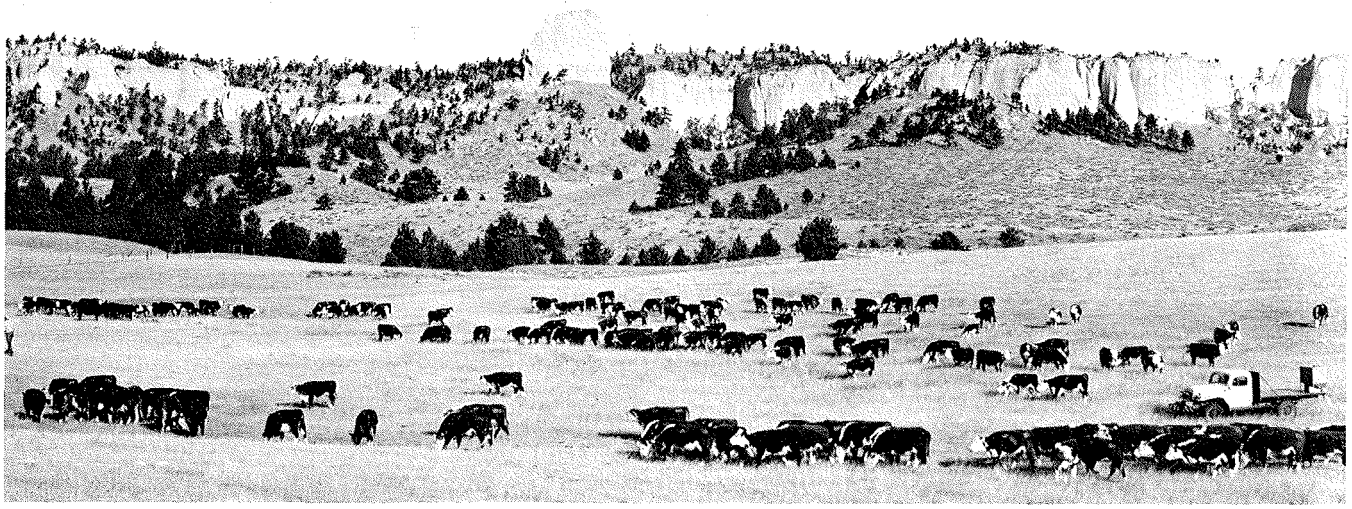

The Beef Cattle Industry in Nebraska

By Marvel L. Baker
Professor, Animal Science (Emeritus)

The beef cattle industry has developed an increasingly effective operation since its inception and especially during the past 70 years.

It has provided a market for a large and growing production of grass, roughages, feed grains and protein-rich feeds.

It has made possible the important and growing mixed-feed industry, and has provided an expanding market for the products from industry.

It has contributed markedly to the growth of the transportation industry and to that of financial institutions, provided the raw materials for the meat-packing industry and undergirded the economy of the State and Nation generally.

It carries within itself one of the most important processing industries for raw materials; in addition it harvests and transports vast quantities of these raw materials which could not be used advantageously otherwise.

More than one-half of the land included in farms and ranches within Nebraska and the United States is grazed. Beef cattle provide the most productive use presently available for much of this land.

Especially during the past 70 years the efficiency of production within the industry has improved. With a decreasing ratio of cattle numbers to population, it has provided the consumer with an increasing supply per capita of palatable, nutritious food for a decreasing proportion of his expendable income.

Nebraska's cattle industry has matched that of the Nation during the past century in its growth and efficiency. In 1868 Nebraska reported 107,000 cattle other than milk cows. These consisted largely of small herds built up along the transcontinental trails which crossed Nebraska and of oxen brought in by incoming settlers.

In 1967 the figure was 6.2 million head of beef cattle of which 2.1 million were cows. Nebraska probably produced 1.8 million calves, some of which were sold to other states, shipped in more than 1.8 million cattle and fed 3.1 million head for market.

Over the years the cattle-feeding industry has developed from a seasonal industry in which the general practice was to buy feeders in the fall and market them in the spring, into our present year-round feeding industry in which the number on feed throughout the year is relatively stable. While Nebraska's beef cattle population was increasing some 57 times its human population increased about 12 times.

Development Factors

A number of factors account for the development of Nebraska's cattle industry. It rested initially, as a frontier cattle industry traditionally has, upon the use of immediately available feed resources, largely grass and water; upon the vision and initiative of men and upon the availability of cattle in numbers.

Texas Longhorns were available because of the accumulation of cattle in the Southwest during the Civil War and the great disparity in their value there and in the North and East. The industry development depended upon these as a base plus increasing feed production, developing transportation and financing and upon an expanding market which is now the most important free-trade area in the world based as it is upon the tremendous industrial and commercial complex in this country.

The founding of the University in 1869 and its opening in 1871 assured Nebraska of the energizing influence of education upon its total economy and society. Fortunately, it was organized as a Land-Grant University.

The development of the College of Agriculture with its Agricultural Experiment Station and its Agricultural Extension Service has been accompanied by the diffusion of knowledge and learning among the rural population.

(continued on next page)

Beef Cattle Industry

(continued from page 3)

In 1868 Nebraska harvested 115,000 acres of corn yielding 28 bushels per acre. In 1967 it harvested more than 4.5 million acres with an average yield of 73 bushels. Of this the average yield on irrigated acreage was 102 bushels and on non-irrigated, 55 bushels per acre. The yield on dryland was twice that in 1868 and most of the increase has been achieved since the turn of the century. In addition, Nebraska harvested almost 3.0 million acres of grain sorghum yielding an average of 57 bushels per acre. Corn was the only important feed grain in 1868.

Besides feed grains and soybeans, Nebraska produces a vast amount of roughages. In 1967 almost 4.0 million tons of corn silage were harvested. Nebraska also produced 2.4 million tons of prairie hay and large quantities of various stovers and other rough feeds, the by-products of its crop production.

The introduction of alfalfa in 1873 and 1875 was a significant factor in the development of the cattle industry. Alfalfa and feed grains gave the cattle feeder a relatively well balanced, home-grown ration for fattening cattle.

Protein-rich supplements from oil seeds of our own production and from other areas in the United States became available. Besides these, large quantities of urea are now used to supplement our protein resources for cattle production. These feed supplies, more generally available here than in most other important commercial beef-producing countries, and the increasing knowledge of how to use them effectively have enabled the industry to increase calf production and weaning weight, to grow and market cattle at younger ages and to increase greatly beef production.

In 1868 the University of Nebraska did not exist, nor did the foundation of Nebraska's present cattle industry. The Texas Longhorns began to move into Nebraska in appreciable numbers in 1870. The Longhorn was transformed into an animal more suitable for producing beef of the quality required by consumer demand by the use of bulls, principally of the Shorthorn, Hereford and Angus breeds. They were brought into Nebraska during the "sixties," the "seventies" and the "eighties."

University Contributions

The University has contributed to development of the cattle industry in many ways. The most obvious impact has come through the College of Agriculture and most directly through the work of the Department of Animal Science.

Although the University owned some registered cattle as early as 1875, the first breeding herds of Shorthorn, Hereford and Angus were established about 1900. They served a useful purpose as demonstration herds and as a source of improved breeding stock. These herds were used as teaching material at Lincoln and at Curtis. At North Platte they provided a relatively risk-free enterprise for using a large acreage of grassland and large quantities of hay and coarse roughages when the University was not in a position to utilize these in research because of limited personnel. As the number of breeders of registered cattle increased and as manpower resources of the Animal Science Department were augmented it seemed more in the public interest to divert these resources to feeding, management and breeding research.

Research work with beef cattle began in earnest with the arrival of E. A. Burnett in 1899 and H. R. Smith in 1901. They published the results of work done from 1899 to 1912 in a series of Station Bulletins. This work, along with pioneer work begun by W. P. Snyder at North Platte in 1905 on winter rations for growing calves until they came off grass as "threes," dealt with simple rations composed largely of home-grown feeds for growing and fattening cattle. From then until recently the emphasis was upon feeding, nutrition and management. These posed the most immediate and most obvious questions. They were the questions which could be answered most quickly in broad terms. They were also the questions which the staff was best prepared to answer.

The place of alfalfa in cattle production was studied extensively. Protein-rich supplements were evaluated as they became available. The relation of age and sex to the fattening of cattle was studied at Lincoln. Extensive work with winter rations for calves headed for summer pastures as yearlings was conducted at Valentine and valuable information on the relation of different supplements and of different levels of protein in the ration to winter gains and to gains from the beginning of the wintering period until the end of the following grazing period was obtained. Some similar work was done at North Platte.

Work with rations for well-wintered calves headed for summer feed lots was conducted at Lincoln and North Platte. The effect of stage of maturity or time of cutting on the feeding value of prairie hay was done at Lincoln and the effect of time of cutting upon the vegetative composition of meadows was done in cooperation with the Department of Agronomy.

Extensive studies of the relation of different levels of wintering and different levels of feeding as yearlings in dry lot and on pasture were made at Lincoln and at North Platte.

During the "forties" and probably earlier, difficulties with rations deficient in carotene or vitamin A were encountered in fattening cattle which had been wintered in dry lot and continued on feed in dry lot the following summer. As a result of research, practical suggestions for coping with the problem were provided for the cattle feeder.

The Valentine Station made 16 lots of a total of 160 wintering calves available for extensive studies on hyperkeratosis of cattle under the direction of Dr. Olson of the Veterinary Science Department. Hyperkeratosis was attract-

ing much attention and causing grave concern as isolated outbreaks were occurring over the country and its cause had not been determined. It was feared that it might be infectious or contagious. Within a short time the Station was able to say that, with the cattle at Valentine, the disease was associated with the feed. By this time a number of Stations were studying different aspects of the problem. It was determined that the causative agent at Valentine was a component of the lubricant used in pelleting the supplemental feeds. This information was useful not only to the cattle producer but also to the feed industry.

The growing shortage of labor and the development of mechanized equipment indicated a shift from corn fodder and stover to corn silage for cattle production and the place of silage in wintering and feeding cattle was investigated. Although mineral nutrition problems are not as acute in Nebraska as in some areas there are conditions under which mineral deficiencies do affect appreciably the economy of production.

The use of a number of feed grains other than corn has been studied, some of them extensively. Wheat, rye, the grain sorghums, barley and oats have been used in growing and fattening rations. Dried beet pulp and molasses also have been evaluated in growing and fattening rations. Wheat and the grain sorghums are likely to continue to be of importance in Nebraska as cattle feeds.

The relation of winter feeding of heifers and cows to their growth and reproductive performance was studied extensively at North Platte and Valentine. With a full feed of the prairie hay used, the importance of feeding additional protein at least during the winter before the heifers dropped their first calves and in subsequent winters until they dropped their second and even third calves was demonstarted. This work should be repeated and amplified.

Information is needed upon the quantitative and qualitative nutrient requirements for reproduction and lactation for specific periods in the reproduction cycle of the cow. These studies should extend over the first two and probably three years of calf production.

Three years work creep-feeding calves was done at North Platte.

Answers Sought

Since Burnett and Smith published the results of their early work to answer immediate and pressing questions of the producer, the Department of Animal Science has continued to seek answers to producer's questions and, where possible, to anticipate them. As we do this we accumulate experience, acquire knowledge and find workable answers to today's problems. We also find that we must delve more deeply seeking answers to "how" and also to "why," to give the producer answers enabling him to cope more adequately with the complex nutritional, physiological, economic and managerial questions which beset him. Neither he nor the University can afford to forget even briefly, that the cattle industry is highly competitive with other segments of agriculture, and among the segments of the industry itself.

Fortunately the public has sensed this to some extent. We now have a greatly enlarged staff compared to that of some years ago. This is a staff composed of men with more adequate professional backgrounds, provided with increased technical support, more sophisticated equipment and better facilities for their work.

Beginning with the middle "forties," the University's breeding cattle at Lincoln and those remaining at North Platte were shifted to genetic or beef-cattle breeding improvement studies. The development of the Fort Robinson Station in cooperation with the Agricultural Research Service enabled Nebraska to play a significant role in beef-cattle breeding investigations in the North Central Region and in the United States. This work has produced an unusually high yield of useful information for the breeder and producer. The current development of the United States Meat Animal Research Center near Clay Center promises continued and accelerated progress in this and other important areas of research. This development involves the transfer of the work at Fort Robinson to Clay Center.

Much Remains

Much has been done; much remains. Some of this, possibly much of it, will require cooperation from other staffs. Beef-cattle breeding research is in its infancy. More and more attention is being given to animal physiology including the physiology of reproduction. No one can estimate the possible importance of this area of research to the industry, the economy and the consumer. Meats research has come a long way during the past 25 years. It plays and will continue to play an increasingly important role in influencing needed changes in meat marketing practices.

Management studies will become more and more important as the size of feed lots increases and as cattle feeding problems become more complex.

As for nutrition, it will continue of basic importance as we cannot hope to realize the possible benefits flowing from advances in other areas unless we are equipped to feed cattle in relation to the increased demands made upon them as a result of these advances, and to feed them economically.

Twenty years ago the Station showed the possibilities of using urea advantageously both for fattening and growing cattle. Much basic work apparently remains to be done before we can tell the producer how to use urea to full advantage, especially in maintenance or near-maintenance rations. We need also to improve the digestibility and utilization of both roughages and concentrates.

The beef cattle industry is indeed a basic industry within Nebraska and within the United States. Based on past and present performance it looks to the future with confidence.

Cattle fed high grain rations and liquid supplements.

Liquid Supplements for Rations

By Walter Woods
Professor of Animal Science

Terry Klopfenstein
Asst. Professor of Animal Science

Interest has developed in supplying supplemental nitrogen to beef cattle rations in liquid forms. The supplemental source of protein in liquid supplements is primarily urea. The importance of the possible advantages and disadvantages of a liquid supplement as compared to a dry supplement is governed primarily by how well one type of supplemental program supports the performance economically in beef cattle as compared to the other.

The objective of this study was to obtain data on the comparative performance of cattle fed protein sources in liquid and dry form, as well as on possible ways of enhancing protein utilization of a liquid supplement. Results to date suggest:

1. Urea is utilized similarly when included in liquid and dry supplements.
2. Cattle performance on urea based supplements is influenced by type of ration fed.
3. Corn steep liquor effectively supplies supplemental protein to high silage rations.

Four Trials

Four feeding trials were conducted to compare the value of liquid and dry supplements for beef cattle on both growing and finishing rations. In each trial, supplements were formulated to be similar in composition and thus the comparisons were the effectiveness of different nitrogen sources for supplying the supplemental protein required and the effect of method used for supplementation. Examples of dry and liquid supplements fed in the experiments are shown in Table 1. Many combinations could be used in formulating the dry supplements as shown; however, when liquid is used, the primary factor influencing protein level of the supplement is the amount of urea used. The four studies conducted are outlined below:

Trial 1. The objective of this study was to compare liquid and dry supplements for supporting performance in beef cattle fed finishing rations. The comparison was made of a 32% dry protein supplement based upon soybean meal, a 64% dry protein supplement based upon urea, a 32% and 64% liquid protein supplement based upon urea. Fortification of each supplement with minerals and vitamins was similar. Two lots of 25 head of steers were fed each supplement with a full feed of corn and limited hay in a complete mixed ration.

Trial 2. The specific objective of this study was to determine if the source of protein fed initially influenced the ability of cattle to adjust to an all urea supplement. In addition, it permitted the comparison of a liquid and dry supplement. The comparison that was made of a 32% dry protein supplement based upon soybean meal and a 64% liquid supplement based upon urea for supplying the supplemental protein needed.

Two additional treatments were those steers were fed the soybean meal supplement for 21 days and then switched to the urea supplement and those that were fed a mixture of urea and soybean meal for 21 days prior to being switched to all urea supplement. The steers were fed a full feed of corn and 10 lbs. of corn silage after reaching full feed. Two lots of about 50 head of steers received each treatment.

Trial 3. The objective of this study was to determine the performance of cattle fed corn silage

Table 1. Composition of supplements.

	Dry		Liquid	
	32%	64%	32%	64%
	%	%	%	%
Molasses	5.0	5.0	74.043	48.337
Urea liquor (50%)	...	...	19.90	39.80
Ammonium polyphosphate	...	...	5.00	10.00
Sodium sulfate	...	...	0.50	1.00
Salt (iodized)	.75	1.5	0.25	0.25
Diethystilbestrol (20 gm/lb.)	...	...	0.025	0.05
Vitmans[a]	...	...	0.032	0.063
Trace minerals	...	...	0.25	0.50
Stilbestrol—2	.25	.50	...	...
Vitamin A premix	.11	.22	...	...
Dicalcium phosphate	1.35	7.4	...	...
Limestone	3.63	5.03	...	...
Trace minerals	...	...	0.25	0.50
Soybean meal	66.65	...	...	...
Ground corn	22.0	57.35	...	...
Vitamin E[b]	+	+	...	...
Vitamin D[b]	+	+	...	...
Urea—281	...	22.5	...	...

[a,b] Formulated to supply 30,000 IU Vitamin A, 5,000 Vitamin D and 10 IU Vitamin E per animal per day.

Table 2. Comparison of liquid and dry supplements for beef cattle finishing rations.[a]

	Protein supplement			
	32% Dry	64% Dry	32% Liquid	64% Liquid
No. head	49	50	50	49
Initial wt., lb.	777	766	761	791
Final wt., lb.	1069	1041	1044	1071
Adj. daily gain, lb.[b]	3.29	3.05	3.11	2.87
Feed consumption per day, lb.	25.06	23.78	24.97	24.59
Feed required/100 lb. gain, lb.	762	780	803	851
Dressing percent[c]	61.5	61.3	61.3	60.3
Quality grade[d]	17.4	17.5	17.2	17.0
FYG[e]	2.9	2.7	2.7	2.7
REA, sq. in.[f]	11.73	12.04	11.53	11.66
Fat thickness, inch	.71	.61	.62	.62

[a] Length of feeding was 87 days.
[b] Adjusted to equal dressing percent.
[c] Based upon hot carcass weight and weight at end of experiment.
[d] Carcass grade scores, 17—low choice, 18—average choice.
[e] Final yield grade.
[f] Rib eye area at 12th rib.

and supplemented with urea in a liquid supplement. In addition, there was the objective to see if liquid supplements could be improved by using some soluble protein in their formulation. The comparison was made of a 32% dry protein supplement based upon soybean meal, a 32% liquid protein supplement based upon urea, a 32% protein supplement based upon urea and corn steep liquor (by-product of starch milling industry—contains about 23-25% protein) and corn steep liquor as the source of supplemental protein for a silage growing ration for heifers. Two lots of 56 head were fed each treatment.

Trial 4. The objective and comparisons made were the same as those in Trial 3 for supplementing a high grain finishing ration. Fortification of supplements changed, but protein sources remained the same. Two lots of approximately 47 head were fed each treatment.

The fortification pattern was the same between protein sources. In the case of the liquid supplements, the addition of limestone to the ration was necessary to balance the calcium supplied as a constituent of the dry supplements. In the case of corn steep liquor fed alone, calcium, trace minerals and Vitamin A were added to equalize intake of nutrients. Because of the high phosphorus level of corn steep liquor, no phosphorus was added to those supplements containing corn steep liquor.

Results

Results are shown in Tables 2, 3, 4 and 5. To facilitate reporting of the data, the following conclusions are made from these studies:

1. Performance of cattle fed a high grain ration containing urea or soybean meal based protein supplements was similar. In two trials, the cattle fed urea were slightly lower in daily gain and in one trial, slightly higher than those fed soybean meal. Indications were that soybean meal feeding during the period cattle are going on feed may help adjust cattle going on high urea supplemented rations. This observation requires further study to know the importance of protein source initially as influencing performance for a total feeding period.

2. Performance of cattle fed rations high in corn silage and supplemented with urea is not equal to those fed a supplement based upon soybean meal (see previous reports showing similar results). The results obtained with liquid supplements appeared to be similar to those obtained with dry urea based supplement used in previous research.

3. Performance of cattle fed liquid or dry urea based supplements was similar. This was under conditions where equal attention was given to fortification of both supplements and rations.

4. Corn steep liquor is as effective as soybean meal in supporting performance of calves fed growing rations. However, it should be noted that the combination of urea and corn steep liquor did not support the performance as might be anticipated from the results of corn steep liquor alone.

5. Carcass yield and grade for the cattle were similar between urea and soybean meal supplemented rations, as well as liquid and dry supplemented rations. One

(continued on next page)

Table 3. Comparison of liquid and dry supplements and method of starting cattle on high urea supplements.[a]

	Supplements			
Item	Soybean meal	Soybean meal then urea	Soybean meal-urea then urea	Urea
No. head	101	100	99	97
Initial weight, lb.	634	626	646	642
Final weight, lb.	1129	1126	1124	1123
Adjusted daily gain, lb.[b]	3.08	3.08	2.96	2.99
Daily feed consumption, lb.				
As fed basis:				
Corn	17.5	17.5	17.8	18.2
Silage	12.6	12.3	12.6	12.8
Hay	.4	.4	.4	.4
Supplement	2.0	1.1	1.1	1.0
Total	32.5	31.3	31.9	32.4
Feed/100 lb. gain, lb.				
As fed basis	1055	1043	1078	1084
Dry basis	711	669	713	709
Carcass grade score[c]	17.8	17.3	17.6	17.7
Yield, %	59.9	59.6	59.8	59.8
Condemned livers, %[d]	18	14	14	13

[a] Length of trial 148 days.
[b] Performance adjusted to equal dressing percent basis.
[c] Carcass grade score assigned, 17—low choice, 18—average choice.
[d] Livers condemned because of abscesses.

Liquid Supplements

(continued from page 7)

exception to this occurred in Trial 1, with the feeding of the 64% protein liquid.

The results of the studies reported indicate that the feeding of urea in liquid or dry forms gives similar results in cattle performance. The decision one must make, then, in evaluating different systems of supplying supplemental protein, would be to evaluate the economics of supplying total supplemental needs of the feeding program. Attention must be given in feeding liquid supplements, as well as dry, to their nutritional adequacy for meeting the complete needs of the ration.

Calves fed corn silage and liquid supplement.

Table 4. Performance of calves fed corn silage supplemented with urea and corn steep liquor.[a]

Item	Supplemental protein from			
	Soybean meal	Urea	50% urea 50% corn steep liquor	Corn steep liquor
No. cattle	112	112	112	111
Initial weight, lb.	377	368	381	371
Daily, gain, lb.	1.95[b]	1.70[b]	1.75[b]	1.90[b]
Daily feed consumption, lbs.				
Corn silage	25.7	26.1	26.3	25.9
Corn	2.0	2.0	2.0	2.0
Supplement	2.0	2.0	2.0	2.72
Daily feed consumption, lbs. on dry matter basis				
Corn silage	10.3	10.4	10.5	10.4
Corn	1.7	1.7	1.7	1.7
Supplement	1.8	1.2	1.1	1.4
Total	13.8	13.3	13.3	13.5
Feed required/100 lb. gain, lb.				
Corn silage	1320	1533	1508	1365
Corn	103	118	115	106
Supplement	103	118	115	144
Feed required/100 lb. gain, lb. on dry matter basis				
Corn silage	518	601	592	535
Corn	87	99	97	89
Supplement	92	69	60	73
Total	697[b]	769[c]	749[c]	697[c]

[a] Experiment conducted for 104 days.
[b,c] Data on the same line bearing different superscript letters differ significantly ($P < .05$).

Table 5. Value of corn steep liquor as protein supplement for high concentrate rations.[a]

	Supplemental protein from			
	Soybean meal	Urea	Corn steep + urea	Liquor 0
No. heifers	94	91	91	92
Initial weight, lb.	547	553	551	550
Adjusted daily gain, lb.[b]	2.35	2.40	2.46	2.40
Daily feed consumption, lb.[c]				
As fed	19.20	20.31	20.66	21.33
Dry matter	17.27	17.72	18.11	18.27
Feed required/100 lb. gain, lb.				
As fed	817	846	840	889
Dry matter	735	738	736	761
Dressing %[d]	62.0	61.7	62.5	61.9
Carcass grade score[e]	16.9	16.9	16.7	17.3
Livers condemned, %	27.7	12.1	17.6	23.9

[a] Length of feeding period was 126 days
[b] Daily gain adjusted to 62% yield on all cattle.
[c] Daily ration after cattle reached full feed was 85% concentrate and 15% chopped alfalfa-bromegrass hay.
[d] Based on live weight at end of experiment and hot carcass weight.
[e] Federal carcass grade score assigned. 16—high good, 17—low choice.

Urea in Range Supplements

By D. C. Clanton
Professor, Animal Science, North Platte

Even though much research has been done on the use of urea in ruminant rations, little data are available on the proper uses of urea in range supplements where low quality forage constitutes the major portion of the diet.

Objectives of the experiments reported here were to compare the performance of calves fed supplements containing different levels of urea while grazing native winter range and to measure the effect of feeding hay with the supplements. Two years data have been collected.

Five calves were individually fed one of six supplements at different amounts (Table 1 and 2) while being wintered on native range. The calves were corraled every day and each calf was individually fed his respective supplement (Figures 1 and 2).

Treatment 1 was an outside control and provided little supplemental protein, primarily mineral and vitamin A, which was provided in a pellet using a small amount of grain. Daily intake of phosphorus and vitamin A was the same for all calves in the experiment. All supplements were ¾ inch pellets the first year and ¼ inch pellets the second year. It was necessary to grind and repellet supplement 4 in ¾ inch size the second year to get calves to eat it.

Treatments 2 through 4 provided a comparison of levels of urea in the supplement. Treatments 5 through 7 were the same supplements as used in Treatments 2 through 4 except fed at 1 lb. per head per day with grass hay. It was

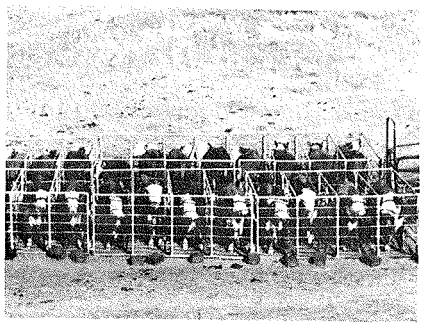

Fig. 1. Individual feeding unit used in range nutrition studies.

Table 2. Amounts and kind of supplements fed and average daily gains of the calves.

Treat-ment	Supple-ment	Daily feed		Protein	Urea	Protein equivalent from urea 281 factor	Av. daily gain	
		Supp.	Hay[a]				1966–67 112 days	1967–68 130 days
		lb.	lb.	%	%	%	lb.	lb.
1	1	0.25	0	9	0.0	0.0	.05	–.37
2	2	1.5	0	40	0.0	0.0	.60	.58
3	3	1.5	0	40	3.0	8.43	.54	.65
4	4	1.5	0	40	6.0	16.86	.54	.43
5	2	1.0	3	40	0.0	0.0	.74	.53
6	3	1.0	3	40	3.0	8.43	.68	.54
7	4	1.0	3	40	6.0	16.86	.62	.49
8	5	1.5	0	32	0.0	0.0	.66	.55
9	6	1.5	0	24	0.0	0.0	.54	.40

[a] The calves averaged 2.9 and 2.7 lbs. per day the 1st and 2nd year, respectively.

estimated the digestible protein intake was about the same for the two sets of three comparisons. However, there was probably more digestible energy in the hay than in the standing forage. The hay was 7.8% protein the first year and 6.5% the second year.

Treatments 8 and 9 provided the same natural protein in the supplements as Treatments 3 and 4, and thus gave an evaluation of the benefit of adding the urea to the supplement.

The only statistically significant difference in daily gain was due to feeding hay the first year (Table 2). The decline in performance when urea was increased to 6% is a definite trend, however. In comparing Treatments 8 and 9 with 3 and 4, respectively, there was no significant benefit received from addition of the urea.

In previous studies conducted at the Fort Robinson Experiment Station using the same procedures it was observed that calves which received 1.5 lbs. of a 40% protein supplement gained 0.52 lbs. per day whereas calves which received 1.5 lbs. of a 20% protein supplement gained 0.34 lb. per day (1966 Beef Cattle Progress Report). In another similar study discussed in the same report calves fed 2 lbs. of a 40% protein supplement gained 0.60 lb. per day whereas those fed 2 pounds of a 20% protein supplement gained 0.41 lb. per day. Based on these studies it appears that increased performance should be expected by feeding up to 0.8 lb. of crude protein per head per day.

In the two experiments reported here the advantage of feeding 1.5 lbs. of 40% protein supplement over 1.5 lbs. of 32% or 24% protein supplements was not as pronounced as was expected based on experiments conducted at Fort Robinson. The experiments reported here were conducted during two exceptionally mild winters, 1966-67 and 1967-68. This may have had an effect on performance. The difference in the species composition of the forage at the two locations could contribute to a difference also.

Supplement 4 was not as palatable as the other supplements, probably a reflection of the amount of urea in the supplement. Some calves would eat it readily whereas other calves would eat little or none on certain days. This points up the problem that no doubt occurs in a practical group supplementing situation. Some calves may consume little or no supplement if it contains too much urea.

It appears that somewhere between three and six percent urea in a 40% protein supplement is the breaking point for satisfactory use. This breaking point may be different with a lower protein supplement or a supplement with a much different composition. At any rate this low level of urea in the supplement does not provide much economical advantage in supplement costs and it will be necessary to find a way to use higher levels of non-protein nitrogen in range supplements before a decided price advantage is achieved.

Currently, another experiment is in progress using these same procedures to compare different forms of non-protein nitrogen in the supplements.

Table 1. Formulation of the supplements and actual protein content.

Ingredient	Supplement					
	1	2	3	4	5	6
Soybean meal, %	...	90.0	66.9	44.0	66.9	44.0
Corn, %	58.7	4.5	24.0	43.3	24.0	43.3
Molasses, %	2.5	2.5	2.5	2.5	2.5	2.5
Urea, %	...	...	3.0	6.0	...	...
Straw, %	...	...	...	...	3.0	6.0
Monosodium phosphate, %	32.0	2.7	3.1	3.5	3.1	3.5
Limestone, %	5.0	...	0.2	0.4	0.2	0.4
Trace minerals, %	1.8	0.3	0.3	0.3	0.3	0.3
Vitamin A (I.U./#)[a]	60,000	10,000	10,000	10,000	10,000	10,000
Actual protein, %						
1966–67	9.2	39.1	38.5	39.6	30.7	23.9
1967–68	6.8	40.8	40.9	44.2	31.9	23.4

[a] To provide each calf not receiving hay 15,000 I.U./day and those receiving hay 10,000 I.U./day. For the groups receiving hay the balance was provided in the hay.

Fig. 2. Each calf was individually fed his respective supplement.

Urea, Soybean Meal as Supplements

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Urea as the only source of supplemental protein for a corn silage ration has not been equal to soybean meal in supporting animal performance. Supplying 3 to 6 pounds of additional corn per calf per day during the growing period did not overcome completely the difference in animal performance between those on urea and those on soybean meal supplement. The response to urea and soybean meal based supplements was similar in the finishing period for the one year it was evaluated following the growing period on the same kind of supplement.

Two trials were conducted in which either urea or soybean meal supplied the supplemental protein to a corn silage based ration. Both rations were equally supplemented with minerals and Vitamin A. With each supplemental protein source, either 0, 3 or 6 lbs. of corn was fed. The calves were fed all the corn silage they would consume with each supplemental program. Two lots of 11 or 12 head of steers were fed each treatment each year. In the second year, the cattle were kept on the same supplemental program and placed on a full feed of corn for finishing to determine if the response during the finishing phase might alter performance.

Results of the growing study are shown in Table 1. Steers fed the urea supplement to a corn silage ration gained less than those fed the soybean meal supplement. This difference of .16 lb. per steer per day is similar to, although slightly less than, the difference observed in other comparisons reported from this station for use of urea and soybean meal. Adding 3 to 6 lbs. of corn did not markedly narrow the gap between urea and soybean meal supplements. The length of the growing trials (105 and 168 days) was sufficient for cattle to have adjusted to urea.

Cattle fed the urea supplement required more feed per pound of gain than those fed the soybean meal supplement. Adding additional corn to the corn silage ration did not change the difference between the sources of supplemental protein.

The reasons why urea does not support the same rate of gain as soybean meal in high silage rations are not clear. It would appear to be more than just an energy factor. However, in evaluating the use of urea in the high silage feeding periods, it is a question of economics. Based upon previous research, the urea supplement might sell for less and give the same feed cost per pound of gain (see 1968 Beef Cattle Report).

Cattle placed upon a full feed of grain following the growing program and kept on the same supplemental protein source performed almost identically (Table 2), in finishing phase. The steers were fed for 92 days following the 168 day growing program. No major differences due to protein sources were noted during the finishing program between cattle fed the different programs as measured by rate and efficiency of gain or in carcass characteristics. There appeared to be no compensation in gain during the finishing period for the slightly lower gain in the growing period.

The results to date would suggest that the optimum rate of gain and efficiency of gain for calves fed high corn silage ration would be with a soybean meal based supplement. The use of high levels of urea would then be a question of economics as to whether it could be purchased competitively with the soybean based supplement.

Table 1. Performance of calves fed corn silage supplemented with urea, soybean meal and corn.[a]

	Soybean meal			Urea		
	0 Corn	3 lb. Corn	6 lb. Corn	0 Corn	3 lb. Corn	6 lb. Corn
No. steers	46	46	46	46	46	46
Initial weight, lb.	466	466	465	467	470	469
Daily gain	1.83	1.91	2.03	1.67	1.79	1.91
Daily feed consumption						
Corn silage	32.5	26.3	20.4	31.2	26.1	20.9
Supplement	1.25	1.25	1.25	1.25	1.25	1.25
Feed required per lb. gain, lb.						
Corn silage[b]	17.7	13.7	10.0	18.6	14.6	10.8
Concentrate	.7	2.1	3.5	.8	2.3	3.7

[a] Two trials conducted. One was 105 days and the second one was 168 days.
[b] Corn silage contained 40% dry matter.

Table 2. Performance of steers on finishing rations following urea and soybean meal feeding.[a]

	Supplement fed in growing and finishing program	
	Soybean meal	Urea
No. head	66	66
Initial weight, lb.	773	766
Final weight, lb.	1047	1038
Daily gain[b]	2.97	2.96
Daily feed consumption, lb.		
Corn	14.4	14.6
Corn Silage	11.7	11.3
Supplement	1.25	1.25
Feed/lb. gain, lb.		
Corn Silage	3.94	3.82
Supplement	.41	.41
Corn	4.85	4.93
Dressing %[c]	63.3	63.5
Carcass grade score[d]	19.3	19.8

[a] 92 day feeding period.
[b] Daily gain adjusted to 60% hot carcass yield. Final weight from which daily gain and feed per pound gain were determined adjusted to 60% hot carcass yield.
[c] Calculated from actual off experimental live weight and hot carcass weight.
[d] 19 = high choice, 20 = low prime.

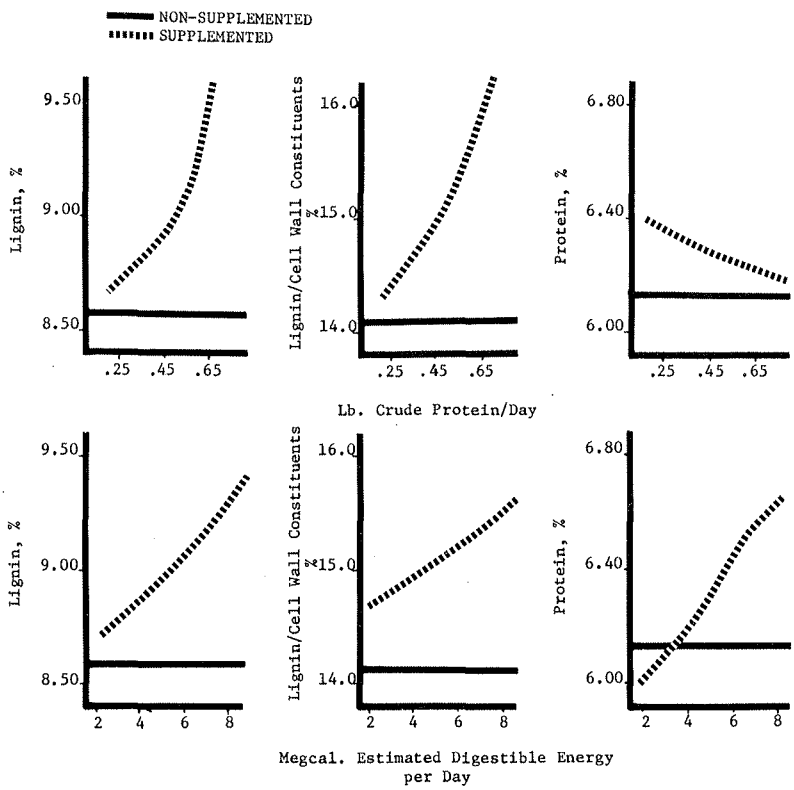

Fig. 1. The influence of supplemented protein and/or energy on the selectivity of cattle grazing native winter range.

Supplements on Winter Range

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Animals wintered on native range are frequently given supplemental feed in the form of pelleted concentrate in accordance with their age and stage of production.

However, there is some question as to the amount of protein and energy that a supplement should provide. For example, which supplement will do the best job: 1 lb. of a 40%, 2 lbs. of a 20%, or 4 lbs. of a 10% crude protein supplement. Each feeding regimen will furnish the same amount of total crude protein, but each succeeding supplement will furnish about twice as much estimated digestible energy as the one prior to it.

Cattle performance studies at the University of Nebraska North Platte Station and the U.S.D.A. Beef Cattle Research Station at Fort Robinson have shown that a complex relationship exists between protein and energy in a supplement.

When forage is supplemented with protein and/or energy, the ultimate purpose is to furnish an optimum balance of these nutrients at the tissue level. Supplying these in the diet in a given ratio does not "guarantee" that they will provide for maximum animal performance.

For example, studies at Fort Robinson and North Platte have shown that increasing the amount of energy fed while maintaining a specific level of supplemented protein did not always increase performance, and in some instances animals actually lost weight. This would indicate that supplements have an influence on the voluntary intake and/or digestibility of range forage dry matter.

During the winter of 1967-68, esophageal fistulated cattle were individually fed the supplements shown in Table 1. These supplements supplied three levels of crude protein and four levels of estimated digestible energy daily. Slight changes in the dry matter content of the supplements and the variation in protein content caused small deviations from planned levels of feeding. Control animals received only minerals and Vitamin A, which were included in the other supplements so that daily intake would be comparable.

Effect on Intake

The largest single factor limiting the availability of nutrients to animals grazing winter range forage is intake. Quantitative intake under these conditions is probably limited most by physical characteristics of the forage and the protein to energy ratio in the diet.

In this study selective grazing accounted for differences in the physical characteristics of the forage ingested (Figure 1). It is not known why this occurred. In general, increasing the amount of supplemented crude protein in the diet resulted in the selection of more highly lignified, fibrous material, but had little influence on the protein content of forage selected by the animals. Increasing amounts of supplemented energy also resulted in the selection of more lignified, fibrous material but

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Table 1. Calculated amount of protein and energy in supplements fed to a 1,000 lb. animal.

Lb. Crude protein/day	Control	Megcal. estimated digestigble energy/day			
		2	4	6	8
		lbs./day			
Control	0.5#–4.1%[a]	...	...	...	...
0.25	...	1.3#–19%	2.6#–9.5%	4.00#–6.3%	5.3#–4.7%
0.45	...	1.3#–34%	2.6#–17%	4.00#–11%	5.3#–8.5%
0.65	...	1.4#–45%	2.6#–24%	4.00#–16%	5.3#–12%

[a] Refers to % protein in supplement.

Supplements

(continued from page 11)

not of the same magnitude as did increased protein. An increase in protein content of selected forage was observed (Figure 1).

Feeding supplements depressed the quantitative intake of forage regardless of the level of protein and/or energy supplied (Figure 2). Apparently, quantitative intake is influenced mostly by extreme imbalances of protein and energy.

For example, the greatest reduction in intake resulted when animals were fed supplements supplying high energy and low protein. When animals were fed 5.3 lbs. of the supplement containing 4.7% protein, their intake was about 79% of the intake of control animals. Some reduction of intake was also observed at low energy-high protein levels of supplementation. When animals were fed 1.4 lbs. of the supplement containing 45% protein, their intake was about 89% of the intake of control animals (Figure 2). This indicates that some factor other than protein was limiting intake. In this case it was probably the source and availability of energy.

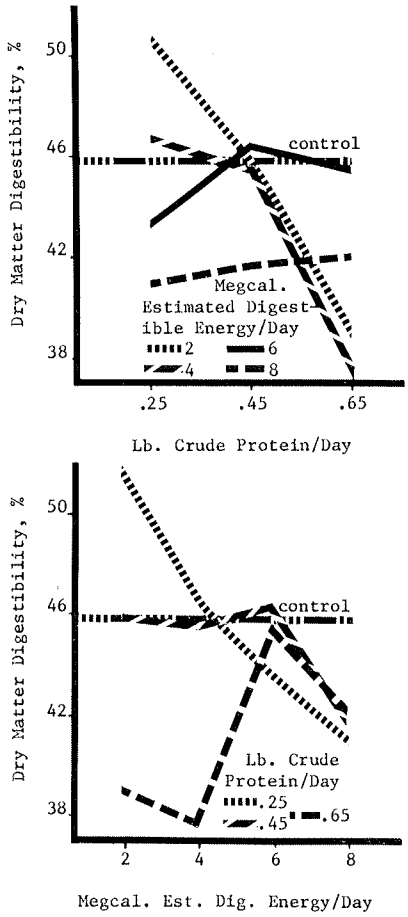

Fig. 2. The influence of supplemented protein and/or energy on intake of forage, based on a 1000 lb. animal.

It is assumed that measured intake values were lower than would have been expected if the experimental procedure had not been used. This assumption is based on the fact that animals on a growth trial in an adjacent pasture receiving 1.5 lbs. of a 40% protein supplement gained 0.58 lb./day. Experimental animals did not consume enough forage to supply sufficient energy to result in gains of this magnitude.

Animals consume less forage dry matter during the winter than during the summer grazing period. A 500 lb. animal consumed 1.2 to 1.5% of its body weight during the winter. A 700 lb. animal consumed 1.7 to 2.1% of its body weight during the summer. It is doubtful that animals of this size grazing range forage can consume as much dry matter as suggested by the National Research Council's bulletin on "Nutrient Requirements of Beef Cattle."

Effect on Digestibility

The influence of varying levels of supplemented protein and energy on forage selectivity was greater than the direct effect on dry matter digestibility. This was particularly true within the lower levels of supplemented energy (Figure 3). This was evidenced by the fact that lignification of the fibrous portion of the ingested forage accounted for over 72% of the observed variability in dry matter digestibility without taking into consideration animal variation or the direct influence of the supplement on dry matter digestibility.

Ordinarily, protein is assumed to stimulate the digestibility of low quality forage. In this study any stimulatory effect supplemented protein may have had was offset by the inhibitory effect of the lignification of the fibrous portion of the ingested forage.

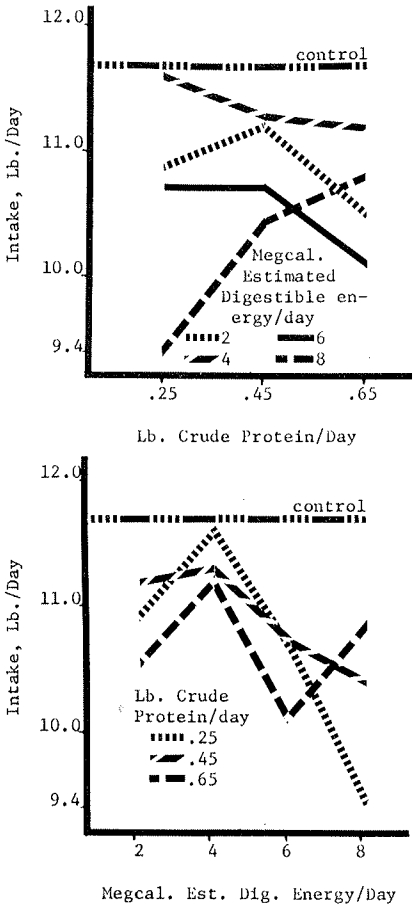

Fig. 3. The influence of supplemented protein and/or energy on dry matter digestibility of forage selected by cattle grazing native winter range.

At lower levels of supplemented protein, increasing increments of supplemented energy depressed forage utilization, while at higher levels an increase in the utilization of the forage was observed (Figure 3). Again, this may have been more a result of animal selectivity than of the supplement, *per se*.

Feeding supplements improved the energy digestibility of the diet as compared to the controls. Increasing levels of supplemental protein had little influence on the digestibility of energy; however, increasing levels of supplemental energy increased energy digestibility. This was probably due to more readily available energy in the supplement which was replacing forage in the diet. Actually the energy digestibility of the forage may have been reduced.

Is Selection Effective?

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Selection occurs when some animals are saved to be parents of the next generation while others are discarded. Hopefully, the potential parents contain genes needed to move the herd toward its goal and the parents will transmit these desired genes to their offspring. Since selection is the tool used by the breeder to direct change in the gene content of his herd, questions concerning what happens with selection are important to breeding plans.

In 1960, a series of three selection experiments was started at Fort Robinson. The experiments consist of three lines of cattle originating from the same foundation stock wherein one line was selected for weaning weight, another line was selected for yearling weight (actually 452 days in bulls and 550 days in heifers) and the third line was selected for an index which combined a muscling score with weight (Index = 100 + 10 $\frac{\text{[muscle score-av. score]}}{\text{standard deviation}}$ + 10 $\frac{\text{[yearling wt.-av. wt.]}}{\text{standard deviation}}$).

Eight years have gone by and some observations on the progress of the experiment are reported here. A recently completed analysis suggests that selection did change the performance in the desired direction in each of the three traits. Changes due to selection were measured by comparing the performance of offspring from parents who differed in the degree of selection practiced. These comparisons were made within a given year and were averaged over a four-year period.

For instance, in 1963 we had offspring from foundation parents representing the base, or no selection, compared with offspring from bulls and heifers that had one cycle of selection, plus all combinations in between. The average superiority of selected parents (selection differential) represented the intensity of selection. The average performance of the offspring reflected the average genetic merit of those parents and constituted the response to selection.

Selection intensity and response was compared from 1121 calves born in 1963, 64, 65 and 66. Records of calves born in 1960, 61 and 62 were not included because all of these calves were out of foundation sires and dams and formed the potential parents of the first selection cycle.

Table 1 presents the cumulative selection differentials. The average selection differential over all pairs of parents was 12 pounds per year for weaning weight, 20 pounds for yearling weight and 4 units for the index of muscling and weight.

Selection differentials for replacement bulls and heifers in the lines were:

In the weaning weight line, bulls averaged 72 pounds and heifers 17 pounds above average.

In the yearling weight line, bulls averaged 138 pounds and heifers 21 pounds above average.

In the index line, bulls were 31 index points and heifers 3 index points above average.

Response to selection was evaluated by the calves born in 1963, 1964, 1965, and 1966. The results of regression analysis are given in Table 2.

The indicated heritabilities as a group were equal to or exceeded our expectations. The response in birth weight suggests that selection which increases weaning weight is likely to cause an increase in birth weight (possibly due to emphasis of early growth).

Weaning weight response was high in all lines but was greater in the line selected for an index of yearling weight and muscling than was expected. The large response in yearling weight of heifers as compared with bulls in the weaning weight and yearling weight lines in contrast with the reverse situation in the index line is interesting but without a ready explanation other than the vagaries of chance.

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Table 1. Cumulative selection differentials of calves.

	Weaning weight line (Lbs.)	Yearling weight line (Lbs.)	Yearling weight and muscling line (Index Units)
1963	12	18	7
1964	33	44	13
1965	44	59	17
1966	47	77	19
Av. Yr. Increase	12	20	4

Table 2. Response to selection.

	Weaning weight line		Yearling weight line		Index line	
	Bulls	Heifers	Bulls	Heifers	Bulls	Heifers
Mean of selected trait	453	423	989	821	100	100
Response per unit of selection differential						
Birth weight	0.07	0.9	0	0	0.21	0
200-day weight	0.38	0.40	0.11	0.26	2.28	1.57
452 or 550-day weight	0.57	1.07	0.40	0.79	3.57	2.21
Muscling score	–.02	...	–.01	...	0.06	...
Index	0	0.14	0	0.11	0.69	0.28
Heritability	.38	.41	.40	.79	.69	.28

Selection

(continued from page 13)

Results for average daily gain suggest that selection for yearling weight is relatively more effective for the postweaning gain than for weaning weight. Muscling score, largely influenced by proportion, responded positively only when direct selection was made for it. The index which combines yearling weight and muscling score pretty well reflects results shown for the components of the index.

The zero index response in bulls in the weaning and yearling weight lines results from the negative response in muscling score and a moderate response in yearling weight. Heifers in these lines show response in yearling weight only since muscling scores were not attempted on heifers.

In the index line, bulls exhibited good response in both muscling score and yearling weight. Response in index of heifers results from changes in yearling weight alone and might be expected to be less than in bulls even if weight were equally heritable in the two sexes.

Another impression of selection response can be gained by looking at a plot of the line averages over the years as shown in Figure 1. Trends since 1963 suggest weaning weight is increasing in all lines and consistently in favor of the line selected for weaning weight. Postweaning gains consistently favor the yearling weight line. When weaning weight and postweaning gain are considered together, as yearling weight, the average values over the four years were almost the same, being 899, 904, and 904 pounds for the weaning weight, yearling weight and index lines, respectively.

Another point of general interest is that although the cattle in the yearling weight and index lines have similar weights at 452 or 550 days, there is an apparent difference in skeletal dimensions. We expect the mature size in the index line to be less than the yearling weight line. The high weaning weights of the index line indicate selection response for rapid early growth.

A more thorough examination needs to be made from actual measurements rather than mere observations which may have been unduly affected by specific bulls.

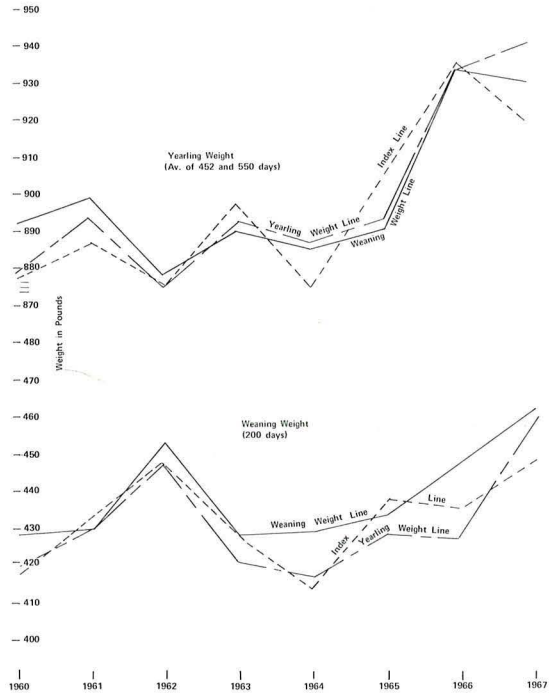

Fig. 1. Average weaning weights and yearling weights of lines selected on different criteria.

Roughage Levels in Finishing Rations

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Continued beef cattle feeding research toward minimum or no roughage rations has shown the following results:

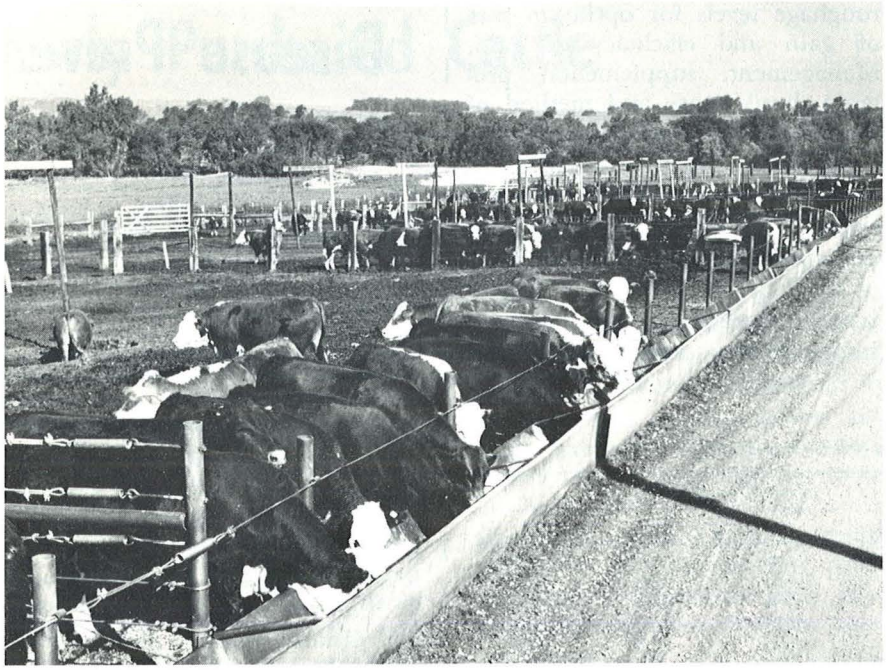
1. The optimum roughage levels in finishing rations appear to be about 5% hay equivalent of the total ration, when fed on percentage basis. This would be equivalent to about 1.25 lbs. per animal per day.
2. Higher levels of roughage than the 5% limit tend to produce more costly gains.
3. Consistency of gain and rate of gain appears to slightly favor minimum roughage rather than all concentrate rations.

This report plus data reported in 1968 Beef Report supports the summary indicated. Additional trials were conducted to determine if the level of roughage could be more effectively determined.

Feeding Trials

Two of the four feeding trials were conducted in spring and summer and two were conducted in fall and winter to determine optimum level of roughage in finishing rations.

Trial 1. The objective was to compare 0, 5 and 15% roughage in finishing rations for cattle. Two lots of seven head each were fed each ration for 134 day period. The roughage in each ration was ½ corn cobs and ½ chopped alfalfa hay. The cattle were brought to full feed with use of additional roughage in the ration. After reaching a full feed, the rations were full fed as a complete mixed



Cattle receiving all concentrate ration.

ration. Terramycin was fed to all steers at the rate of 75 mg. per day.

Trial 2. The objective was to compare 0, 5, 10 and 15% chopped alfalfa-bromegrass hay in finishing rations for steers. In this study, the quantity of protein removed by the hay reductions was added to the ration as soybean meal. Two lots of steers received each ration for the 128 day feeding trial. Additional roughage was used in bringing the cattle to a full feed of the appropriate ration. The rations were mixed daily in an auger wagon and full fed.

Trial 3. The objective of this study was to compare 5, 10 or 15 lbs. of corn silage (45% dry matter) as the roughage source in finishing rations. Two lots of 12 steers each were fed each treatment for the 119 day study. Additional corn silage was fed in bringing steers to a full feed of corn. The corn supplement and corn silage was fed once daily and mixed together in the bunk.

Trial 4. The objective of this study was to compare 5 or 10 lbs. of corn silage (32% dry matter) as the roughage source in finishing rations. Two lots of 10 steers each were fed each treatment for each of two years. In addition, each level of silage was fed as a complete mixed ration and as separate ingredients to determine if method of feeding influenced the results. While the cattle were being brought to full feed, they received more than the level of silage fed after reaching full feed.

The supplemental program for the various rations within each trial was considered to be adequate and in all trials, except Trial 2, were equal in composition. In Trial 2, additional soybean meal was fed in the lower roughage rations. The cattle were fed so feed would be before them at all times after reaching full feed. Once a day feeding was employed in all trials and the feeder was a fence line bunk.

To facilitate summarizing trials, the following statements are indicated from the results shown in Tables 1, 2, 3 and 4.

1. The optimum roughage level in finishing rations appears to be about 5% air dry roughage. This is supported by slightly faster gains and lower amounts of feed required per pound of gain for those fed 5% air dry roughage or 5 lbs. of corn silage as compared to higher levels.

2. Gains tended to be slightly faster for cattle fed the ration with 5% air dry roughage than for those fed all concentrate. In one trial, the steers fed the 5% roughage ration were more efficient than those fed all concentrate. However, in the second study, the all concentrate cattle were slightly more efficient. In considering results of these studies, plus those reported in 1968 Beef Report, more consistent results are found with a minimum level of roughage in the ration as compared to the all concentrate ration as fed and supplemented in these studies.

3. Liver condemnation increased as the level of roughage in the ration decreased.

4. The method of feeding the ration reported in Table 4 did not alter the results. In both cases (complete mixed versus feeding of separate corn, silage and supplement) the cattle fed 5 lbs. of silage per day gained faster and were more efficient in gains than those fed 10 lbs. of corn silage. It is felt likely that cattle and feed management could influence these results; however, the results indicate com-

(continued on next page)

Table 1. Effect of various levels of roughage.[a]

	% Roughage		
	15	5	0
No. head	14	14	14
Initial wt., lb.	705	695	705
Final wt., lb.	1123	1146	1090
Adjusted daily gain,[b] lb.	3.14	3.34	2.89
Adjusted feed/lb. gain, lb.	8.34	6.98	7.44
Daily feed consumption, lb.	26.2	23.3	21.5
Carcass grade score[c]	17	16.7	16.7
Dressing percent[b]	60.4	60.0	60.4
% condemned livers	7.14	21.4	57.1

[a] 134 day feeding trial.
[b] Daily gains calculated by adjusting final weight in order to give equal dressing percent for hot carcass weight. Sixty-two percent was yield for calculating final live weight from hot carcass weight.
[c] 16 = high good, 17 = low choice.

Roughage Levels

(continued from page 15)

parable results may be obtained in small groups between complete mixed ration and where ingredients are fed separately where all cattle can eat at once. It is in larger groups these results would not be implicated because all cattle may not have access to the bunk and ration at one time.

The results from the Nebraska Station would support minimum roughage levels for optimum rate of gain and efficiency of gain. Management, supplemental program, bunk space and method of processing the roughage may alter these results, but with attention to them, the results show increased opportunity for more efficient and economical gains with lower levels of roughage as compared to higher levels. There is the need for more information to determine if season of the year may modify the results.

Table 2. Effect of various levels of roughage.[a]

	Levels of roughage (%)			
	0	5	10	15
No. head	84	86	87	84
Initial wt., lb	655	661	662	650
Final wt., lb.	1020	1038	1052	1034
Adjusted daily gain,[b] lb.	2.70	2.80	2.77	2.87
Feed consumption daily	22.6	24.5	25.6	24.8
Feed/100 lb. adjusted gain, lb.	837	875	924	864
Carcass grade score[c]	16.6	16.6	16.7	16.8
Dressing percent	60.8	60.9	60.0	61.0
% condemned liver	65.5	38.4	32.6	32.2

[a] 128 day feeding program.
[b] Daily gains calculated by adjusting final weight in order to give equal dressing percent for hot carcass weight. Sixty-two percent was yield for calculating final live weight from hot carcass weight.
[c] 16 = high good, 17 = low choice.

Table 3. Performance of cattle fed different levels of corn silage.[a]

	Level of corn silage		
	5 lbs.	10 lbs.	15 lbs.
No. head	24	24	24
Initial wt., lb.	719	725	723
Adjusted daily gain, lb.	2.70	2.48	2.47
Daily feed consumption			
Corn	15.8	15.1	14.2
Corn silage	6.3	10.7	15.4
Supplement	1.0	1.0	1.0
Feed required per adjusted gain, lb.			
Corn	5.85	6.09	5.75
Corn silage	2.33	4.31	6.23
Supplement	.37	.40	.40
Dressing percent[b]	63.0	62.2	62.6
Carcass grade score[c]	17.5	17.6	17.5

[a] 119 day feeding trial.
[b] Daily gains calculated by adjusting final weight in order to give equal dressing percent for hot carcass weight.
[c] Carcass grade score assigned—17 = low choice, 18 = average choice.

Table 4. Comparison of level of silage in finishing rations.

	5 lbs. corn silage	10 lbs. corn silage
No. steer	79	80
Days on feed	117	117
Initial wt., lb.	786	784
Adjusted daily gain, lb.	3.18[a]	3.06
Feed consumption lb./day		
Concentrate	20.67	19.97
Silage	9.90	13.89
Feed/lb. of adjusted gain, lb.[a]		
Concentrate	6.51	6.53
Silage	3.11	4.55
Dressing percent[b]	60.84	60.77
Carcass grade[c]	16.35	16.95

[a] Daily gains calculated by adjusting final weight in order to give equal dressing percent for hot carcass weight. Sixty-two percent was yield for calculating final live weight from hot carcass weight.
[b] Based upon hot carcass weight and weight at end of experiment.
[c] Carcass grade score, 16 = high good, 17 = low choice.

Disease Prevention

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The first 2 to 4 weeks after cattle arrive at the feedlot are critical days in your cattle feeding program. No single set of rules will guarantee getting cattle started right because feeder cattle come in many varieties and from many sources, weather conditions vary with seasons and from year to year, and distance shipped and methods of handling in transit vary greatly. Each factor complicates the management to be followed once cattle arrive at their new home.

You should depend on a local veterinarian for assistance in developing a cattle disease prevention plan. Disease prevention and control is his specialty and his advice is necessary to help you plan a sound program to minimize weight and death loss. The local veterinarian will be familiar with prevention and control of diseases that are most likely to occur in your locality and he is usually the first to recognize new diseases in the area. Don't wait to contact him until you have a pen full of sick cattle. Develop a disease prevention plan before you buy your cattle. Then modify the plan, if needed, following arrival of the cattle.

You should develop your plan in these areas:

(1) Reducing stress during and following shipment.

(2) Close observation and early treatment of sick cattle.

(3) Providing nutrition to offset stress.

(4) Preventive treatment.

(5) Parasite control and abortion of heifers.

Reducing Stress

Shipping fever and other res-

in Newly Purchased Cattle

piratory diseases are the rule rather than the exception for most new cattle in the fall of the year. Many contributing factors are involved, including weather conditions, and the fact that most calves have not yet built up their own immunity to many of the disease agents involved in the shipping fever complex.

Plan to keep stress at a minimum during shipment. Stress can be reduced by hauling direct from the ranch but this may not offset advantages of purchasing at a market. For long hauls, give cattle a feed and rest stop every 28 to 36 hours (this is required for rail shipment but not for truck shipment.)

Upon arrival the cattle need rest. Provide them a dry place to lie without dustiness. Confine them to a fairly small area with good handling facilities for easy treatment of sick cattle. This setup should have adequate catch pens and a squeeze chute located so sick animals can be treated with a minimum of effort on the part of the sick animals and a minimum of disturbance of the other cattle.

Small pastures provide clean dust-free quarters but have a disadvantage in that cattle have opportunity to move or mill around more than desirable. Driving and sorting, which is necessary for treatment of sick cattle, creates additional stress which may weaken resistance of other cattle.

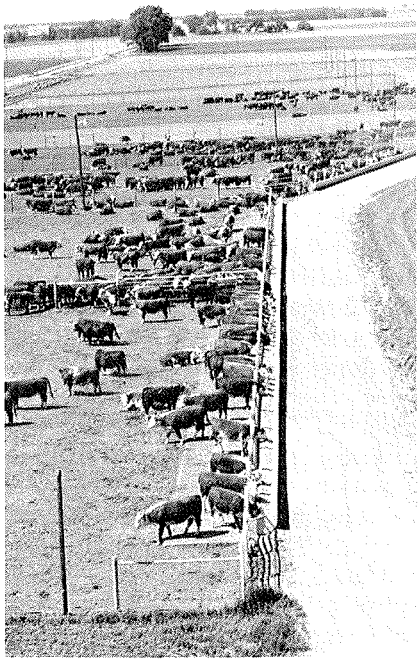
To keep stress at a minimum, routine immunization, parasite treatment, etc., should be delayed a few days, in most instances, until the cattle have rested and have perked up following shipment. The length of the delay will depend on the condition of the cattle. Cattle that are shipped long distances and arrive at the lot in poor condition or with some sick, should not receive routine immunization and parasite treatment until after the cattle have recovered.

Watch cattle closely for symptoms of disease. In most diseases early treatment means early recovery with a minimum weight loss. If you do not already know, observe how a sick beast looks and acts. If you can't tell when an animal is sick by looking at him, assume that he is sick when he refuses to eat and you'll be right a high percentage of the time.

Treatment should follow the plan developed with your veterinarian. Many cattle feeders have the veterinarian treat sick cattle when they arrive. Larger operators may have the veterinarian check and treat the animals each day. Other arrangements involve periodic checks by the veterinarian with a call from the feeder when sick animals need treatment or an alteration of the planned disease prevention program appears needed.

Feeding to Offset Stress

Cattle come to the feedlot or farm with some degree of dehydration and starvation if they have been shipped any appreciable distance. The body is deficient in water, energy, protein and perhaps mineral and vitamins. As discussed earlier, cattle need rest but it takes adequate feed to replenish the nutrients lost during shipping. Quick recovery to the normal healthy state will result in increased resistance to most diseases that affect cattle following shipment.



The first 2 to 4 weeks in the feedlot are critical.

Clean, fresh water should be available for the cattle when they arrive. Small capacity water cups or tanks will not provide enough water for new cattle. Large tanks should be provided until the cattle have filled up and are accustomed to drinking from the small waterers. Cleaning and disinfecting water troughs should become a routine practice before new cattle arrive.

Cattle should be fed so they do not develop diarrhea or scours or become constipated. They need ample energy, protein, minerals and vitamins to replenish their body needs quickly.

Good quality roughage full fed should be the basic feed for starter rations. High quality, early cut grass hay, medium quality alfalfa hay, good quality corn or sorghum silage or mixtures of these are all satisfactory roughages for new cattle. Some dry roughage will be desirable when high moisture silages are fed.

The feeding of 1 to 2 pounds of grain per head daily will aid in supplying the energy needed for recovery to a normal state. The grain can be any one or a mixture of the grains available locally. Young cattle are usually slow in learning to eat grain. Mixing the grain with the roughage or pouring the grain over the roughage will help overcome this problem. Using the whole oats as the grain will also help since oats appears to be the grain best liked by "new cattle."

A small amount of wheat bran may also be helpful in teaching calves to eat since it sticks to wet muzzles. Warning—adjust the

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Disease Prevention

(continued from page 17)

amount of grain fed to the number of cattle that have learned to eat grain.

The amount of supplemental protein needed will depend primarily on the protein content of the other feeds fed. The protein content of the ration should be 11% for light cattle and 10% for cattle over 700 pounds from the first day after arrival until they are changed to their regular feeding program. This may involve the equivalent of 1 pound of 36% to 40% supplement or more in some situations. If the supplement is not mixed with the roughage, adjust the amount of protein fed to the number of calves eating the supplement.

The protein supplement used should be palatable and easily digested. Because of this, supplements containing plant proteins are more appropriate for new cattle than those containing non-protein nitrogen.

Vitamin A stores may be depleted in cattle that come from dry areas or those that spend a considerable time en route to their new home. Vitamin A needs can usually be quickly met by including high levels of Vitamin A (50,000 or more I.U. per head daily) in the feed for the first week to 10 days, by feeding feeds high in carotene (such as dehydrated alfalfa, about 1 pound per head daily), or injecting each animal with 500,000 to 1 million I.U. of Vitamin A on arrival. Using the injection has the disadvantage that the cattle must be run through a chute which creates additional stress.

"B" vitamins may be needed for quick recovery of cattle that are sick or have been sick en route to your feedlot. Animals that are healthy and get started on feed properly after arrival should be producing their own "B" vitamin supply through the rumen fermentation processes.

The mineral depletion that occurs during shipment and mineral needs immediately after arrival have not been thoroughly researched. Observation of many researchers and feeders is that cattle often crave rather large quantities of minerals the first few days after arrival. A supplement containing 8% to 10% phosphorus with trace minerals added should be available, free choice.

Stress feeds are manufactured especially for feeding to cattle the first few days in the feedlot. These include, in addition to varying levels of protein, rather high levels of vitamins and minerals and may also contain antibiotics. Your veterinarian may recommend one of these or you may select one of these that supply the nutrients you need in your starting ration at reasonable cost rather than providing these nutrients separately.

Preventive Treatment

High levels of antibiotics in the feed, sulfonamides in the water or mass injections of antibiotics may be used as disease prevention measures when an outbreak appears imminent. Research that is available would indicate that these are not likely to be profitable as routine practices. There is some indication that routine use of antibiotics can complicate treatment of sick animals.

Immunization

Calves get their first protection from the colostrum. This is a passive immunity that is usually lost by the time the calf is weaned. This means that calves have little or no protection against disease unless they have been given vaccine which helps them develop protection against certain diseases. For best protection vaccination should be done three weeks or longer before calves are weaned and shipped.

There is no effective vaccine at this time for the prevention of shipping fever. There are effective vaccines for the prevention of blackleg, malignant edema, leptospirosis, and infectious bovine rhinotracheitis (rednose).

To be most successful cattle should be vaccinated 3 weeks or more before exposure to disease and the stress of weaning and shipping. When the cattle arrive at the feedlot without vaccination, immunization programs should be delayed until the cattle have recovered from shipping stress. If you decide to vaccinate for virus diarrhea, wait until 2 to 3 weeks after blackleg, malignant edema and rednose vaccines have been administered.

New cattle should be treated routinely for lice (check with your county agent for latest recommendations.) They should be treated for grubs if they are to be slaughtered during the season that grubs will be emerging from the back. (See circular EC 63-1583)

Your working agreement with your veterinarian should include arrangement for a check on the worm load if you have any reason to suspect that worms may be a problem. Then, if a worm load is high enough, treat with phenothiazine or thiabendazole. With a light infestation, the cost of worming and the resulting setback may be more costly than the parasite damage.

Pregnant heifers may be a problem in your feeding program. If they are not guaranteed open, you may want to have them checked for pregnancy or abort them. Usually it is wise to delay either until the heifers become adjusted to their new location.

Summary

Develop a disease prevention and control program for newly arrived cattle which will:

Keep stress at a minimum during and following shipment.

Provide for early treatment of sick cattle.

Provide feed to help the animals quickly overcome shipping stress.

Use preventive treatment when indicated by your veterinarian.

Immunize against rednose, blackleg, malignant edema, leptospirosis and possibly virus diarrhea as soon as the cattle have recovered sufficiently from shipping.

Control both external and internal parasites.

Hybrid Vigor in Beef Cattle

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Comprehensive analyses have been made on the data from the first phase of an extensive crossbreeding experiment conducted at the Fort Robinson Beef Cattle Research Station. This experiment involves Hereford, Angus and Shorthorn breeds.

In the first phase of the experiment, the three straightbreds and all reciprocal crosses among them were produced. Heterosis or hybrid vigor was evaluated by comparing crossbreds with the average of straightbreds for all major economic traits involved from conception through growth and onset of puberty for heifers and through growth and slaughter of the steers.

The effects of heterosis were significant for most of the traits evaluated. The results of these analyses are summarized in the 1966 and 1967 Beef Cattle Progress Reports.

Second Phase

The second phase of this experiment is nearing completion.

This involves the evaluation of the effects of hybrid vigor on fertility and mothering ability.

Table 1 gives the experimental design for the second phase of this experiment. Straightbred cows of the three breeds are being compared with their crossbred half-sisters when both are bred to the same bulls to have crossbred calves.

Table 2. Heterosis effects on fertility in Phase 2 of the experiment (preliminary report results).

	No. matings	Calving to first heat days	Settled on first service %	Pregnant %	Calves born %	Calves weaned %
1962—to calve as 3 year olds						
Crossbreds	30	...	64	94	92	89
Straightbreds	30	...	56	89	78	72
Difference	...	...	+8	+5	+14	+17
1963—to calve as 2, 3 and 4 year olds						
Crossbreds	131	56	59	84	79	75
Straightbreds	109	59	44	81	73	69
Difference	...	–3	+15	+3	+6	+6
1964—to calve as 2, 3, 4 and 5 year olds						
Crossbreds	139	68.9	72	97	90	76
Straightbreds	116	69.4	63	90	80	66
Difference	...	–.5	+9	+7	+10	+10
1965—to calve as 3, 4, 5 and 6 year olds						
Crossbreds	133	55.6	60.2	86.5	85	80
Straightbreds	108	59.6	51.9	92.6	87	83
Difference	...	–4.0	+8.3	–6.1	–2	–3
1966—to calve as 4, 5, 6 and 7 year olds						
Crossbreds	130	47.6	55.4	93.1	92	88
Straightbreds	106	52.9	54.7	86.8	82	77
Difference	...	–5.3	+.7	+6.3	+10	+11
1967—to calve as 5, 6, 7 and 8 year olds						
Crossbreds	125	43.5	65.6	90.4	87.2	84.0
Straightbreds	102	49.4	65.6	83.3	79.4	76.5
Difference	...	–5.9	.0	+7.1	+7.8	+7.5

Table 2 provides a summary of results of the heterosis effects on fertility traits through the 1967 breeding season.

Table 3 provides information on the preweaning performance of calves out of both crossbred and straightbred cows through the 1968 calf crop.

Crossbreds Favored

For the six years (1963, 1964, 1965, 1966, 1967 and 1968), the advantage of the crossbred cows has been 17, 6, 10, –3, 11 and 7.5%, respectively, for calf crop weaned and 17, 32, 21, 23, 28 and 13 lbs., respectively, in weaning weight of calves at 205 days.

On the average, percent calf crop has been 6.5% greater for crossbred dams than for straightbred dams. Crossbred calves out of crossbred dams have on the average had 5% heavier weaning weights than crossbred calves out of straightbred dams.

When both of these traits are considered, a 14% advantage in favor of crossbred cows has been

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Table 1. Experimental design for Phase 2 of the experiment.

Dams	Sires[a] Hereford	Angus	Shorthorn
Hereford		A x H	S x H
Angus	H[b] x A		S x A
Shorthorn	H x S	A x S	
H x A and reciprocal			S x (H x A)
H x S and reciprocal		A x (H x S)	
A x S and reciprocal	H x (A x S)		

[a] Object is to compare crossbred cows with their straightbred half sisters when both produce crossbred calves by the same sires.

[b] Breed of sire is listed first. Comparisons will be between crossbred and straightbred cows for each column and the average of all crossbred cows with the average of all straightbred cows.

Hybrid Vigor

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realized for pounds of calf weaned per cow exposed to a bull in the breeding pasture.

This does not take into account the 3% advantage in percent calf crop weaned and the 4.5% advantage in weaning weight of crossbred calves over straightbred calves indicated in the first phase of this experiment.

The results of heterosis effects on cow performance traits (fertility and mothering ability) should be regarded as preliminary because the data have not been analyzed by the most thorough statistical procedures to date.

Table 3. Weaning weight of calves, weaning scores of calves and estimated milk production of dams in Phase 2 of the experiment—1962, 1963, 1964, 1965, 1966, 1967 and 1968 (Preliminary report of results).

Dams	No.	Wn. wt.[a] 205 days lbs.	Wn. score[b] 205 days	Est. milk production 12-hour period[c] lbs.
		1963 calf crop		
Crossbreds	27	482	12.3	9.44
Straightbreds	24	465	11.6	8.97
Difference	...	+17	+.7	+.47
		1964 calf crop		
Crossbreds	97	484	13.0	7.87
Straightbreds	73	452	12.2	7.03
Difference	...	+32	+.8	+.84
		1965 calf crop		
Crossbreds	105	467	12.6	7.37
Straightbreds	74	446	12.2	6.70
Difference	...	+21	+.4	+.67
		1966 calf crop		
Crossbreds	106	480	12.8	...
Straightbreds	89	457	12.3	...
Difference	...	+23	+.5	...
		1967 calf crop		
Crossbreds	114	488	13.1	...
Straightbreds	82	460	12.7	...
Difference	...	+28	+.4	...
		1968 calf crop		
Crossbreds	105	491	12.9	...
Straightbreds	78	478	12.6	...
Difference	...	13	.3	...

[a] Adjusted to mature equivalent dam basis—average of steers and heifers.
[b] Scores of 12, 13 and 14 = low, average and high choice, respectively.
[c] Calves average 2.3 months of age and dams were on summer range when estimates were made.

Value of Sandhills Upland Hay

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What is the nutritive value of Sandhills upland hay when stored by the various methods commonly used in the area?

A study was conducted on the Reed Hamilton Ranch near Thedford, Nebraska in 1962 and 1963 to help answer this question. Results of the work were reported by Streeter *et al.*, in the 1965 Annual Feeders Day Progress Report.

Hay was cut early (July 13) and late (August 27) in both 1962 and 1963 and stored by: (1) baling with a rotobaler; (2) windrowing with a dump rake; (3) bunching with a basket attached to the cutter bar of a tractor mounted mower; and (4) letting the forage remain standing. Samples from the four storage treatments of both early and late cuttings were collected monthly from July through January for chemical analysis.

Streeter attempted to assess the nutritive value of the hay by: (1) determination of the digestible protein and energy of the early and late-cut round baled hay and (2) the determination of the change in chemical composition as influenced by cutting date, method of storage and storage time.

Results of this work indicated that early cut hay was higher in nutritive value but produced less forage than late cut hay. The nutritive value of the standing forage was considerably lower than that of the other storage treatments, while relatively little difference was found between the nutritive values of the bunched, windrowed and baled hays. Hence, it was thought that these forages should be more thoroughly evaluated to determine if in fact the nutritive value of prairie hay was maintained as well throughout the storage period when stored in bunches and windrows as when stored in bales.

The samples which Streeter collected during his study were used in this work. An attempt to reassess the nutritive value of these hays was made by obtaining dry matter digestibilities (D.M.D.) via the two stage *in vitro* rumen (artificial rumen procedure in the laboratory) fermentation procedure of Tilley and Terry. Samples were fermented in duplicate with replications made on two different days.

Results

Results of the present study are shown in Figures 1 and 2. Figure 1 shows the effect of storage time on D.M.D. for both the early and late cutting in 1962 and 1963. There is a very sharp decline in digestibility both in 1962 and 1963 between July and September. However, there was essentially no change in either year between September and January.

In 1963 the D.M.D.'s appear to increase throughout the latter months of storage. However, this may be an error due to sampling. Considering the wide range of plant species represented in prairie hay it is easy to see why field replications could be quite different

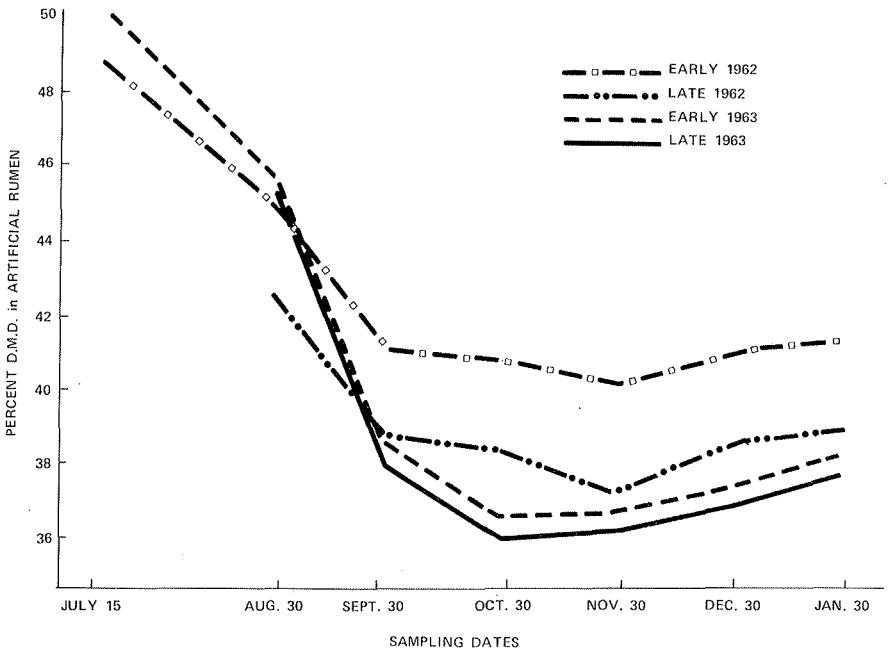

Fig. 1. Effect of storage time on D.M.D. for early and late cutting, 1962, 1963.

with respect to plant composition and hence, D.M.D.

Data for 1963 indicate that there is a much greater decrease in digestibility between July and September than in 1962. Although the hays for 1963 had a higher initial D.M.D. by September they had decreased below the D.M.D.'s for the 1962 hays. This sharp decrease in 1963 is probably due in part to the rainfall pattern. In 1963 there was 5 inches of rainfall the month before both the August and September sampling dates. In 1962 there was nine inches of rainfall before the August sampling date, but only 1.4 inches between the August and September sampling dates.

In 1962 there was a much greater difference between the D.M.D.'s of the early and late cut forages than in 1963 (Figure 1). One of the reasons for the wide difference between the early and late D.M.D.'s in 1962 was probably related to their yields. As was previously mentioned, nine inches of rain fell between the early and late cutting dates with the result that the late cut hay yielded 405 pounds per acre more than the early cut hay. The late cut hay was thus coarse and more highly lignified than the early cut hay which no doubt led to its lower D.M.D. In 1963 there was only 102 pounds greater yield from the late cut than from the early cut hay. There was much less forage growth between cuttings in 1963 than in 1962, and hence less physical change in the forage which would be reflected in its digestibility.

Apparent digestible and apparent metabolizable energy values (steers in conventional digestion trials) obtained by Streeter would tend to substantiate the laboratory (artificial rumen) D.M.D. differences as related to year and cutting date shown in Figure 1.

The effect of method of storage and storage time on D.M.D. in artificial rumen for both 1962 and 1963 is shown in Figure 2. It can be noted from both graphs that the D.M.D.'s for the baled hay remained higher throughout the storage period than the D.M.D.'s of the other storage methods. However, analysis of these forages by Streeter for nitrogen, phosphorus and lignin failed to show a consistent advantage for baled hay as a method of storage.

The 1962 data indicate that there is much less difference between the D.M.D.'s for baled hay and those of the other treatments than is shown by the 1963 data. The curves for 1962 show that D.M.D.'s for the bunched and windrowed hays declined much less than the standing forage. However, in 1963 there seems to be little difference between the windrowed, bunched and standing treatments. It is possible that the greater yield of forage in 1962 might have afforded more protection against weathering for the bunched and windrowed hays and hence less decline in their D.M.D.'s was noted. It should also be pointed out that while the D.M.D.'s of the baled, bunched and windrowed hays for both years declined only until October the standing forage continued to decline until November or December.

The animal D.M.D. values obtained by Streeter in 1963 for the early and late cuttings were 47.6% and 46.6% respectively, while the D.M.D.'s in artificial rumen for the early and late cuttings were 44.6% and 46.9% respectively.

Although the animal and the artificial rumen D.M.D.'s are of the same magnitude it is interesting to note that the late cutting has a higher D.M.D. in the artificial rumen than the early cutting. While this is in disagreement with the above animal D.M.D.'s it exhibits the same trend that is evidenced by Streeter's animal protein (3.2% versus 3.8% respectively for the early and late cuttings) and energy digestibility (776 versus 781

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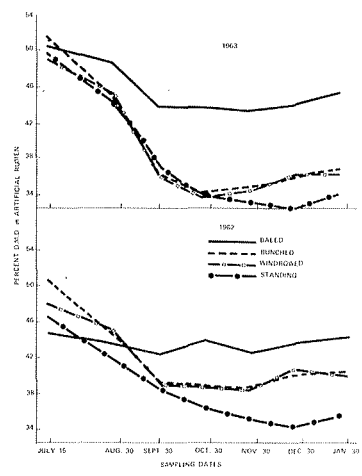

Fig. 2. Effect of method of storage and storage time on D.M.D. in artificial rumen, 1962, 1963.

Value of Hay

(continued from page 21)

Kcal/lb. respectively for the early and late cuttings) data.

The 1962 animal data, however, does not compare well with the artificial rumen data. The animal D.M.D.'s for these hays were 39.5% and 33.4%, respectively, for the early and late cuttings as compared to 48.6% and 44.7% for the artificial rumen D.M.D.'s. It is probable that the animals from which the 1962 data were obtained were not receiving enough protein to meet their requirements and thus, were not fully utilizing the available energy in the forage. This would explain the low animal D.M.D.'s and hence explain the discrepancy between the animal and artificial rumen data.

Summary

With respect to maintenance of nutritive value, storage of prairie hay as round bales appears much superior to storing it in windrows, bunches or letting it remain standing.

It should also be pointed out that the greatest decrease in D.M.D. occurred during the first 60 days in storage. However, the decrease in D.M.D. which occurred during this period is probably related to precipitation levels. The D.M.D. of prairie hay shows a definite decline with advance in season. However, the date of cutting had a more pronounced effect on the D.M.D. in 1962 than in 1963.

Experiments in Progress

Adjusting Cattle to Urea Supplements

Experiments are in progress at the Field Laboratory and Scottsbluff Station to determine if the kind of protein fed during the initial period cattle are in the feedlot aids in the adjustment to high urea supplements.

Urea Supplements of Corn Silage

These experiments are being conducted to determine if the effectiveness of urea as a supplement to a high corn silage ration can be increased.

At the Mead Field Laboratory, combinations of urea and protein in a liquid supplement are being investigated as a supplement to corn silage for calves. In addition, ammonium salts of volatile fatty acids are being investigated in silage and dry roughage rations as sources of supplemental protein.

Factors Influencing Roughage Utilization

The influence of processing upon the utilization of low quality roughages and other high cellulose products by beef cattle and sheep is being investigated at the Lincoln Station. Both high grain and high roughage rations are being fed to determine if processing of the roughage influences its feeding value.

High Sugar Corn

The production per acre, ensiling losses and feeding value of several varieties of corn is being compared at the North Platte Station. One of the varieties in the test is a high sugar corn.

Range Forage Utilization

A study is under way at the North Platte Station to determine the effect of supplemental program upon quantity and quality of range forage consumed as well as supplement effect upon digestibility of the forage.

Factors Affecting Nitrogen Utilization

Factors (such as source of nitrogen, method of administration and source of energy) are being investigated in digestion and metabolism trials to determine if the efficiency of supplemental protein can be increased in beef cattle. This research at the Lincoln Station is investigating the effect of method of feeding and different sources of non-protein nitrogen upon its utilization by cattle.

The Effect of Sex on Production and Carcass Traits

The project in progress has as its objectives: the effects of sex, (bull versus steer), on carcass quality; level of energy on carcass quality and composition; chronological age on carcass desirability; the relationship between chronological and physiological age; and to determine the degree and importance of interactions among sex, level of energy and age with particular attention to the differences in the quality of beef from bulls and steers fed to have the same degree of marbling at the same chronological age.

Seventy-two bulls and 72 steers will be slaughtered. Sixteen of each sex will be slaughtered at 12, 15, 18 and 24 months of age. Each age group will be composed of steers and bulls fed at two levels of energy. They will be fed eight head to the lot by sex; one half of each lot from a different source. One lot of bulls and one lot of steers will be fed on each of the two levels of energy. Two lots, one lot of eight steers and one lot of eight bulls, will be slaughtered at nine months of age. Each lot will be fed on a different level of energy.

Production data and quantitative carcass measures will be obtained. Carcass quality will be measured by marbling score, maturity score, grade, and tenderness measured with the Warner-Bratzler shear. Chemical evaluation, histological studies, and palatability, measured by a taste panel, will also be made. This work will be in cooperation with the Market Quality Research Division, ARS, U.S.D.A.

Beef Cattle Selection Experiments

At Fort Robinson, a breeding experiment is being conducted to determine changes in production when cattle are selected for (1)

weaning weight, (2) yearling weight, and (3) a combination of yearling weight and thicker muscling.

Three lines of cattle originating from the same foundation stock were established in 1960. Since 1960, all replacement bulls and heifers have been selected within each line on the criteria outlined above. Each line has about 150 cows. Six bulls are used each year. Two bulls and 25 heifers are selected to add to each line every year. These criteria of selection (weaning weight, yearling weight, muscling and yearling weight) were chosen because:

1. Weaning and yearling ages represent important ages for marketing cattle.
2. Pre-weaning and post-weaning growth represent distinct production phases.
3. We need to know the correlated response in feed efficiency, longevity, carcass merit and rate of maturity when selection for early growth rate is emphasized.
4. The traits, easily measured, represent simple objectives.
5. Previous research indicates these traits are heritable and should respond to selection.

The experiment is long term in nature and will likely take 20 years to have adequate evaluation.

Supplements on Native Summer Range

At the North Platte Station, various types and amounts of supplements are being studied with yearling cattle grazing native range in the summer.

Pelleted Whole Corn Plant

At the North Platte Station, pelleted whole corn plant is being compared with corn silage. The green chop was dehydrated and pelleted at the time the comparable green chop was ensiled.

Beef Production from Irrigated Pasture

At the North Platte Station, post-calving nutrition and/or management will be studied with major emphasis on the use of irrigated pasture. The use of yearling cattle on irrigated pasture is also being studied.

Silage Quality

Drought corn silage and good quality corn silage are being compared in growing rations for calves at the Northeast Station.

Silage Level in Finishing Ration

The level of corn silage for optimum animal performance is being studied at the Northeast and Scottsbluff Stations. In addition, comparison to other roughage sources and all concentrate rations are being made.

All Concentrate Rations

All concentrate rations are being investigated in trials at the Lincoln station to determine if supplemental program influences cattle response.

Estrous Cycle Control

Although considerable progress has been achieved in the artificial control or synchronization of estrous cycles by the use of hormonal materials, certain problems remain to be solved. A significant one is the tendancy for lowered conception when breeding at the controlled estrous period. The fertility appears only temporarily reduced and apparently returns to normal at the subsequent estrous period which occurs approximately 21 days later. Unfortunately, some of the synchronizing effect is lost by this time.

A study has been initiated at the Mead Field Laboratory in which emphasis is given to cycle control by a gradual process—but yet with a minimum number of actual treatments. Hormone injections were given during parts of two consecutive estrous cycles and an artificial insemination program was initiated subsequent to the hormone-treatment period. The study involves 112 cows which are on a spring calving program.

Hormone Treatments and Ovarian Responses

Pilot studies are presently underway with cyclic cows to gain information on the alterations that various hormone treatments cause with respect to activity of the ovary. Ovaries are manually palpated via the rectum to detect any changes that the treatments may cause, and data of incidence of estrus are collected. It is the hope that these studies will lead to the development of a treatment(s) which would allow for both synchronization of estrus and an increase in the frequency of twinning. If a treatment appears promising, it will be tested under field-type conditions.

Animal Science

Animal science is the art and science of animal agriculture whereby meat and fiber are produced for America's millions. Today Animal Science requires a knowledge of all biological sciences, botany, zoology, bacteriology, genetics and physiology. It also requires a knowledge of mathematics, chemistry, and physics as well as the agricultural sciences dealing with forages, feed grains, insects, animal health, nutrition, breeding and meats.

The person who likes sciences will find Animal Science challenging. Many Animal Science positions require considerable contact with people. For those who would rather work by themselves, there are positions in laboratories and offices. So, whether you prefer the outdoors or the indoors, the market place, the laboratory, or the classroom, there is a place for you in Animal Science if you like livestock.