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Research in Beef Cattle Nutrition and Management

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1968 PROGRESS REPORT

RESEARCH IN BEEF CATTLE NUTRITION AND MANAGEMENT

Robert J. Raleigh and Harley A. Turner

COMPARATIVE VALUE OF BARLEY AND MEADOW HAY WITH TWO SOURCES OF NITROGEN FOR WINTERING CALVES

The net energy value of grain and roughages has been fairly well established for fattening cattle. However, the relative value of barley and meadow hay fed for maintenance and low levels of production such as for wintering weaner calves has not been determined.

Urea has been used as a substitute for protein in the diet of ruminants for many years to reduce the cost of supplemental protein. Although urea has been successfully fed, there is still the problem of toxicity. The extent that urea can be utilized depends on quality of roughage, level of energy, method of feeding, and preparation or mixing. Palatability or acceptability of urea by the animal has been a problem of urea feeding. Biuret 1/, a condensation product of urea, is a nonprotein nitrogen compound similar to urea but releases nitrogen more slowly than urea and is less toxic to the animal. Also, research indicates that problems of palatability are not as great with biuret as with urea.

The objectives of this project were to determine the replacement value of barley for meadow hay when fed to weaner calves on a wintering ration and to compare the value of biuret with cottonseed meal as a protein supplement for wintering weaner steers.

EXPERIMENTAL PROCEDURES

Thirty-six steer calves averaging 473 pounds were stratified by weight to a 2 x 3 factorial trial with two sources of energy and three sources of N (Table 1). Energy sources were (1) high-roughage, with the energy for maintenance calculated to come from meadow hay and the energy for 1.5 pounds daily gain to come from barley, and (2) low-roughage, with half of the energy for maintenance to be provided by meadow hay and the energy for the other half of maintenance and 1.5 pounds daily gain from barley. There were three sources of N to provide the N requirement above that supplied by the hay and barley. Sources for the additional N were biuret alone, cottonseed meal alone, and a biuret-cottonseed meal mixture with each supplying one-half of the additional N. There were six animals per treatment with each treatment fed and maintained in a separate lot. The trial was conducted over a period of 112 days.

1/ Biuret was provided by the Dow Chemical Company under the trade name "Kedlor" and is not yet approved in the United States by the FDA for use in livestock feeds. The Dow Chemical Company also provided financial assistance for this research.

Table 1. Experimental design

Source of N	Energy source 1/ High-roughage	Energy source 1/ Low-roughage	Total per N source
Cottonseed meal	6 2/	6	12
Biuret	6	6	12
CSM & Biuret	6	6	12
Total per energy source	18	18	36

1/ Diets on all treatments were balanced for energy and N with the high-roughage diet providing the energy requirement of maintenance from meadow hay, and the energy required for gain from barley; while the low-roughage diets provided half the energy requirement for maintenance and the rest from barley.

2/ There were six animals on each treatment, making a total of 36 animals.

The grain portion of the ration was fed twice daily in feed troughs and the hay was chopped and fed in covered mangers. The chopped hay was weighed in daily with refusals weighed out each week. Fresh water, salt, and a salt-bonemeal mixture were available free choice in the lots. The animals were weighed at 28-day intervals, before the morning feeding after an overnight restriction from water.

The N and energy content of the feedstuffs used in the diets are given in Table 2. Table 3 shows the composition of the daily rations. The diets were balanced to be as nearly equal for energy and N as possible. A trace mineral mixture and additional sulfur was added to all diets. The biuret and minerals were premixed with a small amount of ground barley before being mixed into the daily ration.

Table 2. Composition of feedstuffs

	Nutrients: Nitrogen	Nutrients: Total digestible nutrient	Nutrients: Digestible energy	Nutrients: Sulfur
	(%)	(%)	(th/lb)	(%)
Hay	1.28	50	0.96	.15
Barley	1.87	78	1.50	.15
Cottonseed meal	6.64	66	1.27	.46
Biuret	38.00	0	----	---

Table 3. Composition of each diet

Ingredient	Diet number 1/					
	1	2	3	4	5	6
	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)
Hay 2/	9.0	9.0	9.0	4.50	4.50	4.50
Barley	2.5	3.35	2.99	5.38	6.23	5.83
Cottonseed meal	1.0	----	.43	1.06	----	.466
Biuret	---	.133	.075	----	.140	.081
Sulfur 3/	.01	.013	.012	.012	.016	.014
TM salt mix	.01	.01	.01	.01	.01	.01
Salt	.17	.07	.14	.27	.13	.23
Salt-bonemeal	.07	.05	.06	.19	.11	.17
Total	12.76	12.626	12.717	11.422	11.136	11.301

1/ Diets 1, 2, and 3 are high-roughage diets with the N source being cottonseed meal, biuret, and cottonseed meal with biuret, respectively, and diets 4, 5, and 6 are low-roughage with N from the same sources as diets 1, 2, and 3, respectively.

2/ As the animals gained weight the hay was increased accordingly, until by the end of the trial the high-roughage group was receiving 12 pounds per day and the low-roughage 6 pounds. The actual consumption of hay was 10.4 and 5.2 pounds, respectively, for the high-roughage and low-roughage diets.

3/ Sulfur was added in the amount that each diet provided .0318 pounds of S per head daily.

OBSERVATIONS AND RESULTS

The production data and costs are presented in Table 4. In all cases steers on the high-roughage diet gained more per day, cost less per pound of gain, and returned more over feed costs than steers on the low-roughage diet. In this study approximately five pounds of hay was replaced by three pounds of barley. The results indicate that for this level of production meadow hay may be of more value than is generally believed.

The low-roughage group consumed approximately twice as much salt and salt-bonemeal mixture free choice as the high-roughage group. This increased the cost of the ration of the low-roughage group about one cent per head daily over that of the high-roughage group. The steers on biuret consumed less of the salt and salt-bonemeal mix than the groups on either the cottonseed meal or cottonseed meal-biuret.

The results of this trial indicate that biuret can be successfully used as a protein supplement. The steers fed biuret and cottonseed meal gained more per day, were more efficient, and returned more over feed costs than the groups receiving either the cottonseed meal alone or biuret alone. The cottonseed-meal fed steers outgained the biuret fed steers, but return over feed costs were about the same. There were no toxicity or palatability problems with the biuret.

Table 4. Average daily gain, feed efficiency, cost per pound of gain, and profit over feed costs for each treatment over the 112 day feeding trial

Treatment Energy Nitrogen	Number of animal	Daily gain	Feed/lb gain	Cost/lb gain 1/	Return over feed cost 2/
		(lb.)	(lb.)	(lb.)	($)
High-roughage					
Cottonseed meal	6	1.40	10.2	.157	14.60
Biuret	6	1.29	10.8	.156	13.54
CSM & Biuret	6	1.40	10.1	.151	15.44
Low-roughage					
Cottonseed meal	6	1.16	10.4	.214	4.68
Biuret	6	1.11	10.6	.205	5.62
CSM & Biuret	6	1.26	9.5	.189	8.60
Averages					
High-roughage	18	1.36	10.4	.156	14.53
Low-roughage	18	1.18	10.2	.203	6.30
Cottonseed meal	12	1.28	10.3	.186	9.64
Biuret	12	1.20	10.7	.180	9.58
CSM & Biuret	12	1.33	9.8	.170	12.02

1/ Native hay was priced @ $20, barley @ $50, cottonseed meal @ $90, biuret @ $160, (estimated market cost), trace mineral salt @ $56, bonemeal @ $120, salt @ $40, and sulfur @ $96 per ton.

2/ Calculated for the 112-day feeding period with gain valued @ $.25 per pound.

VITAMIN A IN RANGE LIVESTOCK PRODUCTION

The hundreds of publications reporting research work done with vitamin A in beef cattle nutrition attest to the interest and concern about problems that are or might be related to vitamin A deficiency. The majority of workers reporting increased performance from vitamin A in the ration have been concerned with feed-lot cattle. Numerous researchers report inconclusive results and some report negative results from vitamin A administration. Many of the inconclusive or negative results reported were qualified by various statements. These might be summarized by saying that various measures indicate animals are in a state of submarginal deficiency, without clinical evidence of malnutrition. A further supposition is often made that even though there is no clinical evidence of a deficiency, if the condition persists deficiency symptoms would be manifested.

One wonders whether or not the positive results under certain situations have not caused us to assume that additional vitamin A should be given under all situations even though evidence is lacking to support such an assumption. The fact that vitamin A does no harm and is not an expensive component of rations lends support to its use as insurance against problems that might develop should a deficiency be present.

EARLY WORK AT THIS STATION

Some aspect of vitamin A nutrition of beef cattle has been under study at Squaw Butte almost continuously since the winter of 1950-51. The practice of holding hay in the stack for several years as an emergency reserve supply was thought to present some possible nutritional problems. Chemical analysis of stored hay showed little or no nutritive change in protein content, energy, phosphorus, or calcium but did show a marked decline in the carotene content of the hay. Carotene is converted to vitamin A in the animal body, and is, therefore, the major plant source of vitamin A to cattle. These studies showed that meadow hay cut at the proper time and stacked without bleaching contained about 60 ppm of carotene the first winter, 30 ppm the second, 15 ppm the third, and finally stabilized at about 5 ppm after the fourth year.

Studies were conducted to determine if the practice of storing and feeding older hay was adversely affecting beef cattle production. A two-year study beginning in the fall of 1950 using 18 pregnant, 4 and 5 year-old Hereford cows, showed no differences in calf crop, calving difficulties, calfhood diseases, or rate of growth that could be associated with decreased carotene content of hay that had been in the stack two or more years.

Sixteen mature Hereford cows were selected in 1952 to go on a three-year study in which sun bleached hay with an average of less than 2 ppm of carotene was used as the roughage ration. The cows were divided into four groups of four head each and received 1.5, 5, 15, and 25 mg of carotene per hundred pounds of body weight throughout the winters of 1952-53, 53-54, and 54-55.

The two groups of cows provided 15 and 25 mg of carotene per hundred pounds of body weight during the three-year period while on the winter feeding regime exhibited no symptoms of vitamin A deficiency in either the cows or their calves. In 1955 all calves from the cows receiving 1.5 and 5 mg of carotene per hundred pounds of body weight exhibited symptoms of night blindness by the 38th day of age. No other deficiency symptom or weight effects were evident.

In 1955 the cows receiving 1.5 mg of carotene per hundred pounds of body weight were held in drylot on their winter ration throughout the summer and fall. These cows did not manifest night blindness until December of 1955, after about one year of continuous feeding of bleached hay and straw. No other vitamin A deficiency symptoms were evident.

The National Research Council recommends a minimum level of 45 mg of carotene per day for wintering a 1000-pound pregnant cow. A 1000-pound cow receiving 15 mg of carotene per 100 pounds body weight would receive more than three times this amount. At this level of feeding there was no evidence of a deficiency in either the cow or calf. Furthermore, a 1000-pound cow consuming 20 pounds of hay that contained 50 ppm carotene would receive about 450 mg of carotene per day, indicating it should be nearly impossible for cattle fed on this type hay to be deficient.

This study along with the one completed in 1952 resulted in the Station recommending that ranchers feed old hay early in the winter and switch to new hay at least one month before calving. This recommendation was made as an extra precaution against the remote possibility that vitamin A deficiency might be a health factor in baby calves if the cows were fed old hay throughout the winter.

RECENT AND CURRENT STUDIES

Thirty-six 400-pound weaner Hereford steers were used during the winter of 1963-64 to determine the effect of additional vitamin A in the winter ration. Half of the calves received 20,000 I.U. of stabilized vitamin A per head daily with all calves receiving hay containing about 20 ppm of carotene. There were no significant differences in animal performance or disease resistance between those receiving additional vitamin A and those receiving no vitamin A supplement.

It has been frequently recommended that vitamin A be either injected or fed to pregnant cows, weaners, and yearlings during the winter period. It is believed that this will increase animal gains and feed efficiency in growing animals; and reduce calving troubles, weak calves, and calf scours in new born calves.

Calf scours have always plagued the cattle industry and vitamin A was used by various cattlemen as both a preventative and a treatment. The value of injectable vitamin A in the newborn calf for the prevention of scours was studied.

Twenty-seven newborn calves dropped between March 27 and April 4, 1963, were stratified by sex and by production index of dam and allotted to treatment. Calves from first-calf heifers or from cows involved in other studies were not used in this study. Thirteen calves received no injection for controls and 14 received 150,000 I.U. injectable vitamin A in oil suspension given intramuscularly within 24 hours after birth.

Results appear in Table 5. Vitamin A injected before calves were 24 hours old did not significantly reduce scours or increase weight gains of baby calves dropped about April 1 to turnout time on April 30, 1963.

Table 5. Effect of vitamin A on calves from birth to turnout time

Treatment	No. head	No. treated for scours	Birth wt.	Wt. 4/30/63	Gain to 4/30
Vitamin A 1/	14	7	79.1	122	42.9
Control	13	9	76.2	128	51.8

1/ 150,000 I.U. of vitamin A was injected at birth.

A study was initiated in the fall of 1966, (1) to determine if injectable vitamin A would increase the performance of weaner calves on a winter growing ration and (2) to study the effects of vitamin A on spring-calving cows and their calves.

Sixty weaners purchased for another study, and 125 weaners and 140 spring-calving cows from the Squaw Butte herd were used in this study. All of the spring-calving cows and weaners were run through a chute, and every other one was injected with 1 1/2 million I.U. and 1 million I.U. of vitamin A, respectively. The other half served as controls. All subsequent studies were then designed so that each study would have half of the vitamin A animals on each treatment, so that there would be no treatment advantage for either the controls or vitamin A-treated animals. All animals were weighed prior to injection and again onto summer range. Calving troubles, weak calves, and scours were recorded for the spring calving cows. The study was initiated on November 9 and ended on May 3.

The results of the trial with weaner calves are summarized in Table 6. There was essentially no difference between the vitamin A-injected animals and the controls. Although not significant, there was a slight advantage in gain for the controls over the vitamin A-injected animals. The average daily gain was .92 pounds for vitamin A-injected calves and .95 pounds for the controls.

There were not enough data on the spring-calving cows to form any conclusions. On the data collected, however, there did not appear to be any benefit from the vitamin A. Both groups lost three calves at birth or shortly after, and four of the animals receiving vitamin A required assistance at calving while one of the control animals required assistance.

The study was repeated beginning on September 27, 1967, with 26 steers and 33 heifers randomly selected and injected with 1 1/2 million I.U. of vitamin A. The control group was made up of 25 steers and 25 heifers.

Table 6. Performance of weaner calves on winter growing rations with and without injected vitamin A during 1966-67

	Number of calves	Beginning wt. 1/	Final wt.	Total gain	Average daily gain
		(lb.)	(lb.)	(lb.)	(lb.)
Purchased Weaners					
Steers, vit. A 2/	13	364	542	178	1.02
Steers, control	17	370	553	183	1.05
Heifers, vit. A	17	315	474	159	.91
Heifers, control	13	373	542	169	.97
Squaw Butte Weaners					
Steers, vit. A	27	403	571	168	.96
Steers, control	25	419	595	176	1.01
Heifers, vit. A	33	381	530	149	.85
Heifers, control	40	383	536	153	.87
Total					
Vit. A	90	373	534	161	.92
Control	95	389	556	167	.95

1/ Beginning weights were taken on 11/9/66 and final weight on 5/3/67.

2/ 1 million I.U. injected at the beginning of the study.

The steers and heifers ran together in a crested wheatgrass field at Squaw Butte from weaning to November 13, 1967, when they were trucked to the Section 5 winter quarters. From the September 27 weaning date to the conclusion of the study the weaners were supplemented on the crested wheatgrass with baled native meadow hay, rolled barley, and cottonseed meal. Carrying the calves through a 45-day post-weaning period before they were moved to winter quarters probably reduced the weaning time stress.

The study shows no advantage from vitamin A injected at weaning time. Calves without the vitamin A went through the stress of weaning with no more difficulty than those receiving the injection. Weight gains were the same for the treated and the control. The results are summarized in Table 7.

This study will not be completed until the late spring of 1968 when data is obtained from calving cows. At this date no measureable benefit has been derived from vitamin A injections in calves at weaning time. No benefit has been obtained from injecting pregnant cows with vitamin A about 30 days before the beginning of calving.

Table 7. Performance of weaner calves with and without injected vitamin A at weaning time during 1967-68

	Number of calves	Beginning wt. 1/	Final wt.	Total gain	Average daily gain
		(lb.)	(lb.)	(lb.)	(lb.)
Heifers					
Vitamin A	33	328	356	28	0.34
Control	25	354	383	29	0.35
Steers					
Vitamin A 2/	26	368	440	72	0.64
Control	25	370	445	75	0.66

1/ Beginning weights were taken at weaning 9/27/67, with final weight for the heifer calves on 12/19/67 and for steer calves 1/18/68.

2/ 1 million I.U. of vitamin A injected at beginning of the study.

BIURET, UREA, AND COTTONSEED MEAL AS SUPPLEMENTAL NITROGEN FOR YEARLINGS ON RANGE FORAGE

Previous studies at this Station have shown that supplementation with protein and energy to yearling cattle on range will give economic returns to about mid-August. The use of nonprotein nitrogen compounds as a replacement for supplemental protein could provide more economical livestock production. It has been generally believed that for proper utilization of nonprotein nitrogen an adequate supply of readily available carbohydrate is necessary. It has also been shown that additional nitrogen will increase the intake of low quality roughage by livestock. Biuret, 1/a condensation production of urea, releases nitrogen in the rumen more slowly, is less toxic and more palatable to the animal than urea.

The purpose of this study was to compare biuret, urea, and cottonseed meal as nitrogen supplements to yearlings on range feed with and without additional energy supplements.

1/ Biuret was provided by the Dow Chemical Company under the trade name of "Kedlor" and is not yet approved in the United States by the FDA for use in livestock feeds. The Dow Chemical Company also provided financial assistance for this research.

EXPERIMENTAL PROCEDURE

Forty yearling heifers averaging 557 pounds were stratified by weight to treatments in a 2 x 4 factorial trial with two levels of energy and four sources of N (Table 8). Energy levels were (1) energy consumed by the animal that occurred naturally in the forage plus the energy from 0.66 pounds of barley that was used as a carrier for the biuret and urea, and (2) supplemental barley calculated to provide the additional energy for gains of about 2.0 pounds per head per day throughout the season. This meant increasing the barley as the season progressed, and energy content of the forage decreased, from 0.66 pounds at the start of the trial to 4.4 pounds at the end of the trial.

Table 8. Experimental design with two levels of energy and four single sources of N 1/

Source of N	Energy level 1	Energy level 2	Number of animals
None	5	5	10
Biuret	5	5	10
Urea	5	5	10
Cottonseed meal	5	5	10
Number of animals	20	20	40

1/ Nitrogen energy supplements started at low levels and increased as forage nutrients decreased to meet the animal's nutrient requirement for about 2.0 pounds daily gain. All diets were balanced for N and energy within energy levels and N sources with the exception of the non-nitrogen supplemented groups.

Nitrogen sources consisted of (1) a control with no additional N, (2) additional N from biuret, (3) additional N from urea, and (4) additional N from cottonseed meal. Nitrogen supplemented to the animal increased as the forage matured and forage N decreased. At the start of the trial N was supplemented at 17 grams per head per day and this was increased to 62 grams by the end of the trial. Table 9 shows levels of N and energy supplementation for different periods during the trial.

The heifers grazed together on crested wheatgrass pasture during the entire trial period. They were gathered daily and put in individual feed pens where they received their respective supplements. Salt and a salt-bonemeal mixture were available to the animals throughout. The cattle were weighed going onto the trial and at four-week intervals during the trial. The trial started on June 21 and ended September 29, 1967.

Table 9. Nitrogen and energy supplementation levels for different periods during the grazing season 1/

Period	Nitrogen	Digestible energy
	(g/hd/day)	(kcal/hd/day)
6/21-6/27	17.2	1120
6/28-7/4	23.2	1420
7/5-7/11	28.5	1800
7/12-7/25	36.2	2390
7/26-8/8	46.3	3550
8/9-8/22	50.4	4620
8/23-9/5	54.2	5180
9/6-9/19	58.0	6150
9/20-9/29	62.0	7000

1/ All diets were balanced for N and energy within energy levels and N sources with the exception of the non-nitrogen supplemented groups. The energy supplement was primarily rolled barley.

OBSERVATIONS AND RESULTS

The daily gains and cost of supplements per pound of gain are given in Table 10. Due to above average rainfall in May and June, the forage was abundant with much lower nutritive value than usual. As a result gains were somewhat lower than in previous years on similar diets.

The heifers receiving biuret with low energy gained 0.25 pounds more per day than the groups receiving either urea or cottonseed meal. However, the animals receiving the low energy with urea and cottonseed meal gained about a half pound more per day than the controls.

The animals did not respond to the high energy diets as well as expected. This was probably due to the lower food value of the forage than predicted. The biuret and cottonseed meal groups with high energy gained 0.2 pounds more per day than the group receiving urea with high energy. The high energy group without additional N gained the same as the urea and cottonseed meal groups with low energy. This is similar to results from previous studies that showed a need for both additional energy as well as additional N.

The animals readily adjusted to their individual feeding regime and the only problem encountered was with the urea-low energy diet. During the

Table 10. Average daily gain and cost of supplement per pound of gain for each treatment

Source of N	Measure of response	Energy level 1	Energy level 2
None	Average daily gain, lb.	0.78	1.27
	Cost/pound gain, $ 1/	----	0.050
Biuret	Average daily gain, lb.	1.49	1.68
	Cost/pound gain, $	0.023	0.045
Urea	Average daily gain, lb.	1.25	1.50
	Cost/pound gain, $	0.022	0.046
Cottonseed meal	Average daily gain, lb.	1.27	1.70
	Cost/pound gain, $	0.053	0.049

1/ Cost represents the cost of the supplements only with no cost for forage since animals on all treatments were grazing the same forage. Prices used for supplemental ingredients were: biuret 8¢, urea 6¢, cottonseed meal 4.5¢, and barley 2.5¢ per pound.

early part of the season the animals on the urea-low energy diet did consume most of their urea, but in the last month of the trial several animals failed to consume the entire amount.

The animals on the biuret and cottonseed meal diets consumed their entire ration within a few minutes. In fact, those receiving biuret seemed to eat their ration most readily. This was true at the beginning of the season when the daily biuret per head was 30 grams and at the end when each animal received 147 grams of biuret daily.

Two animals were lost with urea toxicity, one out of the control group and the other out of the biuret-low energy group. These animals worked a hole through the fence and licked an area where refused urea had been dumped. No disturbances were detected in any of the animals from eating their regular rations.

The cost of supplements per pound of gain was essentially the same for urea and biuret within each level of energy. This does not tell the entire story, however, since at the low level of energy the biuret group gained 0.25 pounds more per day. If these animals are valued at 25 cents per pound, this quarter pound gain is worth 6.25 cents, giving a return of 5.3 cents per day from the animals fed the biuret over those fed urea. This same difference exists at the higher level of energy although it is not as great. Table 11 shows the costs and comparative value of each supplement.

Table 11. Economic evaluation of supplemental treatments

Source of N		Energy level 1	Energy level 2	Comparison of energy levels 2 over 1
None	Gain lb.	78	127	49
	Value, $ 1/	19.50	31.75	12.25
	Cost, $ 2/	------	6.27	6.27
	Return, $	19.50	25.48	5.98
	Value of suppl., $ 3/	------	5.98	5.98
Biuret	Gain lb.	149	168	19
	Value, $	37.25	42.00	4.75
	Cost, $	3.45	7.35	3.90
	Return, $	33.80	34.65	0.85
	Value of suppl., $	14.30	15.15	0.85
Urea	Gain lb.	125	150	25
	Value, $	31.25	37.50	6.25
	Cost, $	2.75	6.93	4.18
	Return, $	28.50	30.57	2.07
	Value of suppl., $	9.00	11.07	2.07
Cottonseed meal	Gain lb.	127	170	48
	Value, $	31.75	42.50	10.75
	Cost, $	6.68	8.44	1.76
	Return, $	25.07	34.06	8.99
	Value of suppl., $	5.57	14.56	8.99
Comparison of protein treatments				
Biuret over control, $		14.30	9.17	
Urea over control, $		9.00	5.09	
Cottonseed meal over control, $		5.57	8.58	
Urea over biuret, $		-5.30	-4.08	
Cottonseed meal over biuret, $		-8.73	-0.59	
Cottonseed meal over urea, $		-3.43	3.49	

1/ Value of gain figured at 25¢ per pound liveweight gain.

2/ Cost represents the cost of the supplements only with no cost for forage since animals on all treatments were grazing the same forage. Prices used for supplemental ingredients were: biuret 8¢, urea 6¢, cottonseed meal 4.5¢, and barley 2.5¢ per pound.

3/ Value of supplement is "return" minus "cost" of supplement.

In this study both urea and biuret replaced cottonseed meal as a N source for range supplements to yearlings. Gains were not as large with urea as with cottonseed meal when used with either level of energy but costs of gains were lower with the urea so that urea fed with low energy gave a better economic return than cottonseed meal with low energy. The reverse was true when comparing the high energy-urea, and high energy-cottonseed meal diets.

When fed with low energy the biuret supplemented group gained more and returned more per animal than either the urea or cottonseed-meal fed groups. When fed with high energy, gains from animals receiving biuret were essentially the same as those from the animals receiving cottonseed meal with the high level of energy. However, the economic returns from the biuret fed group was slightly higher than from the cottonseed-meal fed animals. The additional return from the supplemented animals over the controls averaged for both levels of energy within each source of N supplementation was $14.77, $10.03, and $10.06 per head for the biuret, urea, and cottonseed meal fed groups, respectively.

HIGH QUALITY FALL RANGE FEED BY CHEMICAL CURING

Range forage decreases in quality with forage maturity so that by early July both protein and energy are limiting production on range livestock. Yearling cattle on this type of range feed gain 2.0 pounds or more daily during May and June, 1.5 pounds or less during July, less than a pound in August and relatively no gain after the first of September.

Research at this Station over the past several years has shown that chemical curing of range forage during June, at a time when nutrients are adequate for a high level of livestock production, can provide a good quality forage for fall grazing. Digestibility studies with forage cured with paraquat 1/ in June and harvested in the fall gave values significantly higher than naturally cured forage harvested at the same time. Preference trials with cattle and sheep indicate that the chemically cured forage is acceptable.

Grazing trials were conducted during the summers of 1966 and 1967 to determine the effect of chemically cured forage on nutrient intake and livestock performance.

EXPERIMENTAL PROCEDURES

Two crested wheatgrass pastures of 30 acres each were used for the study in 1966. One of the pastures was sprayed June 16-18 with 0.3 lb/acre paraquat in 20 gallons of water using 0.5% X-77. The other pasture was left untreated.

1/ Paraquat [1,1'-dimethyl-4,4'-bipyridinium di(methylsulphate)] was supplied by the Chevron Chemical Company which also partially financed this research. Paraquat, at the time of this writing, is not cleared through the FDA for use in curing herbage for forage.

Yearling heifers with an average weight of 684 pounds were allotted to each pasture based on the estimated carrying capacity. Fourteen heifers were put in the control pasture and 13 in the treated pasture.

Eight, 15-acre crested wheatgrass pastures were used in the study in 1967, with four pastures for controls and four pastures sprayed with 0.2 lb/acre of paraquat in 10 gallons of water with 0.5% X-77. The spraying was done with a ground rig from June 23-26.

Twenty-four yearling heifers, with an average weight of 664 pounds, were stratified by weight to each of four replications and two treatments with three animals per pasture, making 12 animals on paraquat treated forage and 12 animals on control forage.

The 1966 trial ran for a total of 36 days from August 16 to September 21, while the 1967 trial ran for a total of 75 days from August 14 to October 30. The animals were weighed at the beginning, midway through, and at the end of the trial period each year. Water, salt, and bonemeal intake records were kept for each pasture in each trial and forage intake was determined using a water intake method, for cattle in each pasture. Forage samples were collected weekly from each pasture.

OBSERVATIONS

Gain data are presented for both years in Table 12. Average daily gains of the animals were 1.69 and 1.2 pounds for the animals on the chemically cured and naturally cured forage, respectively, in 1966 and 0.91 and 0.34 pounds for the respective treatments in 1967. Probably the difference in years can best be explained by Table 13 which shows the crude protein values during the time of grazing. This follows the usual pattern for these particular type years. When moisture is short as it was in the growing season of 1966,the quality of the forage is higher than in high moisture seasons such as the growing season of 1967. However, the differences between the animal gains from the treated and untreated forage are of the same magnitude each year.

Table 12. Average daily gain of animals on naturally cured and chemically cured forage for 1966 and 1967

Year	Grazing period	Naturally cured	Paraquat cured
		(lb.)	(lb.)
1966	8/16-9/13	1.20	1.69
1967	8/15-9/19	0.24	1.14
	9/19-10/30	0.43	0.73
	8/15-10/30	0.34	0.91

Table 13. Crude protein content of naturally cured and chemically cured forage during the grazing periods for 1966 and 1967 1/

Date	Naturally cured	Chemically cured
	(%)	(%)
1966		
8/17	5.3	9.1
8/25	4.2	8.2
9/2	4.2	6.8
9/8	3.8	6.2
9/16	4.2	5.3
1967		
8/18	3.2	5.6
8/25	3.1	5.5
9/1	3.1	5.5
9/7	2.9	5.3
9/14	3.0	5.0
9/21	3.0	5.3
9/29	2.7	5.0
10/5	2.6	4.6
10/12	2.7	4.8
10/19	3.0	5.2
10/26	2.7	5.4

1/ Samples were taken from the grazed pastures and values reflect change in forage quality due to both maturity and selective grazing.

Forage moisture, water intake, and estimated forage intake are presented in Table 14. Forage intake follows the same pattern as daily gain with the animals on the treated pastures consuming more forage than animals on the control pastures, indicating no problems with palatability or acceptability. No particular pattern was evident with regard to salt and bonemeal intake with the treated or untreated forage.

These trials were designed to evaluate the comparative quality of the forage from chemically and naturally cured forage. Therefore, stocking rate was not controlled as it would need to be under practical operations. The pastures were stocked at a relatively light rate so the animals would have an opportunity to express their full potential in terms of daily gain. Studies have shown that stocking for light (about 50%) utilization will give greatest daily gain, whereas stocking to a moderately-heavy (about 75%) utilization will reduce daily gain per head but increase gain per acre. Type of cattle, other available resources, cost of pasture and other factors enter into making the decision on stocking rate. Generally the higher stocking rate would be employed. The gain per acre in the second year of this study was 4.5 pounds from the untreated forage and 13.7 pounds from the paraquat-treated forage. Assuming a value of 25 cents per pound for this gain gives a gross return of $1.12 and $3.42, respectively, from the control and treated forage. It was estimated that about two-thirds of the forage available under a practical

Table 14. Daily feed and water intake data on heifers grazing naturally cured and chemcially cured forage in 1966 and 1967

Year	Treatment	Forage moisture	Salt intake	Bonemeal intake	Water intake	Forage intake
		(%)	(lb.)	(lb.)	(gal.)	(lb.)
1966						
	Naturally cured	21.1	0.21	0.03	7.98	22.5
	Chemically cured	8.0	0.23	0.03	9.31	24.8
1967						
	Naturally cured	13.9	0.15	0.05	7.56	18.4
	Chemically cured	8.9	0.14	0.06	8.16	19.5

stocking rate was used in this study indicating that the pastures could have been stocked 50% higher which would have resulted in a return per acre approaching $1.65 and $5.10, respectively, for the control and treated pasture.

The application of paraquat curing of forage would seem to be best adapted to higher producing ranges, since cost of application per acre would be near equal for high or low producing ranges. Fertilization can increase production up to 50%, and this could make the economics of chemical curing of forage more favorable. These factors will be further evaluated.