rot which appeared to be of equal severity and distribution among lots. Differences in average daily gains appear to be large; however, statistical analysis showed that the differences were not significant. Animals in lot 2 were always slow to clean up their feed. Apparently the amylase depressed the appetite. Those in lot 3 ate well at first but tended to have less desire for feed after about midway in the feeding period. There were no significant differences in carcass characteristics. The rumen fluid did not show any differences in concentration of volatile fatty acids or percentage distribution of acetic, propionic, and butyric acids.

Cobalt Bullets for Beef Cattle[1]

D. Richardson, E. F. Smith, J. R. Brethour, B. A. Koch, W. S. Tsien, F. W. Boren, and B. D. Carmack

Cobalt is a trace mineral element which is essential to the health and well-being of animals. If it is deficient in the ration, it should be supplied. A cobalt bullet, which is placed in the rumen, was developed in Australia for sheep and cattle on cobalt-deficient pastures or rations. These cobalt bullets were found to be effective in preventing cobalt deficiency. Cobalt bullets are now available in this country. The bullet is composed of 90% cobalt oxide and 10% binding agent. The weight is 20 grams for cattle and 5 grams for sheep. The bullet is placed in the rumen with a balling gun. Since it is heavy, it remains in the rumen and allows cobalt to become available to the animal. Bullets were recovered at slaughter in some of these tests after over 300 days.

The results reported in Table 20 were obtained on feedlot and grazing tests conducted at Manhattan and Fort Hays. One half of the animals on each test received a cobalt bullet and the others did not. Feed and pasture samples were analyzed for cobalt content.

A significant difference in gain was produced in only one test. This was with corn in a fattening ration and without alfalfa. No significant difference was obtained when alfalfa was in the ration, when sorghum grain was fed, or when animals were on pasture.

It is generally agreed that 0.1 part per million (PPM) cobalt in forage is sufficient for cattle. If this is correct, both rations or pastures used supply sufficient cobalt. Cobalt content of feeds and pasture is shown in Table 21.

Table 20

Results with cobalt bullets in beef cattle.

	Control	Cobalt bullet in rumen
Number animals	15	15
Number days	215	215
Av. daily gain, lbs.	1.54	1.66
Ration: Sorghum silage, alfalfa hay, soybean oil meal, and corn.		
Number animals	15	15
Number days	215	215
Av. daily gain, lbs.	1.49	1.74*
Ration: Same as above except no alfalfa hay.		
Number animals	20	20
Number days	140	140
Av. daily gain, lbs.	1.75	1.67
Ration: Sorghum silage, alfalfa hay, soybean oil meal, and 2 to 4 pounds sorghum grain.		
Number animals	18	20
Number days	158	158
Av. daily gain, lbs.	1.70	1.72
Ration: Sorghum silage, alfalfa hay, soybean oil meal, and sorghum grain.		
Bluestem pasture (Manhattan)		
Number animals	66	61
Number days (May 4-Sept. 29)	147	147
Av. daily gain, lbs.	1.84	1.86
Fort Hays pastures (Blackwell switchgrass, Caucasian bluestem, Western wheatgrass, and native mixture).		
Number animals	60	59
Number days (May 3-Sept. 30)	150	150
Av. daily gain, lb.	0.88	0.87

* Significantly higher gain.

1. We wish to thank Nicholas International Ltd., Toronto, Ontario, Canada, for supplying the cobalt bullets and partial support in these studies.

Table 21

Cobalt analysis of feedstuffs.

Ingredient	Cobalt content on dry matter basis PPM
Manhattan	
Corn	0.21
Corn	0.25
Corn	0.20
Sorghum grain	0.15
Pelleted sorghum grain	0.17
Soybean oil meal	0.15
Soybean oil meal	0.18
Steamed bonemeal	0.12
Common salt	0.10
Alfalfa hay	0.59
Dehydrated alfalfa pellets	0.58
Grain sorghum silage	0.18
Dehydrated grain sorghum pellets	0.21
Atlas sorghum silage	0.17
Big bluestem, ungrazed tops	0.09
Big bluestem, whole plant	0.08
Little bluestem, ungrazed tops	0.13
Little bluestem, whole plant	0.14
Fort Hays	
Blackwell switchgrass	0.12
Blue grama	0.14
Buffalograss	0.11
Caucasian bluestem	0.14
Western ragweed	0.50
Western wheatgrass	0.14

The Value of Added Enzyme Preparations to Beef Steer Calf Wintering Ration[1] (Project 5-662).

D. Richardson, F. W. Boren, E. F. Smith, and B. A. Koch

This is our second test to determine the value of various enzyme preparations added to beef cattle rations. Amylase acts on carbohydrates; protease, on proteins; and cellulase, on cellulose. The previous test involved amylase and a combination of amylase and protease. This test involved a combination of amylase and protease and also this combination plus cellulase. Since a high roughage ration was used, it was thought that cellulase might be of some value. One lot received a combination of all the enzyme preparations on alternate 28 days, that is, the enzymes were fed for 28 days and removed from the ration for the next 28 days. The daily ration and type of enzyme preparation for each lot are shown in Table 22.

Results and Discussion

Results of this test are shown in Table 22. Feeding the enzyme preparations on alternate 28-day periods was of no value in this test. There was a tendency for all lots receiving enzyme preparations to consume less silage and the gains were slightly less; however, there were no significant differences. It is believed that enzyme preparations can be useful in livestock rations but much more work is necessary to determine how they should be used. This test is being continued with the animals receiving a fattening ration. Lot 10 will receive a protease preparation instead of the combination. All lots will receive stilbestrol.

Table 22

Added enzyme preparations in beef cattle wintering rations.

December 9, 1960, to March 31, 1961—112 days.

Lot number	7	8	9	10
Added enzyme preparation	None	Amylase + protease	Amylase + protease + cellulase	Same as 9, fed 28 alternate days
Number animals per lot	11	11	11	11
Av. initial wt., lbs.	541	540	542	541
Av. final wt., lbs.	752	746	743	736
Av. daily gain per steer, lbs.	1.89	1.84	1.80	1.74
Av. daily ration, lbs.:				
Sorghum silage	34.7	34.0	33.9	32.0
Alfalfa hay	1.0	1.0	1.0	1.0
Soybean oil meal	1.0	1.0	1.0	1.0
Sorghum grain	5.0	5.0	5.0	5.0
Av. feed per cwt. gain, lbs.:				
Sorghum silage	1780	1848	1887	1841
Alfalfa hay	53	54.3	55.6	57.6
Soybean oil meal	53	54.3	55.6	57.6
Sorghum grain	265	271	278	288
Feed cost per cwt. gain (Does not include cost of enzymes)	$12.26	12.61	12.92	13.04

1. Appreciation is expressed to Rohm & Haas Company, Philadelphia, Pennsylvania, for partial support and enzyme preparations used in this test.

The Value of Grain Sorghum Harvested as Silage and as Dehydrated Pellets (Project 567).

D. Richardson, E. F. Smith, F. W. Boren, and B. A. Koch

In many instances, sorghum grain contains so much moisture at harvest time that it cannot be stored without artificial drying. Sometimes there is danger of losing immature grain because of early frost. This is the second test to study the value of the entire grain sorghum plant harvested as silage and as dehydrated pellets.

Experimental Procedure

RS610 was the hybrid sorghum used. It produced about 85 bushels of grain or approximately 9 tons of silage per acre. The crop was harvested while the leaves were still green and the grain was in the late dough stage. Part was stored as silage and part as dehydrated pellets. Twenty of the heaviest steer calves were divided into two lots of 10 each. All animals received soybean oil meal and dehydrated alfalfa pellets during the wintering period of 168 days. Silage was fed to one lot and the dehydrated pellets to the other. Both were fed free choice.

The silage was used up at the end of 168 days; the ration was then changed to forage type silage and then to alfalfa hay. Rolled grain was added to both lots. A mixture of steamed bonemeal and salt and salt alone was available at all times.

Results and Discussion

Results of the test are shown in Table 23. The intake of dry matter was approximately the same for each lot during the first phase of the test. There was no significant difference in rate of gain or feed efficiency. The cost per pound of gain was higher for the lot receiving the dehydrated pellets.

There was no difference in rate of gain after grain was added to the ration; however, neither lot gained as well as should be expected. Animals on the pelleted ration were never observed to regurgitate and chew their cud after a few days on the ration. There seemed to be a wide variation in response of individual animals to the pelleted ration. This is indicated by the great variation in carcass grade. It is believed that a small amount of normal roughage would have greatly improved performance of the animals in lot 6.

Table 23

Grain sorghum silage vs. dehydrated grain sorghum pellets in steer rations.

Wintering phase, December 3, 1959, to May 19, 1960—168 days.

Lot number	5	6
Number steers per lot	10	10
Av. initial wt., lbs.	561	562
Av. final wt., lbs.	835	841
Av. daily gain per steer, lbs.	1.63	1.66
Av. daily ration, lbs.:		
Grain sorghum silage	37.1	..
Dehydrated grain sorghum pellets	..	13.1
Dehydrated alfalfa pellets	1.0	1.0
Soybean oil meal	1.0	1.0
Feed per cwt. gain, lbs.:		
Grain sorghum silage	2277	..
Dehydrated grain sorghum pellets	..	791
Dehydrated alfalfa pellets	61	60
Soybean oil meal	61	60
Feed cost per cwt. gain	$15.01	19.39

Table 23 (Continued)

Fattening phase[1]—157 days.

Av. initial wt., lbs.	830.5	841
Av. final wt., lbs.	1078	1094
Av. daily gain per steer, lbs.	1.57	1.61
Av. daily ration, lbs.:		
Forage sorghum silage[2]	4.5	..
Dehydrated grain sorghum pellets	..	5.6
Alfalfa hay	3.2	..
Dehydrated alfalfa pellets	..	1.1
Soybean oil meal	1.0	1.0
Sorghum grain	15.9	9.1
Feed per cwt. gain, lbs.:		
Forage sorghum silage	287	..
Dehydrated grain sorghum pellets	..	345
Alfalfa hay	204	..
Dehydrated alfalfa pellets	..	69
Soybean oil meal	63	63
Sorghum grain	1000	564
Feed cost per cwt. gain	$22.26	20.67
% shrink	4.2	3.9
Dressing %, feedlot wt.	61.8	60.3
Dressing %, pay wt.	64.2	62.7
Av. hot carcass wt.	671.4	667.7
Av. chilled carcass wt.	662.9	660.2
Av. % cooler shrink	1.3	1.1
Av. finish:		
Thickness[3]	3.9	3.7
Distribution[4]	3.4	3.3
Av. degree of marbling[5]	5.1	6.0
Av. size of ribeye[6]	4.1	4.8
Av. degree of firmness[7]	2.7	3.4
Carcass grades:		
Av. prime	1	..
Top choice	1	1
Av. choice	3	3
Low choice	3	2
Top good	1	1
Av. good	..	1
Low good	..	1
Av. carcass value (prime 43.0¢) (choice 41.5¢) (good 39.0¢)	$275.55	268.63

1. One steer lost in each lot from urinary calculi.
2. Silage fed only first 42 days.
3. Based on 2, thick; 3, moderate; 4, modest.
4. Based on 2, uniform; 3, moderately uniform; 4, modestly uniform.
5. Based on 4, slightly abundant; 5, moderate; 6, modest; 7, small amount.
6. Based on 3, moderately large; 4, modestly large; 5, slightly small.
7. Based on 2, firm; 3, moderately firm; 4, modestly firm; 5, slightly firm.

Grain Sorghum Silage vs. Forage Sorghum Silage; Dehydrated Alfalfa vs. Vitamin A, and the Value of Aureomycin in Cattle Rations (Project 567).

D. Richardson, E. F. Smith, F. W. Boren, and B. A. Koch

Two types of sorghum silage were used in this test. They were (1) DeKalb forage type which produced approximately 100 bushels of grain and 20 tons of silage per acre; and (2) RS610 grain type which produced

approximately 75 bushels of grain and 10 tons of silage per acre. Forty Hereford heifer calves were divided into four lots of 10 each. Three lots received the grain sorghum silage and one the forage silage plus 2 pounds of grain. This was an attempt to keep the grain intake equal in all lots; however, since the forage sorghum produced so much grain, this lot may have received slightly more grain than the others. Dehydrated alfalfa as a source of vitamin A was compared with vitamin A and with vitamin A plus Aureomycin. The average daily ration for each lot is shown in Table 24.

Results and Discussion

The test had to be terminated at 77 days when the supply of grain sorghum silage was exhausted. Results are shown in Table 24.

There were no significant differences in rate of gain between animals receiving the forage- and grain-type silage. A combination of vitamin A and Aureomycin produced larger gains than dehydrated alfalfa or vitamin A; however, those receiving dehydrated alfalfa made larger gains than those receiving vitamin A without Aureomycin.

The higher feed costs for grain-type silage are due to a charge of $10 per ton compared with $6 for the forage type. These and previous results indicate that a high grain-yielding forage-type sorghum may be the most desirable for ensilage.

Table 24

Grain- vs. forage-type sorghum silage; dehydrated alfalfa vs. vitamin A, and the value of Aureomycin in cattle rations.

December 9, 1960, to February 24, 1961—77 days.

Lot number	3	4	5	6
Number heifers per lot	10	10	10	10
Av. initial wt., lbs.	518.5	518.5	518	519
Av. final wt., lbs.	656	648	635.5	656
Av. daily gain per animal, lbs.	1.79	1.68	1.53	1.78
Av. daily ration, lbs.:				
DeKalb forage sorghum silage	31.8	..	..	..
RS610 grain sorghum silage	..	31.1	31.4	34.6
Soybean oil meal	1.0	1.0	1.0	1.0
Dehydrated alfalfa pellets	.5	.5	..	..
Sorghum grain	2.0	..	..	..
Vitamin A, I.U.	..	..	10000.0	10000.0
Aureomycin, mg.	..	..	..	72
Feed per cwt. gain, lbs.:				
DeKalb forage sorghum silage	1782	..	..	..
RS610 grain sorghum silage	..	1849	2057	1943
Soybean oil meal	56	59	66	56
Dehydrated alfalfa pellets	28	30	..	..
Sorghum grain	112	..	..	..
Feed cost per cwt. gain (Does not include cost of vitamin A and Aureomycin)	$9.94	12.04	12.57	11.65

Rolled vs. Finely Ground Pelleted Sorghum Grain in Cattle Rations (Project 567).

D. Richardson, E. F. Smith, F. W. Boren, and B. A. Koch

In previous tests where grain intake was held at the same level, finely ground pelleted sorghum grain has produced larger and more efficient