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Cobalt Salt
IN LAMB RATIONS

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During recent years the addition of various trace minerals to livestock rations has become rather popular. The trace minerals most often included are copper, iron, manganese and cobalt. In certain areas of the United States the addition of these trace minerals has been found to produce excellent results in the way of increased productiveness and health of the animals. Trace minerals are usually supplied to livestock by adding them to common salt. This mineralized salt, in turn, is offered to the livestock free choice. Cobalt is the trace mineral with which South Dakota sheep and cattle men seem to be most concerned.

It is interesting to note that many reports from the area west of the Missouri River indicate that the addition of cobalt to salt mixtures fed to cattle and sheep has resulted in increased feed consumption, rate of gain and an over-all improvement in the livestock's health. However, these reports are based on general observation and are not the result of controlled experiments.

It is known that the cobalt content in the forage depends on the cobalt content of the soil, which varies considerably from area to area. Furthermore, some plants are able to take up more cobalt from the soil than others; for example, legumes such as clover and alfalfa generally contain more cobalt than non-legumes raised on the same soil.

The chemical analysis for cobalt is laborious, and it is difficult to determine the exact amount of cobalt in plants or in the soil due to the minute amounts. Also, a chemical analysis does not determine whether the cobalt is available to the livestock. Therefore, in order to be certain that a cobalt deficiency exists, it is necessary to conduct feeding trials.

The Animal Husbandry department of the South Dakota State College Experiment Station conducted a series of lamb feeding trials at Brookings during 1948-49. In cooperation with the United States Field Station at Newell, additional feeding trials were conducted during the years 1949 through 1951 in order to obtain more information as to the need for cobalt in our livestock rations. Inasmuch as the conditions vary greatly in these two areas, the discussion of the feeding trials conducted at Brookings and at Newell, South Dakota, will be treated separately.

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Brookings Trials

Dry Lot Feeding

In 1948-49 two separate trials were conducted under dry lot conditions at Brookings. In each trial, four groups of good quality western feeder lambs were full-fed a ration of corn, a mixture of alfalfa-brome hay and a tenth of a pound of soybean oil meal pellets per lamb daily, and salt (free choice) to which various levels of cobalt chloride were added. The amounts of cobalt chloride added to each 100 pounds of salt in the various lots were: Lot II, ½ ounce; Lot III, 1 ounce; Lot IV, 1½ ounces. Lot I which served as the control lot received plain salt. The lambs were individually weighed at approximately 28-day intervals and a complete record of feed intake was kept. The results of the two trials are shown separately in Table 1.

The addition of cobalt chloride at the various levels caused no positive response in the first trial. In Lot I (the check lot) the lambs gained 0.4 pound per lamb daily, as compared

Table 1. Effect of Cobalt Salt in Lamb Fattening Rations in Dry Lot

	Lot I Corn, Hay, SBOM,* Plain Salt	Lot II Corn, Hay, SBOM, ½ oz. Cobalt Chloride per 100 Lbs. Salt	Lot III Corn, Hay, SBOM, 1 oz. Cobalt Chloride per 100 Lbs. Salt	Lot IV Corn, Hay, SBOM, 1½ oz. Cobalt Chloride per 100 Lbs. Salt
Trial I—Nov. 11 to Jan. 9, 1949, 59 Days, Brookings				
Number of lambs fed	15	15	15	15
Average initial weight (lbs.)	72.1	71.2	71.7	71.2
Average final weight (lbs.)	95.7	91.3	94.4	94.1
Average gain per lamb (lbs.)	23.6	20.1	22.7	22.9
Average daily gain (lbs.)	0.40	0.34	0.38	0.39
Average daily ration (lbs.)				
Corn	1.90	1.60	1.51	1.94
Alfalfa brome hay	1.59	1.43	1.52	1.41
Soybean oil meal	0.10	0.10	0.10	0.10
Salt	0.04	0.03	0.04	0.03
Feed per 100 lbs. gain (lbs.)				
Corn	476.0	470.0	395.0	502.0
Alfalfa brome hay	397.0	421.0	396.0	365.0
Soybean oil meal	25.0	30.0	26.0	24.6
Trial II—January 21 to April 16, 1949, 85 Days				
Number of lambs fed	14	14	14	14
Average initial weight (lbs.)	69.2	68.7	68.3	68.0
Average final weight (lbs.)	112.2	111.9	113.5	112.1
Average gain per lamb (lbs.)	43.0	43.1	45.2	44.1
Average daily gain (lbs.)	0.51	0.51	0.53	0.52
Average daily ration (lbs.)				
Corn	1.83	1.91	1.94	1.96
Alfalfa brome hay	1.58	1.59	1.58	1.60
Soybean oil meal	0.10	0.10	0.10	0.10
Salt	0.033	0.028	0.034	0.037
Feed per 100 lbs. gain (lbs.)				
Corn	359.0	375.0	366.0	379.0
Alfalfa brome hay	313.0	313.0	293.0	308.0
Soybean oil meal	19.0	19.0	18.0	19.0

*SBOM—Soybean oil meal.

to 0.34 pound, 0.38 pound, and 0.39 pound for the lots receiving ½, 1 and 1½ ounces of cobalt chloride per 100 pounds of salt. Lot II, which received one-half ounce of cobalt chloride per 100 pounds of salt, made decidedly slower gains than the check lot or the two lots receiving higher levels of cobalt. Just why this was the case cannot be explained; the amount of cobalt fed was not excessive as shown by the fact that the lambs receiving higher levels of cobalt (Lots III and IV) gained as well as Lot I.

The addition of cobalt to the ration did not consistently reduce the feed required per 100 pounds of gain. For example, Lot I, which received plain salt, required 81 pounds more corn than Lot III (1 ounce cobalt chloride), but 26 pounds less corn than Lot IV (1½ ounces cobalt chloride) per 100 pounds of gain. While the lambs in Lot III which received 1 ounce of cobalt chloride required decidedly less feed per 100 pounds of gain, the lambs in Lot IV required considerably more, and it is concluded that this difference in feed required per 100 pounds of gain between the various lots was not due to the cobalt they were receiving.

The results of the second trial (Table 1) show very little difference in rate of gain between the lambs of the various lots. Lot I, which received plain salt, gained 0.51 pound per lamb daily. Lot II (one-half ounce cobalt chloride per 100 pounds of salt) gained 0.51 pound per lamb daily. Lot III (1 ounce cobalt chloride per 100 pounds of salt) gained 0.53 pound per lamb daily. Lot IV (1½ ounces cobalt chloride per 100 pounds of salt) gained 0.52 pound per lamb daily. The differences in rate of gain are small and are not of any practical significance. When the rate of gain for the two trials was averaged, it was found that the lambs in Lots I, II, III and IV gained 0.46, 0.43, 0.46, and 0.46 pound per lamb daily, respectively.

The amount of feed required per 100 pounds of gain in the second trial is shown in Table 1. Lot I (check lot) required the least feed per 100 pounds of gain (20 pounds less corn than Lot IV, 16 pounds less than Lot II and only 7 pounds less than Lot III). As was the case in the first trial, there was no consistency or pattern evident, as indicated by the fact that Lot III which received the intermediate amount of cobalt (1 ounce cobalt chloride per 100 pounds of salt) required next to the least amount of feed per 100 pounds of gain. The higher feed requirement per 100 pounds of gain by the lambs receiving cobalt chloride was likely due to their greater feed consumption, which was not accompanied by a material increase in rate of gain.

Pasture Feeding

During the summer of 1949, 32 lambs were placed on trial to determine whether there was any response to cobalt when lambs were nursing and eating grass. Half of the lambs received 1 ounce of cobalt chloride per 100 pounds of salt-phenothiazene mixture (1 part phenothiazene, 9 parts of salt), and the other half received the salt

phenothiazene mixture without the addition of cobalt. These lambs were kept on test for 76 days, and during that time, the lambs receiving cobalt gained 0.40 pound per lamb daily, whereas those not receiving cobalt gained 0.42 pound per lamb daily. The results of this trial are summarized in Table 2.

Table 2. Cobalt Salt for Suckling Lambs on Pasture, June 7 to August 22, 1949, 76 days, Brookings

	Lot I No Cobalt	Lot II Cobalt
Number of lambs fed	17	15
Average initial weight (lbs.)	56.56	54.67
Average final weight (lbs.)	88.59	85.33
Average gain per lamb (lbs.)	32.03	30.66
Average daily gain (lbs.)	0.42	0.40
Salt consumed per day (lbs.)	0.047	0.043

Newell Trials

Three separate lamb feeding trials were conducted at the Newell Field Station during the years 1949, '50 and '51. The lambs used in these three trials were obtained from the Antelope Range substation at Buffalo, South Dakota. They were trucked to Newell, allowed to fill and rest for a few days and were individually weighed before being placed on experiment. In these three trials, the lambs were full-fed. However, owing to undetermined circumstances, the lambs fed at Newell consumed less feed than those fed at Brookings. While every effort was made to have the lambs on a full feed, their consumption was less and, therefore, the rate of gain was less than that experienced at the Brookings Station.

In the first trial, which was conducted in 1949, alfalfa hay was used as roughage and corn as the grain. Prairie hay was included in the two trials conducted in 1950 and 1951, since it is the roughage most often fed in this region. Furthermore, prairie hay usually contains less cobalt than alfalfa hay and therefore, if a deficiency in cobalt were to appear it would be more apt to appear under conditions in which prairie hay was being fed.

Table 3. Effect of Cobalt Salt in Lamb Fattening Rations in Dry Lot, 1949—1950, Newell

	Lot I Corn, Alfalfa, Plain Salt	Lot II Corn, Alfalfa, 1 Oz. Cobalt Chloride Per 100 Lbs. Salt
No. of lambs fed	46	45
Av. initial wt. (lbs.)	66.1	66.1
Av. final wt. (lbs.)	96.6	99.9
Av. gain per lamb (lbs.)	30.5	33.8
Av. daily gain (lbs.)	0.25	0.27*
No. lambs died	4	2
Av. daily ration (lbs.)		
Corn	1.28	1.27
Alfalfa hay	1.41	1.41
Salt	0.034	0.030
Feed per 100 lbs. gain (lbs.)		
Corn	518.1	461.0
Alfalfa hay	575.0	518.0

*Highly significant difference.

The results of the first trial at Newell are given in Table 3. The lambs receiving 1 ounce of cobalt chloride per 100 pounds of salt gained 0.27 pound per lamb daily, whereas the lambs receiving plain salt gained 0.25 pound per lamb daily. It should be pointed out that during the later portion of the trial, the feed record and the monthly weigh record showed that the feed consumption and rate of gain were greater for the cobalt supplemented lambs than for the untreated lambs.

While the differences in rate of gain were small in this trial, they actually amounted to about 10 percent greater gains for the cobalt fed lambs than for the check lambs. When these gains were tested statistically, the differences were found to be highly significant. The greatest difference in the two lots of lambs was the feed required per 100 pounds of gain. The lambs that received the plain salt required 57 pounds more corn and 57 pounds more alfalfa hay for 100 pounds of gain than the lambs receiving 1 ounce of cobalt chloride per 100 pounds of salt. The additional 10 percent greater gain made by the lambs supplemented with cobalt accounts for this greater feed efficiency.

In the trial conducted during the year 1950-51, barley, native prairie hay and alfalfa hay grown in the Newell area were fed. The ration was supplemented with soybean oil meal pellets and every effort was made to keep the lambs on full feed. Four lots of 25 lambs each were fed. The complete results of this trial are shown in Table 4.

In this trial the addition of 1 ounce of cobalt chloride per 100 pounds of salt increased the rate of gain and feed efficiency of the lambs receiving a ration of native hay, barley and soybean oil meal pellets (compare Lot I and Lot II). In this particular test the difference in rate of gain was 0.07 pound per lamb daily in favor of the lambs receiving cobalt supplement. These differences were highly significant. This increase in rate of daily gain amounted to a 50 percent increase; however, the addition of cobalt to the ration containing alfalfa hay (Lot III and Lot IV) decreased the rate of gain and feed consumption. Why this was the case cannot be explained as the amount of cobalt fed was not excessive.

In the third trial which was conducted during the year 1951-52 the same type of ration and feeding plan was followed as in 1950. The complete results of this trial are

Table 4. Effect of Cobalt in Lamb Fattening Rations in Dry Lot, 1950—1951, Newell

	Lot I Prairie Hay, Barley, SBOM	Lot II Prairie Hay, Barley, SBOM, Cobalt Chloride	Lot III Alfalfa Hay, Barley, SBOM	Lot IV Alfalfa Hay, Barley, SBOM, Cobalt Chloride
Number of lambs fed	25	25	25	25
Average initial weight (lbs.)	69.2	68.2	70.0	69.2
Average final weight (lbs.)	89.0	96.9	117.3	109.0
Average gain per lamb (lbs.)	19.8	28.7	47.3	39.8
Average daily gain (lbs.)	0.14	0.21*	0.38*	0.32
Days on feed	138	138	124	124
Average daily ration (lbs.)				
Barley	0.75	0.93	1.21	1.04
Hay	1.24	1.24	1.56	1.57
Salt	0.027	0.018	0.010	0.007
Feed per 100 lbs. gain (lbs.)				
Barley	510.0	438.0	346.0	352.0
Hay	848.0	592.0	396.0	493.0
Soybean oil meal	62.0	50.0	38.0	40.0

*Highly significant difference.

Table 5. Effect of Cobalt Salt in Lamb Fattening Rations in Dry Lot, 1951-52, 131 Days, Newell

	Lot I Prairie Hay, Barley, SBOM	Lot II Prairie Hay, Barley, SBOM, Cobalt Chloride	Lot III Alfalfa Hay, Barley, SBOM	Lot IV Alfalfa Hay, Barley, SBOM, Cobalt Chloride
Number of lambs fed	52	51	53	53
Average initial weight (lbs.)	64.6	65.9	67.4	64.7
Average final weight (lbs.)	93.2	98.9	99.6	100.3
Average gain per lamb (lbs.)	28.7	32.9	32.2	35.6
Average daily gain (lbs.)	0.22	0.25	0.25	0.27*
Number lambs died	3	2	4	6
Average daily ration (lbs.)				
Barley	0.89	0.99	1.15	1.21
Hay	1.40	1.47	1.35	1.29
Soybean oil meal	0.17	0.17	0.17	0.17
Salt	0.035	0.035	0.034	0.034
Feed per 100 lbs. gain (lbs.)				
Barley	403	394	469	465
Hay	639	581	550	496
Soybean oil meal	79	69	73	65

*Significant difference.

given in Table 5. Comparing Lots I and II of Table 5, the addition of cobalt chloride increased the rate of gain slightly and increased the hay and grain consumption. The lambs which received alfalfa in their ration and also cobalt chloride gained more rapidly than the lambs that did not receive cobalt chloride (Lots III and IV). This is not in agreement with the results that were obtained in 1950-51 and demonstrates quite aptly the variation that one encounters in conducting feeding trials in which cobalt is being tested as a trace mineral.

Research at other stations has demonstrated that lambs require about 0.07 parts per million of cobalt in their rations. A chemical analysis was determined on the two types of hay fed and the barley fed during the year 1951-52 and the results of this analysis are shown in Table 6.

Both alfalfa hay and prairie hay contained the same amount of cobalt, 0.10 ppm. While this meets the recommended requirements (0.07), it is not excessive and exceeds the minimum requirement by only 0.03 ppm. Furthermore, in evaluating this analysis it should be kept in mind that it does not give a clue as to the availability of the cobalt present in the hays, and it is possible that the cobalt in the alfalfa is more available to the lambs than the cobalt in the prairie hay. In addition, it should be pointed out that in this analysis feeds grown only in one year were represented, and therefore it should not be taken as the final analysis of the cobalt content of feeds grown in this area.

Table 6. Cobalt Content of Feeds Fed, 1951-52*

	Cobalt Content in Parts Per Million
Alfalfa hay	0.10
Prairie hay	0.10
Barley	0.03

*The help of K. C. Beeson, Cornell University, Ithaca, N. Y., who conducted the analysis, is gratefully acknowledged.

Summary and Conclusions

The cobalt content of the soil, and consequently in the plants, varies considerably from area to area. The feeding tests reported herein used feeds from the Brookings area and from the Newell area in South Dakota.

In the three lamb feeding trials at Brookings (1948-49), the addition of cobalt chloride at rates of ½, 1 and 1½ ounces per 100 pounds of salt had no beneficial effect on feed consumption, feed efficiency, or rate of gain under either dry lot or pasture conditions. On the basis of these trials it was concluded that the feeds at Brookings (grown in the Brookings area) contained sufficient amounts of cobalt and that therefore the addition of cobalt to the livestock ration in this area is not likely to be beneficial.

In the three lamb feeding trials conducted at the Newell Field Station (1949, 1950, and 1951), 1 ounce of cobalt chloride per 100 pounds of salt was added to (1) a prairie hay-barley-soybean oil meal ration and (2) to a alfalfa-barley-soybean oil meal ration.

In the feeding trials in which *prairie hay* was fed, a consistent response was obtained when cobalt was added to the ration. An average of the three years shows that the addition of cobalt saved 79 pounds of grain and 156 pounds of prairie hay per 100 pounds of gain and increased the average daily gain per lamb 0.05 pound.

When cobalt was added to the ration containing *alfalfa* hay the results were less consistent than when prairie hay was being fed. During one of the trials, the lambs receiving cobalt chloride actually made slower gains; in the other two trials a positive response was obtained from the addition of cobalt. An average of the three trials shows that the lambs receiving cobalt chloride required 11 pounds less grain and 5 pounds less hay. There was no difference in average daily gains between the two groups. These results were due largely to the negative response made to cobalt during the one year.

For the year 1951-52, a chemical analysis was conducted on the feeds fed and it showed that both alfalfa and prairie hay contained 0.10 ppm. of cobalt. This exceeds the minimum cobalt requirements by only 0.03 ppm. Barley contained 0.03 ppm. of cobalt and therefore a ration consisting of hay and barley (1:1) would be below the minimum requirement for cobalt content.

The trials at Newell suggest a need for the addition of cobalt to the livestock rations in this area. However, it should be kept in mind that due to the variability of the cobalt content in the soils and in the plants, these results may not necessarily apply to the entire west river area. Further chemical analyses are necessary before a complete picture of the need for added cobalt in livestock rations in South Dakota can be obtained.