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AN EXPERIMENT IN THE FREE-CHOICE  
FEEDING OF MINERAL SUPPLE-  
MENTS TO DAIRY CATTLE

By W. B. NEVENS



URBANA, ILLINOIS, DECEMBER, 1928

# AN EXPERIMENT IN THE FREE-CHOICE FEEDING OF MINERAL SUPPLEMENTS TO DAIRY CATTLE

By W. B. NEVENS, Assistant Chief in Dairy Cattle Feeding

Widespread interest in the needs of dairy cattle for minerals has been aroused thru investigations which have shown that the production of large amounts of milk by dairy cows may cause the loss of mineral elements from their bodies.

Investigations have followed two general plans. Under one plan, the intake and outgo of minerals have been measured during periods varying from a few days to several weeks. Under the other plan, rations high and low in minerals, or supplemented by various mineral compounds, have been fed thru one or more lactation periods, and observations made upon the effect which the feeding of minerals might have on milk yield, reproduction, and the general health of the animals.

It is a matter of common knowledge that cattle require sodium and chlorin, the elements of common salt, in amounts greater than those supplied in farm feeds. The experiments mentioned above have shown that, aside from sodium and chlorin, the mineral element most likely to be deficient in rations for milk production is calcium, and that sometimes phosphorus may also be lacking. It has been shown further that minerals play a most important part in the nutrition of dairy cows, and that mineral deficiencies may result in profound effects upon reproductive ability and health. The extent of the losses which occur, however, and the ways in which they can with certainty be prevented, are still questions for study, the investigations not having yielded entirely uniform results on these points.

In view of the evident need for further information regarding the mineral requirements of dairy cows and the value of mineral supplements in their rations, the experiment described herein was carried out. Mineral supplements were provided "free-choice" in feed boxes to which the cattle had access while in the exercising yards. The object of this experiment was to determine whether cattle kept under ordinary herd conditions in barn and dry lot would voluntarily supplement their rations with minerals if given an opportunity. These trials extended over parts of four years.

## Outline of Experiment

The cows used in this test were of moderate to good productivity, quite a number of them producing from 40 to 60 pounds of milk daily during the early part of the lactation period. They were milked but twice daily. The animals designated as the "heifer group" consisted

of the young daughters of cows included in the cow group. The heifers ranged in age from about six to twenty-four months of age. As they came into milk, they were transferred to the cow group.

All the cattle were confined during the entire period covered by the experiments to barns and dry lots.

The ration fed consisted of corn silage, legume hay, and a grain mixture. The hay was a good grade of either alfalfa, soybeans, or red clover. The grain mixture consisted of ground shelled corn, ground oats, wheat bran, and a second protein supplement. Corn gluten feed supplied this second protein supplement from August, 1924, to August, 1925; from August, 1925, to August, 1927, soybean oil meal was used; and subsequent to August, 1927, linseed oil meal was used. The grain was weighed at each feeding and fed to the milk cows in proportion to their milk production and to the heifers at a rate to induce rapid growth.

The minerals fed these cattle were placed in boxes in their exercising yards. A box with three compartments was kept in the yard for the milk cows and another in the yard for the young stock (heifers). The boxes were protected somewhat from the weather by means of a shed roof and partially inclosed sides.

Beginning in the summer of 1924 a supply of very finely ground limestone<sup>1</sup> was kept in one of the compartments of each feed-box and common salt in another. At the end of each week during the experiment the amount in each compartment was weighed, and if still in good condition for feeding, was returned to the compartment. More was added during the week as needed to insure a continuous supply.

About August 1, 1926, after two years of limestone supplement, bone meal was added in the third compartment of each feed-box. This bone meal was called "pure raw bone feeding meal." The manufacturer stated that this product was made from selected fresh bones and was made safe for feeding by treatment with steam at a high temperature. It was nearly free from odor.

From August 2, 1926, to the end of the experiment in November, 1927, the limestone and the bone meal were mixed with common barrel salt at the rate of 4 parts of limestone or bone meal to 1 part of salt.

The feeding of the above supplements was discontinued each year with the arrival of inclement weather, when the cattle were not turned out into the yards, or when the supplements became damp and frozen so that the cattle could not eat them. With the arrival of warm weather, the yard feeding was resumed. During the times when no mineral supplements were fed in the yard, bone meal and salt were incorporated in the grain mixture to the extent of 1.5 per cent each.

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<sup>1</sup>This product was furnished for the experiment thru the courtesy of the Michigan Limestone and Chemical Company, of Buffalo, New York. The company stated that 85 percent of the limestone would pass thru a 200-mesh sieve.

Salt was supplied in the grain mixture at the rate of 1 percent during the yard feeding of mineral supplements.

It was impossible to avoid small errors in this type of feeding. At times rain would blow into the feed boxes, or during damp weather the supplements would absorb moisture. Owing to these circumstances, the amounts weighed from the boxes at the end of the week were occasionally greater than the amounts weighed in. These errors were compensated for in part by replacing the same material in the feedboxes, so that it might have an opportunity to return to air-dry condition during the following week. Occasionally a cow would nose about in one of the supplements and spill a small quantity on the ground. The amounts shown by the records as being consumed, even though very small, are therefore somewhat larger than the actual amounts.

#### **Quantities of Minerals Consumed Under Free-Choice Feeding**

The records obtained during parts of four years show that the animals that received 1 percent of common salt in their grain mixtures consumed considerable additional amounts when given access to it. The amounts eaten by growing heifers were greater than those consumed by the milk cows, as shown by the accompanying table.

The amounts of ground limestone consumed were very small, ranging from .01 to .14 pound per animal weekly as an average for the different periods. There was little difference in consumption between the heifer group and the cow group, and the amounts did not change appreciably after the bone meal feeding was begun. The average amount consumed per animal weekly as an average for the entire period of feeding was about one-half ounce (.028 pound).

The introduction of bone meal into the group of supplements resulted in its free consumption by the cow group for a few weeks, when the amount dropped to about the level of the limestone consumption. There was no such initial variation in bone meal consumption with the heifer group. Upon the whole, the quantity of bone meal eaten was quite comparable to that of the limestone, the average amount for the entire period being about  $1\frac{1}{4}$  ounces (.077 pound) per head weekly, the amounts in both cases thus being almost negligible.

#### **Good Rations Seem to Satisfy Calcium and Phosphorus Needs**

It is evident that dairy cattle satisfy their desires and presumably their needs for common salt as they have opportunity. Reasoning along this line, it would seem that if dairy cattle suffer from deficiencies of calcium or phosphorus, or both, they would crave these minerals and would attempt to satisfy their desires for them. The failure of the animals in these experiments to consume more than very small amounts of limestone and bone meal may be explained on the basis of one of two assumptions: either that dairy cattle re-



TABLE 1.—AMOUNTS OF MINERALS CONSUMED BY DAIRY CATTLE WHEN MINERALS WERE OFFERED FREE-CHOICE IN EXERCISING YARDS

Week ending	Heifer group			Cow group		
	Number of animals	Limestone	Salt	Number of animals	Limestone	Salt
<i>1924 records</i>						
Sept. 8.....	15	5.0	20.0	39	3.0	23.4
" 15.....	15	1.4	30.0	39	.6	25.4
" 22.....	15	.6	38.5	39	.9	15.0
" 29.....	15	1.0	32.7	39	-.1	12.4
Oct. 6.....	15	1.0	13.9	39	.7	11.3
" 13.....	15	1.0	13.9	39	.7	9.3
" 27 <sup>1</sup> .....	14	-.3	11.0	40	.1	9.0
Nov. 3.....	14	1.3	8.2	40	1.4	5.0
" 10.....	14	0	12.8	40	.5	5.5
" 17.....	14	1.6	10.0	40	-.8	.4
" 24.....	14	.3	4.0	40	1.0	1.8
Dec. 1.....	14	1.2	3.5	40	.5	3.3
" 8.....	12	-.2	2.5	40	-1.0	3.0
" 15.....	12	.7	4.6	40	-.2	1.9
Total.....	212	14.6	205.6	594	7.3	126.7
Amount per animal weekly.....	...	.069	.970	...	.012	.213
<i>1925 records</i>						
Mar. 16.....	15	3.0	11.2	40	.5	1.2
" 23.....	15	0	18.4	40	.6	4.3
" 30.....	15	.7	13.5	40	-.1	3.5
Apr. 6.....	15	.6	12.9	40	.2	2.2
" 13.....	15	.9	20.4	40	-.2	3.6
" 20.....	15	-.1	19.4	40	.2	3.4
" 27.....	15	.7	24.0	40	.4	3.0
May 4.....	15	4.2	12.5	40	.3	3.5
" 11.....	15	4.3	37.9	40	.5	4.7
" 18.....	13	.5	19.6	40	.2	2.1
" 25.....	11	0	10.7	40	.2	3.3
June 1.....	12	2.3	11.7	40	.2	4.0
" 8.....	12	.4	9.5	39	0	3.3
" 15.....	12	.7	20.3	39	.5	7.9
" 22.....	12	.6	19.7	39	-.2	15.2
" 29.....	12	1.5	22.3	39	-.1	11.9
July 6.....	12	1.0	27.7	39	.8	17.7
" 13.....	20	3.6	22.1	40	2.0	58.0
" 20.....	20	.1	27.9	41	...	25.4
" 27.....	21	1.7	18.7	40	1.3	23.7
Aug. 3.....	21	.2	33.5	40	.7	27.4
" 10.....	19	-.6	12.9	40	-.2	23.8
" 17.....	19	1.4	28.1	40	0	44.0
" 24.....	19	-.4	42.0	40	1.2	39.9
" 31.....	19	.2	24.1	40	1.7	45.6
Sept. 7.....	19	.2	9.4	40	.8	35.5
" 14.....	19	0	22.6	40	.5	21.6
" 21.....	19	-.1	42.9	40	.8	40.9
" 28.....	18	1.4	38.9	40	6.2	76.1

<sup>1</sup>Two-week period.

ceiving rations containing liberal amounts of well-cured legume hay, which is high in lime content, and a grain mixture containing protein feeds high in phosphorus have little or no calcium and phosphorus deficiency; or that finely ground limestone and high-grade bone meal are so unpalatable that dairy cattle refuse to eat them even tho they crave them.

TABLE 1.—Continued

Week ending	Heifer group			Cow group		
	Number of animals	Limestone	Salt	Number of animals	Limestone	Salt
<i>1925 records</i>						
Oct. 5.....	18	.2	30.1	40	.8	37.3
" 12.....	18	.3	25.8	42	0	41.3
" 19.....	18	0	22.7	42	0	28.7
" 26.....	18	-2.0	19.5	42	-1.5	25.2
Nov. 2.....	18	2.4	7.5	42	.5	12.0
" 9.....	18	0	4.9	42	1.6	11.8
" 16.....	18	-.4	6.9	42	-.4	12.4
" 23.....	18	.6	9.8	42	1.0	20.5
" 30.....	17	.2	10.4	42	1.2	14.4
Dec. 7.....	17	.2	10.0	42	.3	2.2
" 14.....	17	-2.6	17.0	42	.4	11.2
" 21.....	17	-1.2	4.0	42	-.6	1.5
Total.....	676	26.7	803.4	1658	22.3	775.2
Amount per animal weekly.....	...	.040	1.189	....	.014	.468
<i>1926 records</i>						
Jan. 4.....	17	3.4	18.3	..	...	...
" 18.....	17	1.5	21.7	..	...	...
Feb. 1.....	17	.9	14.2	..	...	...
" 8.....	17	.2	14.0	..	...	...
" 15.....	16	.1	10.1	..	...	...
" 22.....	16	-.2	9.2	..	...	...
Mar. 1.....	13	1.1	11.1	..	...	...
" 8.....	13	1.0	10.7	..	...	...
" 15.....	12	.7	14.0	..	...	...
" 22.....	12	.1	21.2	..	...	...
" 29.....	12	.5	12.9	..	...	...
Apr. 5.....	12	-.4	6.0	40	-.3	-.1
" 12.....	12	.1	11.4	40	-.2	2.5
" 19.....	12	.2	9.1	40	2.0	7.9
" 26.....	14	.4	8.5	40	.3	6.6
May 3.....	14	1.5	6.2	40	4.1	7.9
" 10.....	14	.3	15.4	40	1.1	9.4
" 17.....	13	..	8.2	38	1.7	9.7
" 24.....	13	.2	11.3	38	-2.0	12.1
" 31.....	12	-.2	15.4	38	-.3	12.9
June 7.....	12	.5	13.3	38	5.6	21.7
" 14.....	12	.3	9.2	38	1.5	18.9
" 21.....	12	0	14.7	40	7.2	32.8
" 28.....	12	.3	15.1	40	5.5	28.7
July 5.....	12	.9	9.5	40	1.9	30.6
" 12.....	12	0	5.5	40	-.1	26.5
" 19.....	12	.3	7.8	40	6.9	30.4
" 26.....	12	0	7.9	40	3.1	30.2

Of these assumptions the first seems the more logical, since it has been demonstrated experimentally that cattle suffering severely from phosphorus deficiency will consume bone meal when it is offered separately, with resultant beneficial effects.<sup>1</sup> Other investigators and writers state that cattle will eat bone meal either when it is fed alone or when mixed with salt.<sup>2</sup> The second assumption, therefore, seems

<sup>1</sup>Tr. Dept. Agr. (Union S. Africa) 1, 221-247, 1920. Minn. Agr. Exp. Sta. Bul. 229, 1926.

<sup>2</sup>Agr. Gaz. N. S. Wales 23, 885-888, 1912. N. S. Wales Dept. Agr. Sci. Bul. 12, 3-23, 1914. Ohio Agr. Exp. Sta. Mo. Bul. 5, 212-213, 1920. Minn. Agr. Ext. Spec. Bul. 94, 1924. Mont. Agr. Exp. Sta. Circ. 122, 1924.

TABLE 1.—Continued

Week ending	Heifer group				Cow group			
	Number of animals	Lime-stone	Bone Meal	Salt	Number of animals	Lime-stone	Bone Meal	Salt
<i>1926 records</i>		<i>lbs.</i>	<i>lbs.</i>	<i>lbs.</i>		<i>lbs.</i>	<i>lbs.</i>	<i>lbs.</i>
Aug. 2.....	12	.1	...	10.0	40	.1	...	34.7
" 9.....	12	.8 <sup>1</sup>	1.8 <sup>1</sup>	8.8	40	2.0 <sup>1</sup>	16.5 <sup>1</sup>	38.5
" 16.....	12	2.4	2.4	16.2	40	.3	12.8	34.8
" 23.....	12	.9	1.3	18.3	40	4.6	19.2	50.6
" 30.....	12	.3	.4	23.9	40	3.5	28.0	39.4
Sept. 6.....	12	.2	.1	1.4	40	.7	23.7	17.8
" 13.....	12	2.5	.4	13.2	40	3.7	10.0	16.7
" 20.....	12	2.4	.3	6.5	40	-1.3	1.7	11.7
" 27.....	7	-2	0	-2	39	2.9	6.6	20.8
Oct. 4.....	7	.2	1.5	2.3	39	1.6	2.8	4.3
" 11.....	7	-2	0	-3	39	-8	4.7	8.2
" 18.....	...	...	...	...	39	-3	7.8	15.1
" 25.....	...	...	...	...	39	-3	4.7	11.3
Nov. 1.....	...	...	...	...	39	-2	9.4	5.5
" 8.....	...	...	...	...	39	.6	1.5	4.4
" 15.....	...	...	...	...	39	-3	.1	-4
" 22.....	...	...	...	...	39	-1.7	-8	0
" 29.....	...	...	...	...	38	2.4	.6	-2.9
Dec. 6.....	...	...	...	...	38	1.2	-3	0
" 13.....	...	...	...	...	39	1.1	.1	.4
Total.....	491	23.1	8.2	432.0	1456	57.8	149.1	599.6
Amount per animal weekly.	...	.047	.078	.880	....	.041	.200	.412
<i>1927 records</i>								
Apr. 4.....	11	1.5	-5	-5	38	-2.0	-4	1.7
" 11.....	11	2.5	.7	7.1	38	1.0	1.1	5.3
" 18.....	11	1.0	.3	5.1	38	.5	1.0	4.2
" 25.....	11	.5	2.0	8.8	38	1.0	3.0	7.0
May 2.....	11	2.3	4.5	2.0	38	.3	2.5	10.3
" 9.....	11	5.2	1.0	3.5	38	-3.8	-6.4	11.9
" 16.....	9	1.0	2.0	9.5	40	3.0	10.5	10.6
" 23.....	9	.3	0	2.5	23	-1.2	-1.5	5.0
Total.....	84	14.3	10.0	38.0	291	-1.2	9.8	56.0
Amount per animal weekly.	...	.170	.119	.454	...	0	.034	.192

<sup>1</sup>Beginning with this week and continuing to the end of the experiment, the limestone and bone meal were mixed with common salt at the rate of 4 parts of limestone or bone meal to 1 part of salt. The data showing the amounts of limestone and bone meal consumed subsequent to August 2, 1926, are therefore given in terms of the mixtures.

hardly tenable. Furthermore, the animals in this experiment readily consumed grain mixtures containing bone meal during the period when the mineral supplements were not fed free-choice, and in other experiments at this Station, dairy cows were fed successfully on grain mixtures containing 3 percent of ground limestone. The fact that a feed is eaten readily when offered in a mixture is not, however, conclusive evidence that it will be eaten if offered separately; in earlier experiments at this Station in the self-feeding of dairy cows feeds offered separately were neglected even tho eaten without trouble when offered in combination.<sup>1</sup>

From the results of the present experiment and previous investigations it seems doubtful whether dairy cows of moderate to good productivity suffer from calcium or phosphorus deficiency when re-

<sup>1</sup>Ill. Agr. Exp. Sta. Bul. 289. 1927.

TABLE 1.—*Concluded*

Week ending	Group 1 <sup>1</sup>				Group 2 <sup>1</sup>			
	Number of animals	Limestone	Bone Meal	Salt	Number of animals	Limestone	Bone Meal	Salt
May 30.....	23	lbs. .7	lbs. 1.0	lbs. 5.2	18	lbs. .2	lbs. 0	lbs. 3.0
June 6.....	21	1.0	.6	9.5	18	0	0	3.1
" 13.....	23	1.0	.4	12.1	18	1.0	1.0	6.8
" 20.....	23	0	.2	4.0	18	.2	0	6.2
" 27.....	20	.7	1.8	4.4	21	1.7	.2	10.6
July 4.....	20	.8	0	1.9	21	.1	.4	8.9
" 11.....	20	0	.7	3.7	21	.5	.4	.7
" 18.....	20	0	0	3.0	21	0	1.0	11.4
" 25.....	20	-1.0	-2	8.2	21	-1.2	-1.0	13.8
Aug. 1.....	20	1.2	1.7	8.4	21	.7	.5	19.0
" 8.....	20	3.1	.1	10.9	21	.7	1.0	17.2
" 15.....	20	5.5	3.3	15.3	21	.8	.6	24.9
" 22.....	20	2.0	2.2	8.5	21	1.5	1.5	16.9
" 29.....	20	1.2	.5	8.9	21	1.1	0	12.9
Sept. 5.....	20	1.6	8.6	6.0	21	0	2.6	8.8
" 12.....	20	-6.1	1.8	6.9	21	2.0	4.9	9.7
" 19.....	20	.6	-7.6	2.8	21	-7.7	-4.3	9.9
" 26.....	20	.8	10.3	-3.2	21	4.2	11.2	7.5
Oct. 3.....	20	-6.0	-12.8	1.0	21	-2.9	-10.8	18.2
" 10.....	20	3.6	4.3	5.3	21	8.7	4.8	20.2
" 17.....	20	2.0	2.0	12.0	21	3.5	3.9	19.1
" 24.....	20	-2	0	11.0	23	2.0	0	17.4
" 31.....	21	.8	.5	9.0	21	.2	2.3	18.4
Nov. 7.....	21	0	2.0	6.5	21	.3	1.0	15.7
" 14.....	21	-.4	-.7	1.0	21	-.5	3.8	12.9
" 21.....	21	.6	.2	4.2	21	.3	.6	13.0
" 28.....	0	.....	.....	.....	43	3.7	1.4	19.8
Total.....	534	13.5	20.9	166.5	579	21.1	27.0	346.0
Amount per animal weekly.	...	.025	.039	.312	....	.036	.047	.593

<sup>1</sup>Beginning May 24 the animals were divided into two approximately equal groups. Each group contained cows and heifers and was kept in a separate yard.

Amounts (exclusive of salt admixture) per animal (all groups) weekly for four years were: limestone, .028 pound; bone meal, .077 pound; salt offered alone, .54 pound.

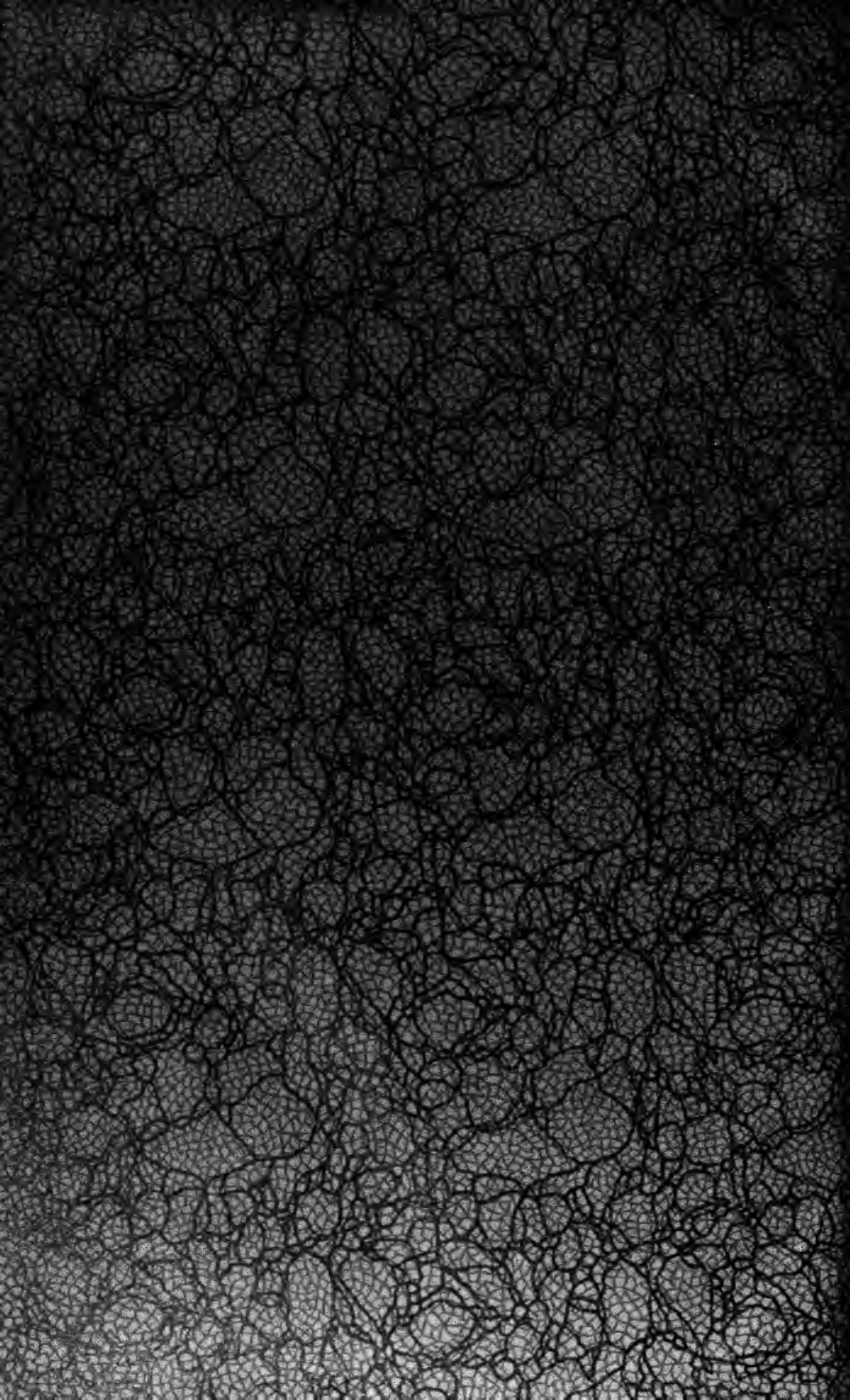
ceiving rations containing liberal amounts of well-cured legume hay, which is high in lime content, and a well-balanced grain mixture containing protein supplements high in phosphorus.

### Summary

No particular craving or desire for mineral supplements other than for common salt was demonstrated in the dairy cattle kept under the conditions of this experiment. The cattle were kept in barns and dry lots, under ordinary herd conditions, and were fed rations consisting of well-cured legume hay, corn silage, and a grain mixture containing protein feeds rich in phosphorus. In addition common salt, finely ground limestone, and bone meal of feeding grade were supplied free-choice. Almost insignificant amounts of the limestone and bone meal were consumed when offered in this manner.

Feeding common salt at the rate of 1 percent of the grain mixture is insufficient to satisfy the desires of dairy cattle for this compound. It was found that when additional salt was supplied in feed boxes in the exercising yards, quite large amounts were consumed.







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