# HIGH SALT RATIONS FOR BEEF CATTLE

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W. A.

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# INTRODUCTION

The use of common salt (sodium chloride) as a regulator of feed intake for livestock has stimulated interest in the effect of large amounts of salt on the health of ruminants. At the present time there is no concrete evidence of detrimental effects if the animals have sufficient water, but skepticism is extremely high among experimental workers as to the long-time effect of such a practice.

In the early 1930's this practice was reportedly used in an attempt to prevent Lechuguilla and Bitterweed poisoning. Apparently the salt failed to prevent the dreaded poisoning of the cattle, but the ranchers did notice that the salt controlled the consumption of concentrates. Now this practice is being used in various areas of the United States and has been adopted in some sections of Australia and New Zealand.

A different concept of feeding cattle would be developed if this plan of feeding were followed, and if there are no ill effects on the cattle. There will be substantial savings through the elimination of much labor previously required for care of cattle on the range with conventional feeding methods.

The success of such a practice depends primarily on whether or not the large quantities of salt consumed by the cattle are injurious when fed over a long period of time. The

investigation reported here was designed to determine the effect of self-feeding a cottonseed meal-salt mixture to beef breeding cows and to determine the effect of a high salt diet on the digestibility of a prairie hay and cottonseed meal ration.

# REVIEW OF LITERATURE

## Sodium Chloride Metabolism and Requirement

Sodium chloride constitutes the greater part of the electrolytes of the tissues, especially in the body fluids, and the sodium chloride ions are essential for normal functioning of body cells. Since these ions are constantly excreted, especially in the urine, they must be steadily replenished.

Eighty percent of the sodium storage is in the extracellular fluid; and the most important sodium depots are the skin, subcutaneous tissue, muscle, and bony skeleton. The largest sodium concentrations are in the cartilage, blood plasma, and lymph; whereas the smallest quantities are found in the gastric juice, muscle, pancreas, milk and saliva. The distribution of chloride in animals roughly parallels that of sodium.

The transfer of NaCl in the animal body accompanies that of the extra-cellular water. The ingestion of high amounts of sodium chloride causes sufficient increase in tissue fluid to produce slight edema in the normal adult animal.

The sodium and chloride ions are rapidly absorbed from the small intestine and transported to the extra-cellular fluid by the blood and lymph. (Everett, 1942)

Babcock (1905) reported a long range study of the salt requirement of dairy cows. He found that cows which received no salt exhibited an abnormal appetite for it after two weeks. A much longer time elapsed before any ill effects on health were noted. These unfavorable results were evidenced as loss of appetite, general unthrifty condition and a marked decline in weight. These symptoms appeared first in the high producers and a breakdown occured most frequently at calvings, or shortly thereafter at the height of milk flow. The feeding of salt produced rapid recovery in animals showing acute symptoms of salt deficiency.

Morrison (1947) lists the salt requirements for dairy and beef cattle as follows:

Dairy Cow:

.75 oz. per day for each 100 lbs. of body weight.

.6 oz. for each 20 lbs. of milk produced.

Beef cows:

2 lbs. per month when on grass.

1-1.5 lbs. per month when in dry lot.

In a series of experiments Smith and Parrish (1950) learned that salt requirements of cattle vary with the type of ration. In their studies the steers on full-grain feed did not require as much salt as those on dry feed or grass.

Parrish (1950) conducted a test to determine whether steers consume more salt if fed a succulent feed, like silage, than if fed a ration of alfalfa hay. These researchers reported that the silage-fed steers consumed more than three times as much salt as the amount required for the alfalfa-fed steers. The average daily salt consumption of 20 head fed alfalfa hay was 0.1 pound per head for a 150-day feeding period, while the 19 head fed silage consumed 0.31 pound per head per day.

Jardine and Anderson (1922) recommended from one to two pounds of salt per head per month for range cattle; two pounds per head per month when the vegetation is succulent and one pound per month the remainder of the season.

Sotola, et al., (1924) state that range steers actually consume 2.42 pounds of salt per head each month during the early grazing season. Toward the end of the season the salt consumption is lessened to approximately 1.77 pounds of salt per head per month.

## Sodium Chloride Toxicity

For many years it has been believed that large amounts of sodium chloride have toxic effects on ruminants. In many areas cattle deaths have been reported due to "Salt Sickness"--the consumption of large amounts of salt and saline waters. This has been customary despite the fact that actual research on the effect of salt on ruminants has been very limited and,

consequently, scientific knowledge up to the present time is slight.

Ramsey (1924) analyzed many of the saline waters in Australia, and through conferences with owners of the water sources, he established permissable tolerances for horses, sheep, and cattle. The work was based largely upon opinions of the livestock owners and not upon experimental data.

Scott (1924), a veterinarian, reported his findings from a study of a salt-water-polluted stream which, it was reported, had killed a number of cattle. Although he used a supply of this same water as the only source of drinking water for cattle over a period of 14 days, he failed to make or report a chemical analysis of the water. It is, of course, not possible to determine the salt concentration with which he was dealing. Since the conditions reported by Scott are not supported in many of the carefully controlled studies by Heller (1933) of the Oklahoma Agricultural Experiment Station, it is believed that Scott was dealing with harmful factors other than the assumed sodium chloride toxicity.

It was brought out by Worden (1941) that under normal circumstances it is doubtful that pigs will voluntarily consume toxic doses of salt. He further suggested that many of the recorded cases of salt poisoning may, in fact, be due to elements other than salt toxicity.

In experimental feeding of salt to swine, Ellis (1924) reported that one 218-pound animal after being fed a high-salt

ration for 26 days, was found to be consuming an average of 8.4 pounds of the total ration and 1.1 pounds of salt per day.

Jones (1930) reported a case of salt poisoning in a cow that was fed one pound of salt in buttermilk, with the same treatments repeated in six hours. An hour after the second dose was administered the animal showed marked weakness and was suffering from severe spasms and diarrhea.

Heller (1933) published information on the toxicity of salt in drinking water for livestock. He tested the salt tolerance of farm animals under varying conditions of growth, reproduction and maintenance when they were compelled to drink water of high salt content. Water which contained 1.5 to 2.0 percent NaCl was given to dairy cows and there were no adverse effects during a two month test period.

In his work at the Arizona Experiment Station, Pistor, et al., (1950) reported several experiments on the effects of sodium chloride on the physiology of ruminants. In these studies he found the symptoms of salt toxicity to be as follows:

1. Anxiety and hypersensitivity to touch.
2. Loss of coordination.
3. Increased rate and intensity of rumen contractions.
4. Gas formation in the rumen.
5. Progressive weakness.
6. Death without struggling.

A 1,000 pound Guernsey cow with a rumen fistula was used in one of the Arizona experiments. This cow was kept from feed and water for thirty-six hours prior to the experiment. Two pounds of salt and three gallons of water were placed in the rumen. At the end of eight hours the blood showed 642 mgs. of sodium chloride per 100 cc. of blood, and there were evidences of nervousness and incoordination. The animal was in critical condition within twelve hours, and in order to save her life, the rumen was washed out with water. At the end of 24 hours she appeared normal.

During the second part of the study the same animal was used and the identical conditions were repeated, except that the animal was allowed all the water she desired. The sodium chloride level of the blood did not increase beyond 505 mgs. per 100 cc. of blood, and there was no distressing action observed.

Many authorities have long believed that high salt intake would cause abortion in cattle. Heller (1933) did not find this to be true in his study of saline waters.

In addition to the experiment cited earlier, workers at the Arizona Experiment Station reported a study to determine the effect of high salt intake during pregnancy. (Pistor, 1950) Five cows were placed on a maintenance ration to which one pound of salt was added daily. The cows were kept in individual pens and the ration was controlled so that one pound of salt was consumed each day. Four of these animals were

pregnant at the beginning of the study. The cows calved three months after being placed on the high-salt ration and were bred before the salt feeding was terminated. Upon later examination the five cows were found to be pregnant.

## Feeding Trials

In a study of the effect of high salt rations on beef cows J. K. Riggs, et al., (1950) concluded that under ideal conditions of feed and water supply dry cows can tolerate large quantities of salt in the diet. In this 107-day feeding trial the cows in the high-salt group consumed 1.05 pound of salt and 2.19 pounds of cottonseed meal per day.

Sells (1951) studied the effect of high salt intake upon cows fed at different nutritional levels. Twenty grade Herefords were divided into four groups. Three of the lots were self-fed a cottonseed meal-salt mixture and the fourth lot was hand-fed cottonseed meal. All four of the lots consumed approximately 2 pounds of cottonseed meal per day, and the amount of roughage fed determined the nutritional level to be maintained. These levels were low, maintenance, and high. In these studies Sells found no detrimental effects from feeding high levels of sodium chloride.

D. A. Savage (1951) reported that salt successfully controlled the consumption of cottonseed meal self-fed to grade Hereford steers on native range at the USDA Southern Great

Plains Field Station, Woodward, Oklahoma. A series of summer and winter feeding trials has been conducted and, to the present time, the consumption of salt as used in this experiment had no effect on gains, grade, and condition or "bloom" of the cattle. In these trials the amount of salt necessary to maintain the consumption of cottonseed meal at 2 pounds per day was 3/4 pound of salt with every 2 pounds of meal for 700 pound steers, 5/8 pound for 450 pound steers and 1/2 pound for 300 pound steers. These workers suggest that the salt-meal method of supplementing native range has the following advantages: (1) Reduction in labor costs for feedings, and (2) Secure uniform grazing over the entire range.

During 1949 A. S. Pickett and Ed F. Smith (1948) tested various methods of feeding protein supplement with 40 head of yearling steers. The steers of Lot 1 were fed 3 pounds of soybean pellets every other day; a cottonseed meal-salt mixture was self-fed to the steers of Lot 2; steers in Lot 3 were fed alfalfa hay daily; and those in Lot 4 were fed 3 pounds of soybean pellets daily (The 3 pounds of soybean pellets actually contained only 50 percent soybean meal). All four lots were wintered on Bluestem grass and were fed prairie hay when snow covered the ground. At the end of the trial the average daily gain was -.07, .22, -.04, and .06 pounds for the steers in Lots 1, 2, 3, and 4, respectively.

The greater daily gain for the steers in Lot 2 was explained by the fact that the animals in this lot consumed

2.83 pounds of cottonseed meal per day while those in Lot 4 which were offered 3 pounds of soybean pellets actually consumed only 1.5 pounds of soybean meal. There were no detrimental effects noted from the large amount of salt consumed by these steers.

Smith and Pickett (1949) repeated the experiment in 1950 and similar results were obtained. Smith and Cox (1950-51) found that steers fed every other day made the largest gain, and the steers fed daily ranked second. The lowest gaining steers were those fed alfalfa hay, as was true in the two previous experiments. The lot fed the soybean oil meal-salt mixture did not gain quite as much as the steers fed every other day, but they compared favorably. The amount of soybean meal consumed by the high-salt lot was 1.97 pounds per day and 2 pounds for the lots fed soybean pellets.

## Digestion Trials

Pistor, et al., (1950) reported that preliminary work indicates an increase in cellulose digestion due to high salt intake. In a digestion trial using four cows Sells (1951) concluded that a high salt intake increased the digestibility of all nutrients. The cows were placed in digestion stalls--two of the cows were fed a salt-cottonseed mixture consisting of 45 percent salt and 55 percent cottonseed meal, and the other two cows were fed cottonseed meal. A seven-day

preliminary period and one eight-day collection period were used in determining the digestibility of the rations.

PART I

# THE SELF-FEEDING OF COTTONSEED MEAL-SALT MIXTURES TO BEEF COWS

## EXPERIMENTAL PROCEDURE

At the beginning of the winter feeding period of 1950, 37 grade Hereford cows, which averaged six years of age, were divided into two lots on the basis of weight, age and the average weaning weight of their calves produced in previous years.

During this winter season the cows were allowed to graze dry, cured grass and, in addition, they consumed at least 2.5 pounds of either 41 percent cottonseed cake or cottonseed meal per day.

The cows of Lot 1 were hand-fed cottonseed cake every other day, while the cows of Lot 2 had access to a self-feeder containing a mixture of salt and cottonseed meal.

The level of salt in the self-fed mixture was gradually increased until the cattle consumed a mixture containing 25 percent salt at the end of 19 days, and 33.3 percent salt at the end of 30 days. The composition of the mixture remained at the higher level during the rest of the winter period, and the average salt content of the mixture for the entire feeding period was 29 percent. All cattle had available a mineral

mixture containing one part salt, one part ground limestone, and one part steamed bone meal. Weight records and blood samples were collected monthly during the winter period. Blood samples were collected from the calves during their early lives and analyzed for plasma sodium, potassium and chlorides. Milk samples were collected during early lactation and analyzed.

This work was continued during the winter period of 1951 and 1952, using the same cows. Additional cows of the same breeding were added so that each experimental lot consisted of 25 cows. The mineral mixture which was self-fed to Lot 1 this season consisted of two parts salt and one part steamed bone meal, while the cows in Lot 2 were self-fed steamed bone meal in the cottonseed meal mixture in sufficient quantities to equal the phosphorus intake of the cows in Lot 1.

## RESULTS AND DISCUSSION

### Winter 1950-51

The cows self-fed cottonseed meal-salt mixture lost an average of 15 pounds from the beginning of the winter feeding period until the last weight recorded before the first calf was born, as compared with an average gain of five pounds for the cows hand-fed cottonseed cake. The cows self-fed the mixture consumed an average of 0.1 pound more protein supplement per head daily than the hand-fed lot. The yearly gain of the cows hand-fed cottonseed cake was 67 pounds as compared to a yearly gain of 35 pounds for the cows self-fed the cottonseed meal-salt mixture. The cows which lost weight during the winter also gained less during the subsequent summer grazing season.

The average birth weight of calves produced by cows which had been self-fed cottonseed meal-salt mixture was nine pounds less than the average birth weight of the calves produced by the cows which were hand-fed cottonseed cake. It should be pointed out, however, that the lighter calves, in the salt-cottonseed meal lot, appeared to be as vigorous and healthy as the calves in the cottonseed cake lot. stop

A summary of the weight changes, feed consumption and calving data is presented in Table 1. The chemical composition

of the cottonseed meal and cake fed during the winter period is given in Table 2.

As shown in Table 3 plasma sodium and potassium levels of the cows were essentially the same in both groups throughout the experimental period. A slight elevation was noted in the plasma chloride of the cows fed the salt-cottonseed meal supplement. No differences were evident in the sodium, potassium or chloride content of the plasma of calves suckling these cows. Milk samples were collected at intervals during early lactation and no differences in total chlorides were found (Table 4).

The plasma sodium and potassium levels of the calf blood were also very similar (Table 5).

## Winter 1951-52 Begin

In this year's work the average weight loss from the beginning of the winter period until the last weight recorded before calving was 20 pounds, the same in both lots. The amount of protein supplement consumed by Lot 1 was 2.4 pounds per day and 2.7 pounds per day for Lot 2. At the end of the winter period the weight of the cows in Lot 1 was 901 pounds compared with 930 pounds for the cows in Lot 2.

The average birth weight of the calves in Lot 1 was 75 pounds and Lot 2 calves average 72 pounds. The calves in the

cottonseed meal-salt lot appeared to be as vigorous and healthy as the calves in the cottonseed cake lot, as was the case last year.

The level of salt was again gradually increased until the cows were consuming a mixture of 33 percent salt and 66 percent cottonseed meal at the end of 30 days. However, the average salt content of the mixture throughout the feeding period was 28.4 percent. Stop.

A summary of the weight changes, feed consumption, and calving data is presented in Table 6.

The plasma chloride, sodium, and potassium levels of the cows were essentially the same throughout this winter period (Table 7). The calf blood plasma chloride, sodium, and potassium levels were also comparatively the same (Table 8). Table 9 shows the similarities of the chemical composition of milk in each lot.

Table 1

SUMMARY OF PRODUCTION DATA 1950-51

| | Lot 1 Cottonseed cake, hand-fed | Lot 2 Cottonseed meal-salt, self-fed |
|---|---|---|
| Number of cows | 18 | 19 |
| Average weight per cow (lbs) | | |
| Beginning winter period (10/31/50) | 1028 | 1039 |
| Before calving (2/2/51) | 1033 | 1024 |
| Change from 10/31/50 to 2/2/51 | 5 | -15 |
| End of summer period (10/25/51) | 1095 | 1074 |
| Yearly gain | 67 | 35 |
| Average daily winter ration[1] (lbs) | | |
| Cottonseed cake | 2.6 | - |
| Cottonseed meal | - | 2.7 |
| Salt (self-fed with cottonseed meal) | - | 1.2 |
| Mineral mixture[2] | free-choice | free-choice |
| Average birth weight of calves | 76 | 67 |
| Average birth weight of calves produced by these cows in previous years | 73 | 73 |
| Average birth date | Mar. 10 | Mar. 10 |
| Average weaning weight of calves[3] (10/4/51) | 458 | 450 |
| Average weaning weight of calves produced by these cows in previous years[3] | 456 | 463 |

1 In addition to winter grazing.

2 Mixture consisted of 1 part salt, 1 part ground limestone, and 1 part steamed bone meal.

3 Corrected for age and sex of the calf and age of the dam.

4 The number of calves used to determine the birth weight was 18 for Lot 1 and 19 for Lot 2.

Table 2

CHEMICAL COMPOSITION OF PROTEIN SUPPLEMENTS

| | Percent Dry Matter | Percent composition of dry matter | | | | | |
|---|---|---|---|---|---|---|---|
| | | Ash | Protein | Fat | Fiber | N.F.E. | Ca | P |
| 1950-51 | | | | | | | | |
| Cottonseed cake | 93.69 | 7.59 | 42.16 | 4.74 | 11.23 | 34.28 | .21 | 1.09 |
| Cottonseed meal | 93.12 | 7.12 | 42.83 | 6.88 | 10.38 | 32.79 | .19 | 1.03 |
| 1951-52 | | | | | | | | |
| Cottonseed cake | 94.99 | 6.16 | 45.13 | 4.77 | 9.73 | 34.23 | .19 | .85 |
| Cottonseed meal | 93.93 | 6.79 | 42.59 | 7.19 | 8.86 | 34.57 | .22 | 1.10 |

Table 3

CHEMICAL COMPOSITION OF COW BLOOD 1950-51
(Expressed in mg. %)

| Lot | 1950 Oct.31 | 1950 Nov.30 | 1951 Jan.6 | 1951 Feb.2 | 1951 Mar.3 | 1951 Mar.31 | 1951 Apr.28 | 1951 May 26 |
|---|---|---|---|---|---|---|---|---|
| | | | | Plasma Chloride | | | | |
| 1 | 360 | 349 | 334 | 331 | 377 | 343 | 339 | 333 |
| 2 | 358 | 358 | 321 | 366 | 401 | 357 | 326 | 333 |
| | | | | Plasma Sodium | | | | |
| 1 | 285 | 265 | 329 | 319 | 318 | 313 | 287 | 297 |
| 2 | 286 | 267 | 312 | 333 | 325 | 300 | 284 | 292 |
| | | | | Plasma Potassium | | | | |
| 1 | 21 | 16 | 20 | 22 | 31 | 26 | 36 | 27 |
| 2 | 22 | 17 | 20 | 21 | 33 | 27 | 36 | 28 |

Table 4

CHLORIDE CONTENT OF MILK 1950-51
(Expressed in mg. %)

| Lot | 1951 | |
|---|---|---|
| | Mar. 31 | Apr. 28 |
| 1 | 61 | 56 |
| 2 | 66 | 55 |

Table 5

CHEMICAL COMPOSITION OF CALF BLOOD 1950-51
(Expressed in mg. %)

| Lot | 1951 | | | |
|---|---|---|---|---|
| | Mar. 3 | Mar. 31 | Apr. 28 | May 26 |
| | | Plasma Chloride | | |
| 1 | 344 | 334 | 360 | 335 |
| 2 | 349 | 341 | 352 | 334 |
| | | Plasma Sodium | | |
| 1 | 328 | 310 | 310 | 310 |
| 2 | 330 | 312 | 310 | 312 |
| | | Plasma Potassium | | |
| 1 | 49 | 37 | 42 | 31 |
| 2 | 50 | 42 | 44 | 35 |

Table 6

SUMMARY OF PRODUCTION DATA 1951-52

| | Lot 1 Cottonseed cake, (hand-fed) | Lot 2 Cottonseed meal-salt, self-fed |
|---|---|---|
| No. of cows | 24 | 25 |
| Ave. wt. per cow (lbs) | | |
| Beginning of winter period (10/25/52) | 1028 | 1039 |
| Before calving (1/29/52) | 1054 | 1047 |
| End of winter period (4/17/52) | 901 | 930 |
| Ave. daily winter ration | | |
| Cottonseed cake | 2.4 | - |
| Cottonseed meal | - | 2.7 |
| Salt | .06 | 1.07 |
| Steamed bone meal | .03 | .025 |
| Ave. birth weight of calves | 75 | 72 |
| Ave. birth weight of calves produced by these cows in years previous to 1951 | 73 | 73 |

1 The number of calves used to determine the birth weight was 20 for Lot 1 and 23 for Lot 2.

Table 7

CHEMICAL COMPOSITION OF COW BLOOD 1951-52
(Expressed in mg.%)

| Lot | 1951 Oct. 25 | 1951 Nov. 20 | 1951 Dec. 26 | 1952 Jan. 29 | 1952 Feb. 27 | 1952 Mar. 26 |
|---|---|---|---|---|---|---|
| | | | Plasma Chloride | | | |
| 1 | 322 | 339 | 343 | 355 | 340 | 344 |
| 2 | 319 | 340 | 341 | 344 | 343 | 381 |
| | | | Plasma Sodium | | | |
| 1 | 299 | 295 | 290 | 286 | 310 | 297 |
| 2 | 300 | 298 | 283 | 277 | 305 | 286 |
| | | | Plasma Potassium | | | |
| 1 | 191 | 31 | 15 | 15 | 16 | 19 |
| 2 | 19 | 13 | 15 | 14 | 17 | 21 |

Table 8

CHEMICAL COMPOSITION OF CALF BLOOD 1951-52
(Expressed in mg. %)

| Lot | 1952 Feb. 27 | 1952 Mar. 26 |
|---|---|---|
| | Plasma Chloride | |
| 1 | 342 | 341 |
| 2 | 340 | 348 |
| | Plasma Sodium | |
| 1 | 300 | 293 |
| 2 | 297 | 289 |
| | Plasma Potassium | |
| 1 | 19 | 23 |
| 2 | 18 | 23 |

Table 9

CHEMICAL COMPOSITION OF MILK 1951-52
(Expressed in mg. %)

| Lot | 1952 | |
|---|---|---|
| | Feb. 27 | Mar. 25 |
| | Chloride | |
| 1 | 109 | 53 |
| 2 | 91.6 | 56 |
| | Sodium | |
| 1 | 60 | 46 |
| 2 | 44 | 51 |
| | Potassium | |
| 1 | 138 | 163 |
| 2 | 163 | 168 |

PART II

## A METABOLISM STUDY OF THE EFFECT OF A HIGH SALT DIET UPON STEERS

### EXPERIMENTAL PROCEDURE

The average weight of the grade Hereford weanling steers used in these metabolism studies was 500 pounds. They were kept in metabolism stalls with a standard 10-day preliminary period preceding each series of three five-day collection periods. The ration fed to each steer was changed in the second trial so that each steer was fed each experimental ration. They were fed twice daily and each stall was equipped with a water container so that each steer had water before him at all times. Due to the abnormal surroundings in the metabolism stalls, it was not possible to get the steers to consume the desired amount of a cottonseed meal-salt mixture. The desired consumption was achieved by feeding a ration of cottonseed meal and prairie hay and the salt was given in gelatin capsules.

Feces were collected in gutter boxes and removed at frequent intervals and placed in covered containers. The feces were weighed daily, aliquoted and the samples preserved with thymol and refrigeration. After drying the samples, proximate analyses, as described by the Association of Official

Agricultural Chemists (1945), were made on the composite samples. Chlorides were determined through the method described by McLean and Van Slyke (Peters, 1932); sodium and potassium contents of feed, urine, and feces by means of a Perkin-Elmer flame photometer using lithium as an internal standard.

Urine was collected by means of a rubber funnel supported by two straps over the back of each steer. A hose connected to each funnel directed the urine through the false bottom stalls into eight-liter collection bottles. The urine was measured daily and an aliquot, acidified with concentrated $H_2SO_4$, was placed under refrigeration. Total urinary nitrogen was determined by the Kjeldahl method on the composite five day samples from each steer.

The hay used in this study was good quality prairie hay obtained in the vicinity of Stillwater, Oklahoma. The cottonseed meal used was 41 percent protein expeller process cottonseed meal. A feeding grade of ground rock salt was fed.

## RESULTS OF THE METABOLISM STUDY

The chemical composition of the feeds used in this study is described in Table 10. The chemical composition of each ration was the same with the exception of the salt content. The daily allowances in ration A were as follows: prairie hay, 3,178 grams; cottonseed meal, 681 grams; gelatin, 26 grams; and salt, 10 grams. The only change in ration B was to increase the salt content to 250 grams, as is shown in Table 11. The mineral composition of the various feed stuffs is given in Table 12.

The average nitrogen balance data are given in Table 13. There is an indication that the addition of large quantities of salt to the ration increased the amount of nitrogen excreted by the steers; however, this difference is of little significance and cannot be considered a detrimental effect. The average nitrogen balance for ration A and 16.25, and for ration B was 13.77 grams. The steers grew slightly throughout the experiment as evidenced by a positive nitrogen balance by all steers. The complete nitrogen balance data are given in Appendix Table IV.

The average apparent digestion coefficients for this metabolism study are shown in Table 14. The average organic matter coefficient for ration A was 63.2; crude protein, 61.8; ether

extract, 69.8; crude fiber, 69.3; and N.F.E. (Nitrogen-free extract), 63.2 percent. For ration B the average coefficient for organic matter was 62.2; crude protein, 60.0; ether extract, 68.5; crude fiber, 68.2; and N.F.E., 62.5 percent. There was a tendency for the large quantity of salt to decrease the digestibility of these nutrients slightly. Appendix Table V gives the complete data for the two trials.

Sells (1951) found an increase in the digestibility of all nutrients. His results were not supported in this study. Sells reported the results of one trial with one eight-day collection period. This being true, it is doubtful that his data gave a true picture of the effect on digestibility.

Table 15 gives the chloride balance data. The constant chloride content of the urine indicates that the steers were excreting urine at the maximum concentration. Appendix Table VI presents the complete chloride balance data. This data reveals that less than 1 percent of the chloride was excreted in the feces, and more than 98 percent of the chloride was excreted in the urine.

Table 16 consists of the sodium balance data, indicating that sodium is not absorbed from the intestinal tract as efficiently as is chloride. The complete sodium balance data can be found in Appendix Table VII.

The potassium balance data are given in Table 17. Here there is an indication that the increased sodium content of the ration resulted in increased absorption of potassium from the

intestinal tract. When the sodium content of the ration was increased the percentage of potassium in the feces was lowered. The complete potassium balance data are presented in Appendix Table VIII.

The water consumption of the steers in this study is recorded in Table 18. The average water consumption of the steers fed ration A was 11,080 cc. and for ration B, 25,294 cc.

Table 10

PERCENTAGE COMPOSITION OF FEED STUFFS

| Feed | Dry Matter | Crude Protein | Ether Extract | Crude Fiber | Ash | N.F.E. |
|---|---|---|---|---|---|---|
| Prairie Hay | 92.21 | 5.19 | 2.24 | 34.19 | 7.65 | 50.73 |
| Cottonseed Meal | 93.81 | 43.51 | 7.27 | 10.08 | 6.85 | 32.29 |
| Salt | 99.98 | - | - | - | 99.98 | - |
| Gelatin | 100 | 100 | - | - | - | - |

Table 11

DAILY ALLOWANCE IN RATION
(Expressed in grams)

| Feed | Daily Allowance in Ration | |
|---|---|---|
| | A | B |
| Prairie Hay | 3178 | 3178 |
| Cottonseed Meal | 681 | 681 |
| Salt | 10 | 250 |
| Gelatin | 26 | 26 |

Table 12

MINERAL COMPOSITION OF THE FEED STUFFS
(Expressed in percent)

| Feed | Sodium | Potassium | Chloride |
|---|---|---|---|
| Prairie Hay | .0036 | .827 | .0037 |
| Cottonseed Meal | .0072 | .141 | .0054 |
| Salt | 37.75 | 1.75 | 58.60 |

Table 13

AVERAGE DAILY NITROGEN BALANCE DATA
(Expressed in gms.)

| Steer No. | Trial | Ration | Nitrogen Intake | Fecal Nitrogen | Urinary Nitrogen | Nitrogen Balance |
|---|---|---|---|---|---|---|
| 95 | 1 | A | 72.6 | 26.6 | 31.8 | 15.3 |
| 95 | 2 | B | 72.6 | 26.2 | 32.8 | 14.7 |
| 8 | 2 | A | 72.6 | 26.2 | 30.5 | 15.9 |
| 8 | 1 | B | 72.6 | 26.0 | 34.5 | 12.2 |
| 5 | 1 | A | 72.6 | 26.3 | 28.2 | 18.1 |
| 5 | 2 | B | 72.6 | 25.3 | 28.8 | 18.5 |
| 94 | 2 | A | 72.6 | 27.0 | 29.9 | 15.7 |
| 94 | 1 | B | 72.6 | 30.1 | 32.9 | 9.6 |
| Ave. | | A | 72.6 | 26.5 | 30.1 | 16.3 |
| Ave. | | B | 72.6 | 26.9 | 32.3 | 13.8 |

Table 14

THE AVERAGE APPARENT DIGESTION COEFFICIENTS
(Expressed in percent)

| Steer No. | Trial | Ration | Organic Matter | Crude Protein | Ether Extract | Crude Fiber | N.F.E. |
|---|---|---|---|---|---|---|---|
| 95 | 1 | A | 63.4 | 61.7 | 71.8 | 69.6 | 63.1 |
| 95 | 2 | B | 63.0 | 63.7 | 71.1 | 67.7 | 63.2 |
| 8 | 2 | A | 63.8 | 62.3 | 67.6 | 70.3 | 63.9 |
| 8 | 1 | B | 62.2 | 62.6 | 69.0 | 69.2 | 62.7 |
| 5 | 1 | A | 65.2 | 62.1 | 73.3 | 72.3 | 64.3 |
| 5 | 2 | B | 66.1 | 63.6 | 67.4 | 72.2 | 66.0 |
| 94 | 2 | A | 60.4 | 61.1 | 66.5 | 65.3 | 61.4 |
| 94 | 1 | B | 57.3 | 53.7 | 66.5 | 63.7 | 58.0 |
| Ave. | | A | 63.2 | 61.8 | 69.8 | 69.3 | 63.2 |
| Ave. | | B | 62.2 | 60.9 | 68.5 | 68.2 | 62.5 |

Table 15

CHLORIDE BALANCE DATA
(Expressed in gms.)

| Steer No. | Trial | Ration | Chloride Intake | Fecal Chloride | Urinary Chloride | Total Excreted | Chloride Balance |
|---|---|---|---|---|---|---|---|
| 95 | 1 | A | 6 | .068 | 8.2 | 8.3 | -2.3 |
| 95 | 2 | B | 146 | .079 | 145.9 | 146.0 | 0.0 |
| 8 | 2 | A | 6 | .091 | 10.1 | 10.2 | -4.2 |
| 8 | 1 | B | 146 | .093 | 145.3 | 145.4 | 0.6 |
| 5 | 1 | A | 6 | .015 | 6.7 | 6.8 | -0.6 |
| 5 | 2 | B | 146 | .071 | 141.1 | 141.4 | 4.6 |
| 94 | 2 | A | 6 | .109 | 10.3 | 10.4 | -4.4 |
| 94 | 1 | B | 146 | .085 | 143.2 | 143.2 | 2.8 |

Table 16

SODIUM BALANCE DATA
(Expressed in gms.)

| Steer No. | Trial | Ration | Sodium Intake | Fecal Sodium | Urinary Sodium | Total Excreted | Sodium Balance |
|---|---|---|---|---|---|---|---|
| 95 | 1 | A | 4.0 | 1.81 | 1.9 | 3.7 | 0.3 |
| 95 | 2 | B | 94.5 | 1.12 | 88.9 | 90.0 | 4.5 |
| 8 | 2 | A | 4.0 | 1.06 | 2.2 | 3.2 | 0.8 |
| 8 | 1 | B | 94.5 | 6.86 | 80.5 | 87.4 | 7.1 |
| 5 | 1 | A | 4.0 | 2.23 | 0.5 | 2.8 | 1.2 |
| 5 | 2 | B | 94.5 | 1.30 | 78.0 | 79.3 | 15.2 |
| 94 | 2 | A | 4.0 | 0.57 | 3.0 | 3.5 | 0.5 |
| 94 | 1 | B | 94.5 | 4.84 | 80.4 | 86.2 | 8.3 |

Table 17

POTASSIUM BALANCE
(Expressed in gms.)

| Steer No. | Trial | Ration | Intake | Fecal Potassium | Urinary Potassium | Total Excreted | Potassium Balance |
|---|---|---|---|---|---|---|---|
| 95 | 1 | A | 27.4 | 4.4 | 28.6 | 33.0 | -5.6 |
| 95 | 2 | B | 31.6 | 0.7 | 35.6 | 36.3 | -4.7 |
| 8 | 2 | A | 27.4 | 0.8 | 33.4 | 34.2 | -6.8 |
| 8 | 1 | B | 31.6 | 1.4 | 34.2 | 36.1 | 0.0 |
| 5 | 1 | A | 27.4 | 7.9 | 24.6 | 32.5 | -5.1 |
| 5 | 2 | B | 31.6 | 1.0 | 32.5 | 33.5 | -1.9 |
| 94 | 2 | A | 27.4 | 1.4 | 33.5 | 34.9 | -7.5 |
| 94 | 1 | B | 31.6 | 2.1 | 31.4 | 33.5 | -1.9 |

Table 18

AVERAGE DAILY WATER CONSUMPTION

| Steer No. | Ration | Water Consumed (cc.) |
|---|---|---|
| 95 | A | 13,279 |
| 95 | B | 24,000 |
| 8 | A | 11,733 |
| 8 | B | 26,335 |
| 5 | A | 15,989 |
| 5 | B | 24,533 |
| 94 | A | 14,400 |
| 94 | B | 27,106 |

## SUMMARY

Studies were conducted to determine the effect of a high salt diet on beef cows. Two lots of cows grazed the native grass pastures at the experimental range of the Oklahoma Agricultural Experiment Station during the winter of 1950-51 and 1951-52. One of these lots was hand-fed cottonseed cake while the other was self-fed a mixture of cottonseed meal and salt. The results do not show any harmful effect upon the cows as indicated by weight loss during the winter period, or on birth weight of the calves produced. There was some indication, in general appearance, that there was some effect from the high salt intake. The cows in Lot 2 had a rough hair coat and appeared to be carrying less flesh than the cows in Lot 1. However, it is not possible at this time to classify the slight apparent effects as detrimental.

Blood samples were taken at monthly intervals and no changes were noted in the plasma chloride, potassium or sodium levels.

Although the salt did control the intake of cottonseed meal, it must be remembered that this method of feeding should be used only with caution, since the long time effect is not yet known. It should never be used if the cows do not have access to good water supply.

A metabolism study with four steers (each steer fed both a normal and high salt ration) indicated no difference in the digestion coefficients of the various nutrients. The chloride balance showed that less than 1 percent of the chloride was excreted in the feces while the remainder was excreted in the urine.

The advisability of feeding high salt rations to beef cattle is still controversial. There is, on the part of some ranchers, high hopes for eventual use of the method; on the other hand, many cattle men have seen tragic results from their previous experiences with toxic amounts of sodium chloride. The writer can present no definite conclusions, although it is evident that the cattle used in these experiments seemed to tolerate the high-salt intake very well and suffered no striking ill effects through the two winters.

There is no doubt that a high salt ration, within safe limits, can be used to regulate the food intake of beef cattle, thus cutting considerably not only operating expenses but also the number of men necessary to feed cattle on the range. It is possible that the method--whether it is ever practical under normal conditions or not--could be highly valuable in the event of a serious man-power shortage.

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# APPENDIX

## COMPLETE DATA FOR METABOLISM TRIALS

TABLE I

DRY MATTER EXCRETED AND ITS CHEMICAL COMPOSITION
(Expressed in gms.)

| Steer No. | Period | Dry Matter | Crude Protein | Ether Extract | Ash | Crude Fiber | N.F.E. |
|---|---|---|---|---|---|---|---|
| | | | Trial 1 | | | | |
| 95 | 1 | 1407 | 12.48 | 2.10 | 12.97 | 24.66 | 49.01 |
| 95 | 2 | 1474 | 11.35 | 2.78 | 14.42 | 24.40 | 47.06 |
| 95 | 3 | 1390 | 11.16 | 2.29 | 15.32 | 25.07 | 46.16 |
| 8 | 1 | 1556 | 11.08 | 2.64 | 13.09 | 24.20 | 48.96 |
| 8 | 2 | 1423 | 11.24 | 2.79 | 14.35 | 25.22 | 46.49 |
| 8 | 3 | 1336 | 11.58 | 2.42 | 15.48 | 24.00 | 46.94 |
| 5 | 1 | 1443 | 11.99 | 2.98 | 14.09 | 23.10 | 48.72 |
| 5 | 2 | 1319 | 11.91 | 1.99 | 15.55 | 23.60 | 47.66 |
| 5 | 3 | 1342 | 12.08 | 2.16 | 16.20 | 23.60 | 46.83 |
| 94 | 1 | 1787 | 11.12 | 2.40 | 12.32 | 23.90 | 47.27 |
| 94 | 2 | 1622 | 11.20 | 2.69 | 13.75 | 25.40 | 47.04 |
| 94 | 3 | 1531 | 12.02 | 2.30 | 15.00 | 24.86 | 45.82 |
| | | | Trial 2 | | | | |
| 95 | 4 | 1371 | 11.02 | 2.74 | 12.85 | 25.40 | 47.91 |
| 95 | 5 | 1373 | 10.89 | 2.28 | 12.15 | 27.19 | 47.49 |
| 95 | 6 | 1380 | 11.60 | 1.51 | 12.15 | 26.87 | 48.31 |
| 8 | 4 | 1425 | 11.74 | 2.69 | 13.60 | 22.96 | 49.58 |
| 8 | 5 | 1404 | 11.74 | 2.94 | 13.05 | 26.50 | 45.77 |
| 8 | 6 | 1344 | 11.79 | 2.82 | 13.25 | 24.73 | 47.41 |
| 5 | 4 | 1354 | 11.91 | 2.96 | 13.85 | 24.22 | 48.78 |
| 5 | 5 | 1317 | 11.27 | 2.85 | 13.05 | 25.07 | 47.76 |
| 5 | 6 | 1259 | 13.06 | 3.33 | 13.75 | 24.28 | 47.33 |
| 94 | 4 | 1499 | 11.24 | 3.48 | 12.55 | 26.04 | 46.81 |
| 94 | 5 | 1511 | 10.84 | 2.47 | 11.85 | 27.05 | 47.55 |
| 94 | 6 | 1488 | 11.75 | 2.89 | 11.10 | 27.23 | 47.23 |

TABLE II

MINERAL COMPOSITION OF FECAL DRY MATTER
(Expressed in Percentage)

| Steer No. | Period | Sodium | Chloride | Potassium |
|---|---|---|---|---|
| | | Trial 1 | | |
| 95 | 1 | .127 | .004 | .400 |
| 95 | 2 | .119 | .005 | .236 |
| 95 | 3 | .136 | .005 | .285 |
| 8 | 1 | .430 | .007 | .124 |
| 8 | 2 | .480 | .007 | .094 |
| 8 | 3 | .528 | .005 | .070 |
| 5 | 1 | .099 | .008 | .724 |
| 5 | 2 | .156 | .007 | .527 |
| 5 | 3 | .238 | .009 | .472 |
| 94 | 1 | .308 | .004 | .133 |
| 94 | 2 | .314 | .007 | .136 |
| 94 | 3 | .258 | .005 | .114 |
| | | Trial 2 | | |
| 95 | 4 | .117 | .005 | .041 |
| 95 | 5 | .054 | .005 | .027 |
| 95 | 6 | .070 | .006 | .086 |
| 8 | 4 | .071 | .006 | .037 |
| 8 | 5 | .095 | .007 | .064 |
| 8 | 6 | .062 | .007 | .069 |
| 5 | 4 | .065 | .005 | .094 |
| 5 | 5 | .077 | .005 | .087 |
| 5 | 6 | .016 | .007 | .035 |
| 94 | 4 | .020 | .007 | .095 |
| 94 | 5 | .049 | .009 | .095 |
| 94 | 6 | .045 | .007 | .091 |

TABLE III

VOLUME OF URINE EXCRETED AND ITS MINERAL COMPOSITION

| Steer No. | Period | Urine cc. | Sodium mg./ml. | Chloride mg./ml. | Potassium mg./ml. |
|---|---|---|---|---|---|
| | | Trial 1 | | | |
| 95 | 1 | 2,687 | 0.72 | 3.68 | 10.56 |
| 95 | 2 | 2,940 | 0.76 | 2.76 | 9.63 |
| 95 | 3 | 2,549 | 0.64 | 2.65 | 11.50 |
| 8 | 1 | 10,884 | 7.40 | 13.35 | 3.14 |
| 8 | 2 | - | - | - | - |
| 8 | 3 | - | - | - | - |
| 5 | 1 | 2,832 | 0.09 | 1.84 | 7.65 |
| 5 | 2 | 2,640 | 0.28 | 3.70 | 10.20 |
| 5 | 3 | 3,290 | 0.21 | 1.53 | 7.70 |
| 94 | 1 | 9,587 | 8.45 | 14.35 | 3.20 |
| 94 | 2 | 10,642 | 8.20 | 14.35 | 2.90 |
| 94 | 3 | 9,840 | 7.70 | 14.15 | 3.33 |
| | | Trial 2 | | | |
| 95 | 4 | 10,900 | 8.45 | 13.20 | 3.38 |
| 95 | 5 | 10,650 | 8.45 | 14.25 | 3.38 |
| 95 | 6 | 10,300 | 8.20 | 13.80 | 3.30 |
| 8 | 4 | 2,550 | 1.22 | 4.79 | 15.20 |
| 8 | 5 | 2,640 | 0.72 | 4.14 | 13.65 |
| 8 | 6 | 2,150 | 0.69 | 3.33 | 12.10 |
| 5 | 4 | 10,312 | 8.00 | 13.15 | 2.80 |
| 5 | 5 | 10,687 | 6.70 | 13.80 | 3.38 |
| 5 | 6 | 10,166 | 7.85 | 13.80 | 2.20 |
| 94 | 4 | 4,120 | 0.88 | 2.85 | 7.75 |
| 94 | 5 | 4,090 | 0.61 | 2.43 | 7.68 |
| 94 | 6 | 4,890 | 0.57 | 1.89 | 7.60 |

TABLE IV

NITROGEN BALANCE DATA
(Expressed in gms.)

| Steer No. | Period | Ration | Fecal Nitrogen | Urinary Nitrogen | Total Nitrogen Excreted | Nitrogen Intake | Nitrogen Balance |
|---|---|---|---|---|---|---|---|
| | | | | Trial 1 | | | |
| 95 | 1 | A | 28.2 | 28.2 | 56.4 | 72.6 | 16.2 |
| 95 | 2 | A | 26.8 | 34.4 | 61.2 | 72.6 | 14.4 |
| 95 | 3 | A | 24.8 | 32.7 | 57.5 | 72.6 | 15.1 |
| Ave. | | | 26.6 | 31.8 | 58.4 | 72.6 | 15.3 |
| 8 | 1 | B | 27.6 | 34.5 | 62.1 | 72.6 | 10.6 |
| 8 | 2 | B | 25.6 | - | 60.1 | 72.6 | 12.6 |
| 8 | 3 | B | 24.8 | - | 59.2 | 72.6 | 13.4 |
| Ave. | | | 26.0 | 34.5 | 60.4 | 72.6 | 12.2 |
| 5 | 1 | A | 27.7 | 24.8 | 52.5 | 72.6 | 20.1 |
| 5 | 2 | A | 25.5 | 29.9 | 55.1 | 72.6 | 17.5 |
| 5 | 3 | A | 26.0 | 29.9 | 55.9 | 72.6 | 16.7 |
| Ave. | | | 26.3 | 28.2 | 54.5 | 72.6 | 18.1 |
| 94 | 1 | B | 31.8 | 30.0 | 61.8 | 72.6 | 10.9 |
| 94 | 2 | B | 29.1 | 34.8 | 63.8 | 72.6 | 8.8 |
| 94 | 3 | B | 29.4 | 34.1 | 63.5 | 72.6 | 9.1 |
| Ave. | | | 30.1 | 32.9 | 63.0 | 72.6 | 9.6 |
| | | | | Trial 2 | | | |
| 95 | 4 | B | 24.2 | 31.5 | 55.7 | 72.6 | 16.9 |
| 95 | 5 | B | 25.7 | 32.6 | 58.2 | 72.6 | 14.4 |
| 95 | 6 | B | 25.6 | 34.2 | 59.8 | 72.6 | 12.8 |
| Ave. | | | 25.2 | 32.8 | 57.9 | 72.6 | 14.7 |
| 8 | 4 | A | 26.8 | 30.7 | 57.4 | 72.6 | 15.2 |
| 8 | 5 | A | 26.4 | 32.5 | 58.9 | 72.6 | 13.7 |
| 8 | 6 | A | 25.3 | 28.4 | 53.7 | 72.6 | 18.9 |
| Ave. | | | 26.2 | 30.5 | 56.3 | 72.6 | 15.9 |
| 5 | 4 | B | 25.8 | 26.2 | 52.0 | 72.6 | 15.2 |
| 5 | 5 | B | 23.7 | 30.7 | 54.4 | 72.6 | 13.7 |
| 5 | 6 | B | 26.3 | 29.6 | 25.9 | 72.6 | 18.9 |
| Ave. | | | 25.3 | 28.4 | 54.1 | 72.6 | 15.9 |
| 94 | 4 | A | 27.0 | 31.3 | 58.3 | 72.6 | 14.4 |
| 94 | 5 | A | 26.2 | 29.0 | 55.3 | 72.6 | 17.4 |
| 94 | 6 | A | 28.0 | 29.4 | 57.4 | 72.6 | 15.2 |
| Ave. | | | 27.1 | 29.9 | 57.0 | 72.6 | 15.7 |

TABLE V

APPARENT DIGESTION COEFFICIENT
(Expressed in percent)

| Steer No. | Period | Ration | Organic Matter | Crude Protein | Ether Extract | Crude Fiber | N.F.E. |
|---|---|---|---|---|---|---|---|
| | | | Trial 1 | | | | |
| 95 | 1 | A | 63.3 | 59.4 | 75.6 | 70.0 | 62.3 |
| 95 | 2 | A | 62.2 | 61.4 | 66.1 | 68.8 | 62.1 |
| 95 | 3 | A | 64.7 | 64.2 | 73.7 | 69.4 | 65.0 |
| Ave. | | | 63.4 | 61.7 | 71.8 | 69.6 | 63.1 |
| 8 | 1 | B | 57.1 | 60.3 | 66.0 | 67.4 | 58.4 |
| 8 | 2 | B | 63.5 | 63.0 | 67.2 | 68.9 | 64.0 |
| 8 | 3 | B | 66.2 | 64.4 | 73.7 | 71.2 | 65.8 |
| Ave. | | | 62.2 | 62.6 | 69.0 | 69.2 | 62.7 |
| 5 | 1 | A | 62.9 | 60.0 | 65.7 | 71.2 | 61.6 |
| 5 | 2 | A | 66.6 | 63.7 | 78.3 | 73.1 | 65.7 |
| 5 | 3 | A | 66.3 | 62.6 | 76.0 | 72.6 | 65.7 |
| Ave. | | | 65.2 | 62.1 | 73.3 | 72.3 | 64.3 |
| 94 | 1 | B | 53.0 | 54.0 | 64.6 | 59.7 | 53.9 |
| 94 | 2 | B | 58.1 | 58.0 | 64.0 | 64.3 | 58.4 |
| 94 | 3 | B | 61.0 | 57.5 | 71.0 | 67.0 | 61.7 |
| Ave. | | | 57.3 | 53.7 | 66.5 | 63.7 | 58.0 |
| | | | Trial 2 | | | | |
| 95 | 4 | B | 64.2 | 65.1 | 69.0 | 60.9 | 64.1 |
| 95 | 5 | B | 61.2 | 63.0 | 74.1 | 69.4 | 61.9 |
| 95 | 6 | B | 63.7 | 63.0 | 70.3 | 70.9 | 63.6 |
| Ave. | | | 63.0 | 63.7 | 71.1 | 67.7 | 63.2 |
| 8 | 4 | A | 66.1 | 61.4 | 68.3 | 71.7 | 61.5 |
| 8 | 5 | A | 63.4 | 62.1 | 65.8 | 67.8 | 65.0 |
| 8 | 6 | A | 65.1 | 63.5 | 68.7 | 71.3 | 65.2 |
| Ave. | | | 63.8 | 62.3 | 67.6 | 70.3 | 63.9 |
| 5 | 4 | B | 65.1 | 62.8 | 66.9 | 71.6 | 64.7 |
| 5 | 5 | B | 65.7 | 65.8 | 70.0 | 71.4 | 65.7 |
| 5 | 6 | B | 67.5 | 62.1 | 65.3 | 73.5 | 67.5 |
| Ave. | | | 66.1 | 63.6 | 67.4 | 72.2 | 66.0 |
| 94 | 4 | A | 60.7 | 61.2 | 62.8 | 66.2 | 61.7 |
| 94 | 5 | A | 60.1 | 62.4 | 69.8 | 64.7 | 60.8 |
| 94 | 6 | A | 60.4 | 59.8 | 67.0 | 64.9 | 61.7 |
| Ave. | | | 60.4 | 61.2 | 66.5 | 65.3 | 61.4 |

TABLE VI

CHLORIDE BALANCE DATA
(Expressed in gms.)

| Steer No. | Period | Ration | Chloride Intake | Fecal Chloride | Urinary Chloride | Total Excreted |
|---|---|---|---|---|---|---|
| | | | Trial 1 | | | |
| 95 | 1 | A | 6 | .059 | 9.89 | 9.95 |
| 95 | 2 | A | 6 | .079 | 8.11 | 8.19 |
| 95 | 3 | A | 6 | .067 | 6.73 | 6.79 |
| Ave. | | | 6 | .068 | 8.24 | 8.31 |
| 8 | 1 | B | 146 | .104 | 145.30 | 145.41 |
| 8 | 2 | B | 146 | .105 | - | 145.40 |
| 8 | 3 | B | 146 | .072 | - | 145.37 |
| Ave. | | | 146 | .093 | 145.30 | 145.39 |
| 5 | 1 | A | 6 | .113 | 5.21 | 5.32 |
| 5 | 2 | A | 6 | .088 | 9.77 | 8.95 |
| 5 | 3 | A | 6 | .115 | 5.30 | 5.14 |
| Ave. | | | 6 | .105 | 6.67 | 6.77 |
| 94 | 1 | B | 146 | .066 | 137.57 | 137.63 |
| 94 | 2 | B | 146 | .108 | 152.71 | 152.81 |
| 94 | 3 | B | 146 | .082 | 139.24 | 139.32 |
| Ave. | | | 146 | .085 | 143.17 | 143.22 |
| | | | Trial 2 | | | |
| 95 | 4 | B | 146 | .074 | 143.88 | 143.95 |
| 95 | 5 | B | 146 | .079 | 151.76 | 151.84 |
| 95 | 6 | B | 146 | .085 | 142.14 | 142.23 |
| Ave. | | | 146 | .079 | 145.93 | 146.00 |
| 8 | 4 | A | 6 | .088 | 12.21 | 12.29 |
| 8 | 5 | A | 6 | .094 | 10.92 | 11.01 |
| 8 | 6 | A | 6 | .090 | 7.16 | 7.25 |
| Ave. | | | 6 | .091 | 10.10 | 10.18 |
| 5 | 4 | B | 146 | .066 | 135.60 | 135.67 |
| 5 | 5 | B | 146 | .064 | 147.48 | 148.12 |
| 5 | 6 | B | 146 | .084 | 140.29 | 140.37 |
| Ave. | | | 146 | .071 | 141.12 | 141.38 |
| 94 | 4 | A | 6 | .100 | 11.74 | 11.81 |
| 94 | 5 | A | 6 | .129 | 9.94 | 10.03 |
| 94 | 6 | A | 6 | .099 | 9.24 | 9.30 |
| Ave. | | | 6 | .109 | 10.30 | 10.38 |

TABLE VII

SODIUM BALANCE DATA
(Expressed in gms.)

| Steer No. | Period | Ration | Sodium Intake | Fecal Sodium | Urinary Sodium | Total Excreted |
|---|---|---|---|---|---|---|
| | | | Trial 1 | | | |
| 95 | 1 | A | 3.99 | 1.78 | 1.93 | 3.71 |
| 95 | 2 | A | 3.99 | 1.75 | 2.23 | 3.98 |
| 95 | 3 | A | 3.99 | 1.89 | 1.63 | 3.52 |
| Ave. | | | 3.99 | 1.81 | 1.93 | 3.74 |
| 8 | 1 | B | 94.54 | 6.69 | 80.54 | 87.23 |
| 8 | 2 | B | 94.54 | 6.83 | - | 87.37 |
| 8 | 3 | B | 94.54 | 7.05 | - | 87.59 |
| Ave. | | | 94.54 | 6.86 | 80.54 | 87.40 |
| 5 | 1 | A | 3.99 | 1.43 | 0.25 | 1.68 |
| 5 | 2 | A | 3.99 | 2.06 | 0.69 | 2.75 |
| 5 | 3 | A | 3.99 | 3.19 | 0.69 | 3.88 |
| Ave. | | | 3.99 | 2.23 | 0.54 | 2.77 |
| 94 | 1 | B | 94.54 | 5.50 | 81.01 | 86.51 |
| 94 | 2 | B | 94.54 | 5.09 | 87.26 | 92.35 |
| 94 | 3 | B | 94.54 | 3.95 | 75.78 | 79.73 |
| Ave. | | | 94.54 | 4.84 | 81.35 | 86.19 |
| | | | Trial 2 | | | |
| 95 | 4 | B | 94.54 | 1.60 | 92.10 | 93.70 |
| 95 | 5 | B | 94.54 | 0.79 | 89.99 | 90.78 |
| 95 | 6 | B | 94.54 | 0.97 | 84.46 | 85.43 |
| Ave. | | | 94.54 | 1.12 | 88.85 | 89.97 |
| 8 | 4 | A | 3.99 | 1.01 | 3.11 | 4.12 |
| 8 | 5 | A | 3.99 | 1.33 | 1.90 | 3.23 |
| 8 | 6 | A | 3.99 | 0.83 | 1.48 | 2.31 |
| Ave. | | | 3.99 | 1.06 | 2.16 | 3.22 |
| 5 | 4 | B | 94.54 | 0.88 | 82.49 | 83.37 |
| 5 | 5 | B | 94.54 | 1.01 | 71.60 | 72.61 |
| 5 | 6 | B | 94.54 | 2.01 | 79.80 | 81.81 |
| Ave. | | | 94.54 | 1.30 | 77.96 | 79.26 |
| 94 | 4 | A | 3.99 | 0.29 | 3.62 | 3.91 |
| 94 | 5 | A | 3.99 | 0.74 | 2.49 | 3.23 |
| 94 | 6 | A | 3.99 | 0.67 | 2.79 | 3.46 |
| Ave. | | | 3.99 | 0.57 | 2.96 | 3.53 |

TABLE VIII

POTASSIUM BALANCE DATA
(Expressed in gms.)

| Steer No. | Period | Ration | Potassium Intake | Potassium Fecal | Potassium Urinary | Total Excreted |
|---|---|---|---|---|---|---|
| | | | Trial 1 | | | |
| 95 | 1 | A | 27.41 | 5.62 | 28.37 | 33.99 |
| 95 | 2 | A | 27.41 | 3.48 | 28.31 | 31.79 |
| 95 | 3 | A | 27.41 | 3.96 | 29.21 | 33.17 |
| Ave. | | | 27.41 | 4.35 | 28.63 | 32.98 |
| 8 | 1 | B | 31.61 | 1.93 | 34.17 | 36.10 |
| 8 | 2 | B | 31.61 | 1.34 | - | - |
| 8 | 3 | B | 31.61 | 0.94 | - | - |
| Ave. | | | 31.61 | 1.40 | 34.17 | 36.10 |
| 5 | 1 | A | 27.41 | 10.44 | 21.66 | 32.10 |
| 5 | 2 | A | 27.41 | 6.95 | 26.93 | 33.88 |
| 5 | 3 | A | 27.41 | 6.33 | 25.33 | 31.66 |
| Ave. | | | 27.41 | 7.91 | 24.64 | 32.54 |
| 94 | 1 | B | 31.61 | 2.38 | 30.67 | 33.05 |
| 94 | 2 | B | 31.61 | 2.21 | 30.86 | 33.07 |
| 94 | 3 | B | 31.61 | 1.75 | 32.76 | 34.51 |
| Ave. | | | 31.61 | 2.11 | 31.43 | 33.54 |
| | | | Trial 2 | | | |
| 95 | 4 | B | 31.61 | 0.56 | 36.84 | 37.40 |
| 95 | 5 | B | 31.61 | 0.40 | 35.99 | 36.39 |
| 95 | 6 | B | 31.61 | 1.49 | 33.99 | 35.18 |
| Ave. | | | 31.61 | 0.72 | 35.61 | 36.33 |
| 8 | 4 | A | 27.41 | 0.53 | 38.76 | 39.29 |
| 8 | 5 | A | 27.41 | 0.90 | 36.03 | 36.93 |
| 8 | 6 | A | 27.41 | 0.93 | 26.01 | 26.94 |
| Ave. | | | 27.41 | 0.79 | 33.36 | 34.15 |
| 5 | 4 | B | 31.61 | 1.27 | 28.87 | 30.14 |
| 5 | 5 | B | 31.61 | 1.15 | 36.12 | 37.27 |
| 5 | 6 | B | 31.61 | 0.44 | 32.53 | 32.97 |
| Ave. | | | 31.61 | 0.95 | 32.51 | 33.46 |
| 94 | 4 | A | 27.41 | 1.42 | 31.93 | 33.35 |
| 94 | 5 | A | 27.41 | 1.44 | 31.41 | 32.85 |
| 94 | 6 | A | 27.41 | 1.35 | 37.16 | 38.51 |
| Ave. | | | 27.41 | 1.40 | 33.50 | 34.90 |

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